ABB Robotics

Technical reference manual
RAPID Instructions, Functions and Data types

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Technical reference manual
RAPID Instructions, Functions and Data types

RobotWare 5.13

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2 Functions 759

Overview

About this manual

This is a technical reference manual intended for the RAPID programmer. The RAPID base instructions, functions and data types are detailed in this manual.

Usage

This manual should be read during programming and when you need specific information about a RAPID instruction, function or data type.

Who should read this manual?

This manual is intended for someone with some previous experience in programming, for example, a robot programmer.

Prerequisites

The reader should have some programming experience and have studied

- Operating manual - Introduction to RAPID
- Technical reference manual - RAPID overview

Organization of chapters

The manual is organized in the following chapters:

Chapter	Contents
1. Instructions	Detailed descriptions of all RAPID base instructions, including examples of how to use them.
2. Functions	Detailed descriptions of all RAPID base functions, including examples of how to use them.
3. Data types	Detailed descriptions of all RAPID base data types, including examples of how to use them.
4. Programming type examples	A general view of how to write program code that contains different instructions/functions/data types. The chapter contains also programming tips and explanations.

References

Reference	Document ID
Operating manual - Introduction to RAPID	3HAC029364-001
Technical reference manual - RAPID overview	3HAC16580-1
Technical reference manual - RAPID kernel	3HAC16585-1

Continues on next page

Revisions

Revision	Description
F	7th edition. RobotWare 5.10. New chapter added, *4 Programming type examples*.
G	8th edition. RobotWare 5.11. New instructions, functions and data types are added. Also a new programming type example is added.
H	9th edition. RobotWare 5.12. New instructions, functions and data types are added.
J	10th edition. RobotWare 5.13. The following new instructions, functions and data types are added: • *TPReadNum - Reads a number from the FlexPendant on page 564* • *Type - Get the data type name for a variable on page 1030* • *UIDnumEntry - User Number Entry on page 1038* • *UIDnumTune - User Number Tune on page 1044* • *triggiosdnum - Positioning events, trigg on page 1217* Updated safety signal graphics for the levels *Danger* and *Warning*.

1 Instructions

1.1. AccSet - Reduces the acceleration

Usage

`AccSet` is used when handling fragile loads. It allows slower acceleration and deceleration, which results in smoother robot movements.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Basic examples

Basic examples of the instruction `AccSet` are illustrated below.

Example 1

```
AccSet 50, 100;
```

The acceleration is limited to 50% of the normal value.

Example 2

```
AccSet 100, 50;
```

The acceleration ramp is limited to 50% of the normal value.

Arguments

```
AccSet Acc Ramp
```

`Acc`

Data type: `num`

Acceleration and deceleration as a percentage of the normal values. 100% corresponds to maximum acceleration. Maximum value: 100%. Input value < 20% gives 20% of maximum acceleration.

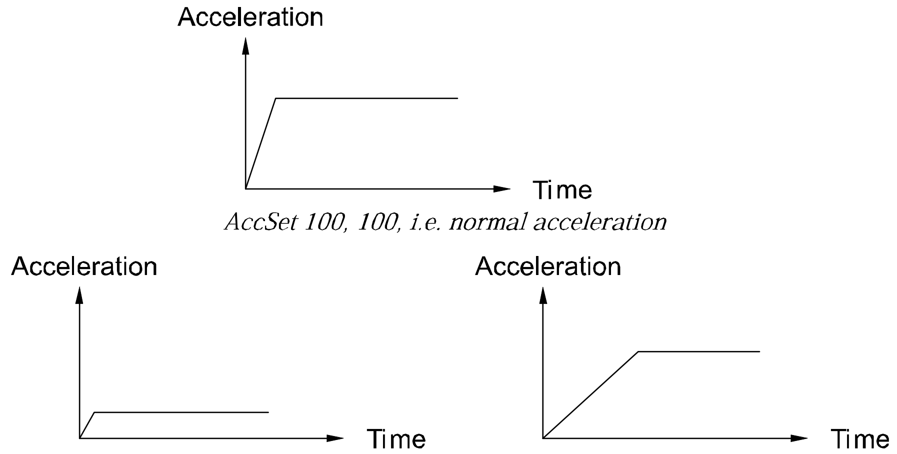
`Ramp`

Data type: `num`

The rate at which acceleration and deceleration increases as a percentage of the normal values. Jerking can be restricted by reducing this value. 100% corresponds to maximum rate. Maximum value: 100%. Input value < 10% gives 10% of maximum rate.

Continues on next page

The figures show that reducing the acceleration results in smoother movements.



AccSet 100, 100, i.e. normal acceleration

AccSet 30, 100

AccSet 100, 30

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Program execution

The acceleration applies to both the robot and external axes until a new `AccSet` instruction is executed.

The default values (100%) are automatically set

- at a cold start.
- when a new program is loaded.
- when starting program execution from the beginning.

Syntax

```
AccSet
  [ Acc ':=' ] < expression (IN) of num > ','
  [ Ramp ':=' ] < expression (IN) of num > ';'
```

Related information

For information about	See
Control acceleration in world coordinate system	*WorldAccLim - Control acceleration in world coordinate system on page 707*
Reduce TCP acceleration along the path	*PathAccLim - Reduce TCP acceleration along the path on page 295*
Positioning instructions	*Technical reference manual - RAPID overview*

1.2. ActUnit - Activates a mechanical unit

Usage

`ActUnit` is used to activate a mechanical unit.

It can be used to determine which unit is to be active when, for example, common drive units are used.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Basic examples

A basic example of the instruction `ActUnit` is illustrated below.

Example 1

```
ActUnit orbit_a;
```

Activation of the `orbit_a` mechanical unit.

Arguments

```
ActUnit MechUnit
```

`MechUnit`

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit that is to be activated.

Program execution

When the robots and external axes actual path is ready, the path on current path level is cleared and the specified mechanical unit is activated. This means that it is controlled and monitored by the robot.

If several mechanical units share a common drive unit, activation of one of these mechanical units will also connect that unit to the common drive unit.

Limitations

If this instruction is preceded by a move instruction, that move instruction must be programmed with a stop point (zonedata `fine`), not a fly-by point, otherwise restart after power failure will not be possible.

`ActUnit` cannot be executed in a RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart, Reset.or Step.

It is possible to use `ActUnit - DeactUnit` on `StorePath` level, but the same mechanical units must be active when doing `RestoPath` as when `StorePath` was done. Such operation on the Path Recorder and the path on the base level will be intact, but the path on the `StorePath` level will be cleared.

Syntax

```
ActUnit
  [MechUnit ':=' ] < variable (VAR) of mecunit> ';'
```


Continues on next page

Related information

For information about	See
Deactivating mechanical units	*DeactUnit - Deactivates a mechanical unit on page 79*
Mechanical units	*mecunit - Mechanical unit on page 1139*
More examples	*DeactUnit - Deactivates a mechanical unit on page 79*
Path Recorder	*PathRecMoveBwd - Move path recorder backwards on page 298*

1.3. Add - Adds a numeric value

Usage

`Add` is used to add or subtract a value to or from a numeric variable or persistent.

Basic examples

Basic examples of the instruction `Add` are illustrated below.

Example 1

```
Add reg1, 3;
```

`3` is added to `reg1`, i.e. `reg1:=reg1+3`.

Example 2

```
Add reg1, -reg2;
```

The value of `reg2` is subtracted from `reg1`, i.e. `reg1:=reg1-reg2`.

Example 3

```
VAR dnum mydnum:=5;
Add mydnum, 500000000;
```

`500000000` is added to `mydnum`, i.e. mynum:=mynum+500000000.

Example 4

```
VAR dnum mydnum:=5000;
VAR num mynum:=6000;
Add mynum, DnumToNum(mydnum \Integer);
```

`5000` is added to `mynum`, i.e. `mynum:=mynum+5000`. You have to use `DnumToNum` to get a `num` numeric value that you can use together with the `num` variable `mynum`.

Arguments

```
Add Name | Dname AddValue | AddDvalue
```

`Name`

Data type: `num`

The name of the variable or persistent to be changed.

`Dname`

Data type: `dnum`

The name of the variable or persistent to be changed.

`AddValue`

Data type: `num`

The value to be added.

`AddDvalue`

Data type: `dnum`

The value to be added.

Continues on next page

Limitations

If the value to be added is of the type `dnum`, and the variable/persistent that should be changed is a `num`, a runtime error will be generated. The combination of arguments is not possible (see Example 4 above how to solve this).

Syntax

```
Add
  [ Name ':=' ] < var or pers (INOUT) of num >
  | [ Dname' :=' ] < var or pers (INOUT) of dnum > ','
  [ AddValue ':=' ] < expression (IN) of num >
  | [ AddDvalue' :=' ] < expression (IN) of dnum > ';'
```

Related information

For information about	See
Incrementing a variable by 1	*Incr - Increments by 1 on page 131*
Decrementing a variable by 1	*Decr - Decrements by 1 on page 81*
Changing data using an arbitrary expression, e.g. multiplication	*":=" - Assigns a value on page 24*

1.4. AliasIO - Define I/O signal with alias name

Usage

`AliasIO` is used to define a signal of any type with an alias name or to use signals in built-in task modules.

Signals with alias names can be used for predefined generic programs, without any modification of the program before running in different robot installations.

The instruction `AliasIO` must be run before any use of the actual signal. See *Basic examples on page 21* for loaded modules, and *More examples on page 22* for installed modules.

Basic examples

A basic example of the instruction `AliasIO` is illustrated below.

See also *More examples on page 22*.

Example 1

```
VAR signaldo alias_do;
PROC prog_start()
  AliasIO config_do, alias_do;
ENDPROC
```

The routine `prog_start` is connected to the `START` event in system parameters. The program defining digital output signal `alias_do` is connected to the configured digital output signal `config_do` at program start.

Arguments

```
AliasIO FromSignal ToSignal
```

`FromSignal`

Data type: `signalxx` or `string`

Loaded modules:

The signal identifier named according to the configuration (data type `signalxx`) from which the signal descriptor is copied. The signal must be defined in the I/O configuration.

Installed modules or loaded modules:

A reference (`CONST`, `VAR` or parameter of these) containing the name of the signal (data type `string`) from which the signal descriptor after search in the system is copied. The signal must be defined in the I/O configuration.

`ToSignal`

Data type: `signalxx`

The signal identifier according to the program (data type `signalxx`) to which the signal descriptor is copied. The signal must be declared in the RAPID program.

The same data type must be used (or found) for the arguments `FromSignal` and `ToSignal` and must be one of type `signalxx` (`signalai`, `signalao`, `signaldi`, `signaldo`, `signalgi`, or `signalgo`).

Continues on next page

Program execution

The signal descriptor value is copied from the signal given in argument `FromSignal` to the signal given in argument `ToSignal`.

Error handling

Following recoverable errors can be generated. The errors can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_ALIASIO_DEF`	The `FromSignal` is not defined in the IO configuration or the `ToSignal` is not declared in the RAPID program or the `ToSignal` is defined in the IO configuration.
`ERR_ALIASIO_TYPE`	The data types for the arguments `FromSignal` and `ToSignal` is not the same type.

More examples

More examples of the instruction `AliasIO` are illustrated below.

Example 1

```
VAR signaldi alias_di;
PROC prog_start()
  CONST string config_string := "config_di";
  AliasIO config_string, alias_di;
ENDPROC
```

The routine `prog_start` is connected to the `START` event in system parameters. The program defined digital input signal `alias_di` is connected to the configured digital input signal `config_di` (via constant `config_string`) at program start.

Limitation

When starting the program, the alias signal cannot be used until the `AliasIO` instruction is executed.

Instruction `AliasIO` **must** be placed

- either in the event routine executed at program start (event `START`)
- or in the program part executed after every program start (before use of the signal)

In order to prevent mistakes it is not recommended to use dynamic reconnection of an `AliasIO` signal to different physical signals.

Syntax

```
AliasIO
  [ FromSignal ':=' ] < reference (REF) of anytype> ','
  [ ToSignal ':=' ] < variable (VAR) of anytype> ';'
```


Continues on next page

Related information

For information about	See
Input/Output instructions	*Technical reference manual - RAPID overview*
Input/Output functionality in general	*Technical reference manual - RAPID overview*
Configuration of I/O	*Technical reference manual - System parameters*
Defining event routines	*Technical reference manual - System parameters*
Loaded/Installed task modules	*Technical reference manual - System parameters*

1.5. ":=" - Assigns a value

Usage

The "`:=`" instruction is used to assign a new value to data. This value can be anything from a constant value to an arithmetic expression, e.g. `reg1`+5*`reg3`.

Basic examples

Basic examples of the instruction "`:=`" are illustrated below.

See also *More examples on page 24*.

Example 1

```
reg1 := 5;
```

`reg1` is assigned the value `5`.

Example 2

```
reg1 := reg2 - reg3;
```

`reg1` is assigned the value that the `reg2-reg3` calculation returns.

Example 3

```
counter := counter + 1;
```

`counter` is incremented by one.

Arguments

```
Data := Value
```

`Data`

Data type: `All`

The data that is to be assigned a new value.

`Value`

Data type: `Same as Data`

The desired value.

More examples

More examples of the instruction "`:=`" are illustrated below.

Example 1

```
tool1.tframe.trans.x := tool1.tframe.trans.x + 20;
```

The TCP for `tool1` is shifted `20` mm in the X-direction.

Example 2

```
pallet{5,8} := Abs(value);
```

An element in the `pallet` matrix is assigned a value equal to the absolute value of the `value` variable.

Continues on next page

Limitations

The data (whose value is to be changed) must not be

- a constant
- a non-value data type.

The data and value must have similar (the same or alias) data types.

Syntax

```
(EBNF)
<assignment target> ':=' <expression> ';'
<assignment target> ::=
          <variable>
          | <persistent>
          | <parameter>
          | <VAR>
```

Related information

For information about	See
Expressions	*Technical reference manual - RAPID overview*
Non-value data types	*Technical reference manual - RAPID overview*
Assigning an initial value to data	*Operating manual - IRC5 with FlexPendant*

1.6. BitClear - Clear a specified bit in a byte data

Usage

`BitClear` is used to clear (set to 0) a specified bit in a defined `byte` data.

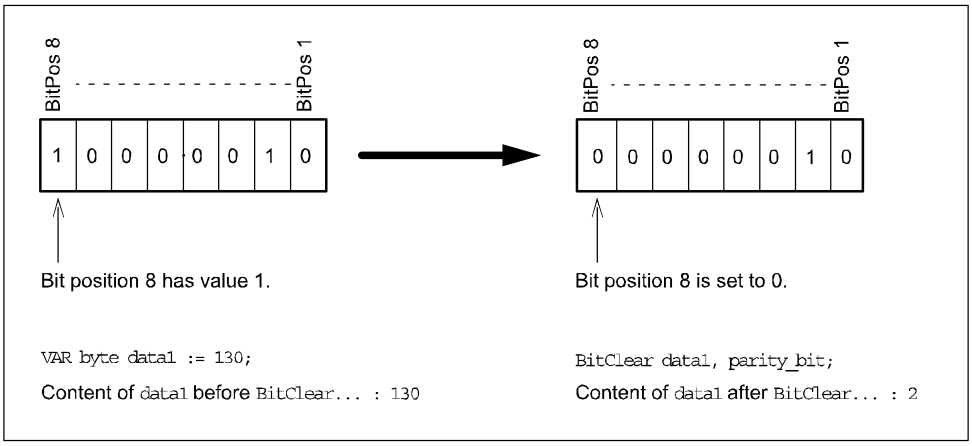
Basic examples

A basic example of the instruction `BitClear` is illustrated below.

Example 1

```
CONST num parity_bit := 8;
VAR byte data1 := 130;
BitClear data1, parity_bit;
```

Bit number `8` (parity_bit) in the variable `data1` will be set to 0, e.g. the content of the variable `data1` will be changed from 130 to 2 (integer representation). Bit manipulation of data type `byte` when using `BitClear` is illustrated in the figure below.



xx0500002147

Arguments

```
BitClear BitData BitPos
```

`BitData`

Data type: `byte`

The bit data, in integer representation, to be changed.

`BitPos`

Bit Position

Data type: `num`

The bit position (1-8) in the `BitData` to be set to 0.

Limitations

The range for a data type `byte` is 0 - 255 decimal.

The bit position is valid from 1 - 8.

Continues on next page

Syntax

```
BitClear
  [ BitData ':=' ] < var or pers (INOUT) of byte > ','
  [ BitPos ':=' ] < expression (IN) of num > ';'
```

Related information

For information about	See
Set a specified bit in a byte data	*BitSet - Set a specified bit in a byte data on page 28*
Check if a specified bit in a byte data is set	*BitCheck - Check if a specified bit in a byte data is set on page 772*
Other bit functions	*Technical reference manual - RAPID overview*

1.7. BitSet - Set a specified bit in a byte data

Usage

`BitSet` is used to set a specified bit to 1 in a defined byte data.

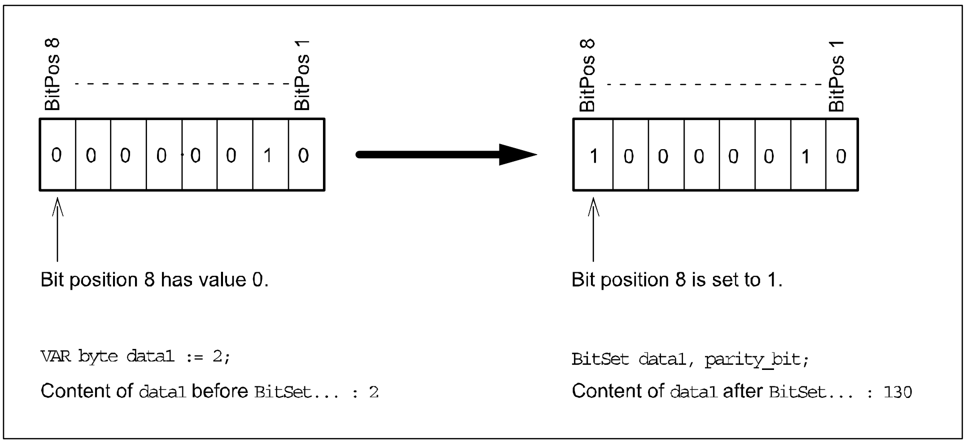
Basic examples

A basic example of the instruction `BitSet` is illustrated below.

Example 1

```
CONST num parity_bit := 8;
VAR byte data1 := 2;
BitSet data1, parity_bit;
```

Bit number 8 (`parity_bit`) in the variable `data1` will be set to `1`, e.g. the content of the variable `data1` will be changed from 2 to 130 (integer representation). Bit manipulation of data type `byte` when using `BitSet` is illustrated in the figure below.



xx0500002148

Arguments

```
BitSet BitData BitPos
```

`BitData`

Data type: `byte`

The bit data, in integer representation, to be changed.

`BitPos`

Bit Position

Data type: `num`

The bit position (1-8) in the `BitData` to be set to 1.

Limitations

The range for a data type `byte` is integer 0 - 255.

The bit position is valid from 1 - 8.

Continues on next page

Syntax

```
BitSet
  [ BitData':=' ] < var or pers (INOUT) of byte > ','
  [ BitPos':=' ] < expression (IN) of num > ';'
```

Related information

For information about	See
Clear a specified bit in a byte data	*BitClear - Clear a specified bit in a byte data on page 26*
Check if a specified bit in a byte data is set	*BitCheck - Check if a specified bit in a byte data is set on page 772*
Other bit functions	*Technical reference manual - RAPID overview*

1.8. BookErrNo - Book a RAPID system error number

Usage

`BookErrNo` is used to book a new RAPID system error number.

Basic examples

A basic example of the instruction `BookErrNo` is illustrated below.

Example 1

```
! Introduce a new error number in a glue system
! Note: The new error variable must be declared with the initial
     value -1
VAR errnum ERR_GLUEFLOW := -1;

! Book the new RAPID system error number
BookErrNo ERR_GLUEFLOW;
```

The variable `ERR_GLUEFLOW` will be assigned to a free system error number for use in the RAPID code.

```
! Use the new error number
IF di1 = 0 THEN
  RAISE ERR_GLUEFLOW;
ELSE
...
ENDIF

! Error handling
ERROR
  IF ERRNO = ERR_GLUEFLOW THEN
     ...
  ELSE
     ...
  ENDIF
```

If the digital input `di1` is `0`, the new booked error number will be raised and the system error variable `ERRNO` will be set to the new booked error number. The error handling of those user generated errors can then be handled in the error handler as usual.

Arguments

```
BookErrNo ErrorName
```

`ErrorName`

Data type: `errnum`

The new RAPID system error variable name.

Limitations

The new error variable must not be declared as a routine variable.

The new error variable must be declared with an initial value of -1, that gives the information that this error should be a RAPID system error.

Continues on next page

Syntax

```
BookErrNo
  [ ErrorName ':='] < variable (VAR) of errnum > ';'
```

Related information

For information about	See
Error handling	*Technical reference manual - RAPID overview*
Error number	*errnum - Error number on page 1108*
Call an error handler	*RAISE - Calls an error handler on page 334*

1.9. Break - Break program execution

Usage

`Break` is used to make an immediate break in program execution for RAPID program code debugging purposes. The robot movement is stopped at once.

Basic examples

A basic example of the instruction `Break` is illustrated below.

Example 1

```
...
Break;
...
```

Program execution stops and it is possible to analyze variables, values etc. for debugging purposes.

Program execution

The instruction stops program execution at once, without waiting for the robot and external axes to reach their programmed destination points for the movement being performed at the time. Program execution can then be restarted from the next instruction.

If there is a `Break` instruction in some routine event, the execution of the routine will be interrupted and no STOP routine event will be executed. The routine event will be executed from the beginning the next time the same event occurs.

Syntax

```
Break';'
```

Related information

For information about	See
Stopping for program actions	*Stop - Stops program execution on page 510*
Stopping after a fatal error	*EXIT - Terminates program execution on page 105*
Terminating program execution	*EXIT - Terminates program execution on page 105*
Only stopping robot movements	*StopMove - Stops robot movement on page 515*

1.10. CallByVar - Call a procedure by a variable

Usage

`CallByVar` (*Call By Variable*) can be used to call procedures with specific names, e.g. `proc_name1, proc_name2, proc_name3 ... proc_namex` via a variable.

Basic examples

A basic example of the instruction `CallByVar` is illustrated below.

See also *More examples on page 33*.

Example 1

```
reg1 := 2;
CallByVar "proc", reg1;
```

The procedure `proc2` is called.

Arguments

```
CallByVar Name Number
```

`Name`

Data type: `string`

The first part of the procedure name, e.g. `proc_name`.

`Number`

Data type: `num`

The numeric value for the number of the procedure. This value will be converted to a string and gives the 2nd part of the procedure name, e.g. `1`. The value must be a positive integer.

More examples

More examples of how to make static and dynamic selection of procedure call.

Example 1 - Static selection of procedure call

```
TEST reg1
  CASE 1:
     lf_door door_loc;
  CASE 2:
     rf_door door_loc;
  CASE 3:
     lr_door door_loc;
  CASE 4:
     rr_door door_loc;
  DEFAULT:
     EXIT;
ENDTEST
```

Depending on whether the value of register `reg1` is 1, 2, 3, or 4, different procedures are called that perform the appropriate type of work for the selected door. The door location in argument `door_loc`.

Continues on next page

Example 2 - Dynamic selection of procedure call with RAPID syntax

```
reg1 := 2;
%"proc"+NumToStr(reg1,0)% door_loc;
```

The procedure `proc2` is called with argument `door_loc`.

Limitation: All procedures must have a specific name e.g. `proc1, proc2, proc3`.

Example 3 - Dynamic selection of procedure call with CallByVar

```
reg1 := 2;
CallByVar "proc",reg1;
```

The procedure `proc2` is called.

Limitation: All procedures must have specific name, e.g. `proc1`, `proc2`, `proc3`, and no arguments can be used.

Limitations

Can only be used to call procedures without parameters.

Can not be used to call LOCAL procedures.

Execution of `CallByVar` takes a little more time than execution of a normal procedure call.

Error handling

In the argument `Number` is < 0 or is not an integer, the system variable ERRNO is set to ERR_ARGVALERR.

In reference to an unknown procedure, the system variable ERRNO is set to ERR_REFUNKPRC.

In procedure call error (not procedure), the system variable ERRNO is set to ERR_CALLPROC.

These errors can be handled in the error handler.

Syntax

```
CallByVar
  [Name ':='] <expression (IN) of string>','
  [Number ':='] <expression (IN) of num>';'
```

Related information

For information about	See
Calling procedures	*Technical reference manual - RAPID overview* *Operating manual - IRC5 with FlexPendant*

1.11. CancelLoad - Cancel loading of a module

Usage

`CancelLoad` can be used to cancel the loading operation generated from the instruction `StartLoad`.

`CancelLoad` can only be used between the instruction `StartLoad` and `WaitLoad`.

Basic examples

A basic example of the instruction `CancelLoad` is illustrated below.

See also *More examples on page 35*.

Example1

```
CancelLoad load1;
```

The load session `load1` is cancelled.

Arguments

```
CancelLoad LoadNo
```

`LoadNo`

Data type: `loadsession`

Reference to the load session, created by the instruction `StartLoad`.

More examples

More examples of how to use the instruction `CancelLoad` are illustrated below.

Example 1

```
VAR loadsession load1;

StartLoad "HOME:"\File:="PART_B.MOD",load1;
...
IF ...
  CancelLoad load1;
  StartLoad "HOME:"\File:="PART_C.MOD",load1;
ENDIF
...
WaitLoad load1;
```

The instruction `CancelLoad` will cancel the on-going loading of the module `PART_B.MOD` and instead make it possible to load `PART_C.MOD`.

Error handling

If the variable specified in argument `LoadNo` is not in use, meaning that no load session is in use, the system variable ERRNO is set to ERR_LOADNO_NOUSE. This error can then be handled in the error handler.

Limitation

`CancelLoad` can only be used in the sequence after that instruction `StartLoad` is ready and before instruction `WaitLoad` is started.

Continues on next page

Syntax

```
CancelLoad
  [ LoadNo ':=' ] < variable (VAR) of loadsession >';'
```

Related information

For information about	See
Load a program module during execution	*StartLoad - Load a program module during execution on page 482*
Connect the loaded module to the task	*WaitLoad - Connect the loaded module to the task on page 682*
Load session	*loadsession - Program load session on page 1138*
Load a program module	*Load - Load a program module during execution on page 208*
Unload a program module	*UnLoad - UnLoad a program module during execution on page 655*
Check program references	*CheckProgRef - Check program references on page 37*

1.12. CheckProgRef - Check program references

Usage

`CheckProgRef` is used to check for unresolved references at any time during execution.

Basic examples

A basic example of the instruction `CheckProgRef` is illustrated below.

Example 1

```
Load \Dynamic, diskhome \File:="PART_B.MOD" \CheckRef;
Unload "PART_A.MOD";
CheckProgRef;
```

In this case the program contains a module called `PART_A.MOD`. A new module `PART_B.MOD` is loaded, which checks if all references are OK. Then `PART_A.MOD` is unloaded. To check for unresolved references after unload, a call to `CheckProgRef` is done.

Program execution

Program execution forces a new link of the program task and checks for unresolved references.

If an error occurs during `CheckProgRef`, the program is not affected, it just tells you that an unresolved reference exists in the program task. Therefore, use `CheckProgRef` immediately after changing the number of modules in the program task (loading or unloading) to be able to know which module caused the link error.

This instruction can also be used as a substitute for using the optional argument `\CheckRef` in instruction `Load` or `WaitLoad`.

Error handling

If the program task contains unresolved references, the system variable ERRNO will be set to ERR_LINKREF, which can be handled in the error handler.

Syntax

```
CheckProgRef';'
```

Related information

For information about	See
Load of a program module	*Load - Load a program module during execution on page 208*
Unload of a program module	*UnLoad - UnLoad a program module during execution on page 655*
Start loading of a program module	*StartLoad - Load a program module during execution on page 482*
Finish loading of a program module	*WaitLoad - Connect the loaded module to the task on page 682*

1.13. CirPathMode - Tool reorientation during circle path

Usage

`CirPathMode` (*Circle Path Mode*) makes it possible to select different modes to reorientate the tool during circular movements.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system in Motion tasks.

Basic examples

Basic examples of the instruction `CirPathMode` are illustrated below.

Example 1

```
CirPathMode \PathFrame;
```

Standard mode for tool reorientation in the actual path frame from the start point to the `ToPoint` during all succeeding circular movements. This is default in the system.

Example 2

```
CirPathMode \ObjectFrame;
```

Modified mode for tool reorientation in actual object frame from the start point to the `ToPoint` during all succeeding circular movements.

Example 3

```
CirPathMode \CirPointOri;
```

Modified mode for tool reorientation from the start point via the programmed `CirPoint` orientation to the `ToPoint` during all succeeding circular movements.

Example 4

```
CirPathMode \Wrist45;
```

Modified mode such that the projection of the tool's z-axis onto the cut plane will follow the programmed circle segment. Only wrist axes 4 and 5 are used. This mode should only be used for thin objects.

Example 5

```
CirPathMode \Wrist46;
```

Modified mode such that the projection of the tool's z-axis onto the cut plane will follow the programmed circle segment. Only wrist axes 4 and 6 are used. This mode should only be used for thin objects.

Example 6

```
CirPathMode \Wrist56;
```

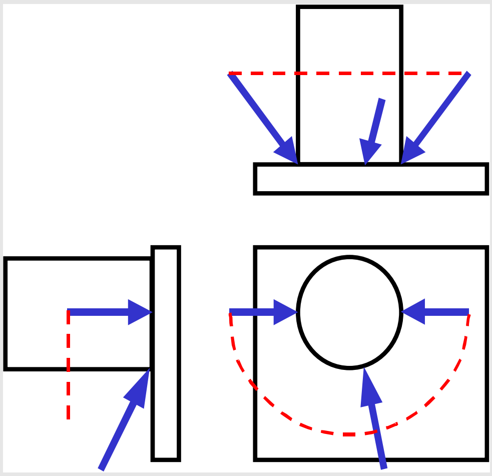
Modified mode such that the projection of the tool's z-axis onto the cut plane will follow the programmed circle segment. Only wrist axes 5 and 6 are used. This mode should only be used for thin objects.

Continues on next page

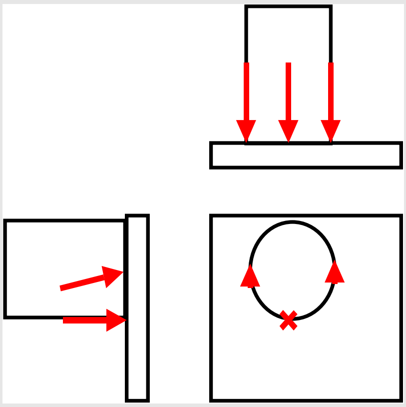
Description

PathFrame

The figure in the table shows the tool reorientation for the standard mode `\PathFrame`.

Illustration	Description
 xx0500002152	The arrows shows the tool from wrist center point to tool center point for the programmed points. The path for the wrist center point is dotted in the figure. The `\PathFrame` mode makes it easy to get the same angle of the tool around the cylinder. The robot wrist will not go through the programmed orientation in the `CirPoint`

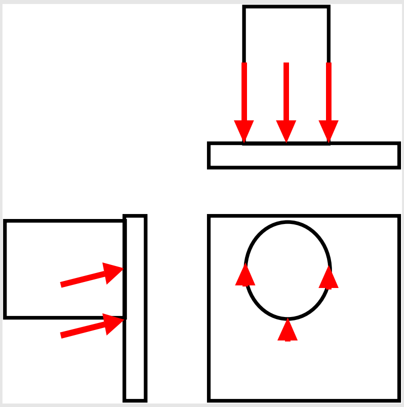
The figure in the table shows the use of standard mode `\PathFrame` with fixed tool orientation.

Illustration	Description
 xx0500002153	This picture shows the obtained orientation of the tool in the middle of the circle using a leaning tool and `\PathFrame` mode. Compare with the figure below when `\ObjectFrame` mode is used.

Continues on next page

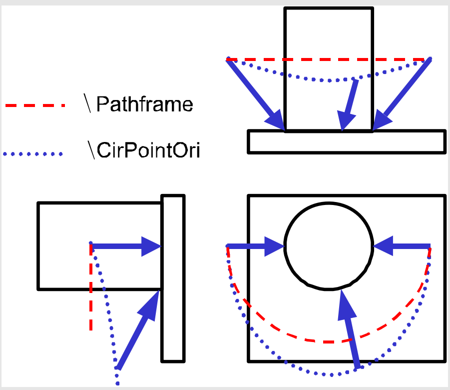
ObjectFrame

The figure in the table shows the use of modified mode `\ObjectFrame` with fixed tool orientation.

Illustration	Description
 xx0500002151	This picture shows the obtained orientation of the tool in the middle of the circle using a leaning tool and `\ObjectFrame` mode. This mode will make a linear reorientation of the tool in the same way as for `MoveL`. The robot wrist will not go through the programmed orientation in the `CirPoint`. Compare with the figure above when `\PathFrame` mode is used.

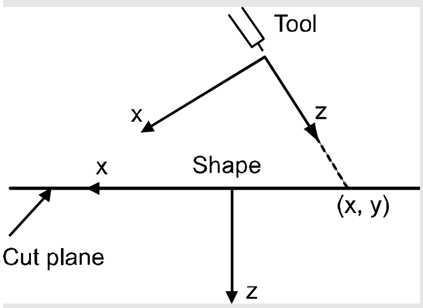
CirPointOri

The figure in the table shows the different tool reorientation between the standard mode `\PathFrame` and the modified mode `\CirPointOri`.

Illustration	Description
 xx0500002150	The arrows show the tool from wrist center point to tool center point for the programmed points. The different paths for the wrist center point are dashed in the figure. The `\CirPointOri` mode will make the robot wrist to go through the programmed orientation in the `CirPoint`.

Wrist45 / Wrist46 / Wrist56

The figure in the table shows the frames involved when cutting a shape using axes 4 and 5..

Illustration	Description
 xx0800000294	It is assumed that the cutting beam is aligned with the tool's z axis. The coordinate frame of the cut plane is defined by the robot's starting position when executing the MoveC instruction.

Continues on next page

Arguments

```
CirPathMode [\PathFrame] | [\ObjectFrame] | [\CirPointOri] |
     [\Wrist45] | [\Wrist46] | [\Wrist56]
```

`[ \PathFrame ]`

Data type: `switch`

During the circular movement the reorientation of the tool is done continuously from the start point orientation to the `ToPoint` orientation in the actual path frame. This is the standard mode in the system.

`[ \ObjectFrame ]`

Data type: `switch`

During the circular movement the reorientation of the tool is done continuously from the start point orientation to the `ToPoint` orientation in the actual object frame.

`[ \CirPointOri ]`

Data type: `switch`

During the circular movement the reorientation of the tool is done continuously from the start point orientation to the programmed `CirPoint` orientation and further to the `ToPoint` orientation.

`[ \Wrist45 ]`

Data type: `switch`

The robot will move axes 4 and 5 such that the projection of the tool's z-axis onto the cut plane will follow the programmed circle segment. This mode should only be used for thin objects as only 2 wrist axes are used and thus give us increased accuracy but also less control.

NOTE: This switch requires option Wrist Move.

`[ \Wrist46 ]`

Data type: `switch`

The robot will move axes 4 and 6 such that the projection of the tool's z-axis onto the cut plane will follow the programmed circle segment. This mode should only be used for thin objects as only 2 wrist axes are used and thus give us increased accuracy but also less control.

NOTE: This switch requires option Wrist Move.

`[ \Wrist56 ]`

Data type: `switch`

The robot will move axes 5 and 6 such that the projection of the tool's z-axis onto the cut plane will follow the programmed circle segment. This mode should only be used for thin objects as only 2 wrist axes are used and thus give us increased accuracy but also less control.

NOTE: This switch requires option Wrist Move.

If you use `CirPathMode` without any switch then result is the same as `CirPointMode \PathFrame`

Continues on next page

Program execution

The specified circular tool reorientation mode applies for the next executed robot circular movements of any type (`MoveC`, `SearchC`, `TriggC`, `MoveCDO`, `MoveCSync`, `ArcC`, `PaintC` ...) and is valid until a new `CirPathMode` (or obsolete `CirPathReori`) instruction is executed.

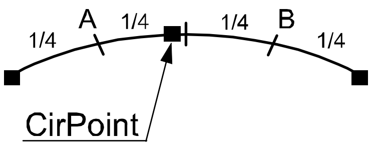
The standard circular reorientation mode (`CirPathMode \PathFrame`) is automatically set

- At a cold start-up.
- When a new program is loaded.
- When starting program execution from the beginning.

Limitations

The instruction only affects circular movements.

When using the `\CirPointOri` mode, the `CirPoint` must be between the points **A** and **B** according to the figure below to make the circle movement to go **through** the programmed orientation in the `CirPoint`.



xx0500002149

`\Wrist45`, `\Wrist46`, and `\Wrist56` mode should only be used for cutting thin objects as the ability to control the angle of the tool is lost when using only two wrist axes. Coordinated movements are not possible since the main axis is locked.

If working in wrist singularity area and the instruction `SingArea\Wrist` has been executed, the instruction `CirPathMode` has no effect because the system then selects another tool reorientation mode for circular movements (joint interpolation).

This instruction replaces the old instruction `CirPathReori` (will work even in the future but will not be documented any more).

Syntax

```
CirPathMode
  ['\'PathFrame] | ['\'ObjectFrame] | ['\'CirPointOri] |
       ['\'Wrist45] | ['\'Wrist46] | ['\'Wrist56] ';'
```

Related information

For information about	See
Interpolation	*Technical reference manual - RAPID overview*
Motion settings data	*motsetdata - Motion settings data on page 1141*
Circular move instruction	*MoveC - Moves the robot circularly on page 236*
Wrist movements	*Application manual - Motion Performance*, section *Wrist Move*

1.14. Clear - Clears the value

Usage

`Clear` is used to clear a numeric variable or persistent , i.e. set it to 0.

Basic examples

Basic examples of the instruction `Clear` are illustrated below.

Example 1

```
Clear reg1;
```

`Reg1` is cleared, i.e. `reg1:=0`.

Example 2

```
CVAR dnum mydnum:=5;
Clear mydnum;
```

`mydnum` is cleared, i.e. `mydnum:=0`.

Arguments

```
Clear Name | Dname
```

`Name`

Data type: `num`

The name of the variable or persistent to be cleared.

`Dname`

Data type: `dnum`

The name of the variable or persistent to be cleared.

Syntax

```
Clear
  [ Name ':=' ] < var or pers (INOUT) of num >
  | [ Dname ':=' ] < var or pers (INOUT) of dnum > ';'
```

Related information

For information about	See
Incrementing a variable by 1	*Incr - Increments by 1 on page 131*
Decrementing a variable by 1	*Decr - Decrements by 1 on page 81*
Adding any value to a variable	*Add - Adds a numeric value on page 19*
Changing data using arbitrary	*":=" - Assigns a value on page 24*

1.15. ClearIOBuff - Clear input buffer of a serial channel

Usage

`ClearIOBuff` (*Clear I/O Buffer*) is used to clear the input buffer of a serial channel. All buffered characters from the input serial channel are discarded.

Basic examples

A basic example of the instruction `ClearIOBuff` is illustrated below.

Example 1

```
VAR iodev channel2;
...
Open "com2:", channel2 \Bin;
ClearIOBuff channel2;
WaitTime 0.1;
```

The input buffer for the serial channel referred to by `channel2` is cleared. The wait time guarantees the clear operation enough time to finish.

Arguments

```
ClearIOBuff IODevice
```

`IODevice`

Data type: `iodev`

The name (reference) of the serial channel whose input buffer is to be cleared.

Program execution

All buffered characters from the input serial channel are discarded. Next read instructions will wait for new input from the channel.

Limitations

This instruction can only be used for serial channels. Do not wait for acknowledgement of the operation to finish. Allow a wait time 0.1 after the instruction is recommended to give the operation enough time in every application.

Error handling

If trying to use the instruction on a file, the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

Syntax

```
ClearIOBuff
  [IODevice ':='] <variable (VAR) of iodev>';'
```

Related information

For information about	See
Opening a serial channel	*Technical reference manual - RAPID overview*

1.16. ClearPath - Clear current path

Usage

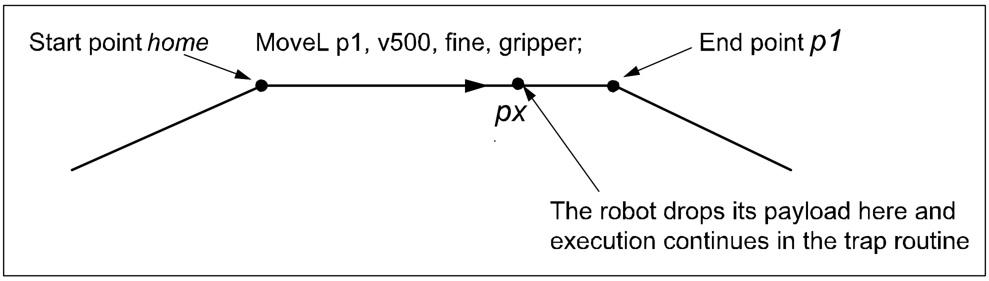
`ClearPath` (*Clear Path*) clears the whole motion path on the current motion path level (base level or `StorePath` level).

With motion path, meaning all the movement segments from any move instructions which have been executed in RAPID but not performed by the robot at the execution time of `ClearPath`.

The robot must be in a stop point position or must be stopped with `StopMove` before the instruction `ClearPath` can be executed.

Basic examples

Basic examples of the instruction `ClearPath` are illustrated below.



xx0500002154

In the following program example, the robot moves from the position `home` to the position `p1`. At the point `px` the signal `di1` will indicate that the payload has been dropped. The execution continues in the trap routine `gohome`. The robot will stop moving (start the braking) at `px`, the path will be cleared, the robot will move to position `home`. The error will be raised up to the calling routine `minicycle` and the whole user defined program cycle `proc1 .. proc2` will be executed from the beginning one more time.

Example 1

```
VAR intnum drop_payload;
VAR errnum ERR_DROP_LOAD := -1;

PROC minicycle()
  BookErrNo ERR_DROP_LOAD;
  proc1;
  ...
  ERROR (ERR_DROP_LOAD)
     RETRY;
ENDPROC

PROC proc1()
   ...
  proc2;
  ...
ENDPROC
```


Continues on next page

```
PROC proc2()
  CONNECT drop_payload WITH gohome;
  ISignalDI \Single, di1, 1, drop_payload;
  MoveL p1, v500, fine, gripper;
  ...........
  IDelete drop_payload
ENDPROC

TRAP gohome
  StopMove \Quick;
  ClearPath;
  IDelete drop_payload;
  StorePath;
  MoveL home, v500, fine, gripper;
  RestoPath;
  RAISE ERR_DROP_LOAD;
  ERROR
     RAISE;
ENDTRAP
```

If the same program is being run but **without** `StopMove` **and** `ClearPath` in the trap routine `gohome`, the robot will continue to position `p1` before going back to position `home`.

If programming `MoveL home` with flying-point (zone) instead of stop-point (`fine`), the movement is going on during the `RAISE` to the error handler in procedure `minicycle` and further until the movement is ready.

Limitations

Limitation examples of the instruction `ClearPath` are illustrated below.

Example 1 - Limitation

```
VAR intnum int_move_stop;
...
PROC test_move_stop()
  CONNECT int_move_stop WITH trap_move_stop;
  ISignalDI di1, 1, int_move_stop;
  MoveJ p10, v200, z20, gripper;
  MoveL p20, v200, z20, gripper;
ENDPROC

TRAP trap_move_stop
  StopMove;
  ClearPath;
  StartMove;
  StorePath;
  MoveJ p10, v200, z20, gripper;
  RestoPath;
ENDTRAP
```


Continues on next page

This is an example of `ClearPath` limitation. During the robot movement to `p10` and `p20`, the ongoing movement is stopped and the motion path is cleared, but no action is done to break off the active instruction `MoveJ p10` or `MoveL p20` in the `PROC test_move_stop`. So the ongoing movement will be interrupted and the robot will go to `p10` in the `TRAP trap_move_stop`, but no further movement to `p10` or `p20` in the `PROC test_move_stop` will be done. The program execution will be hanging.

This problem can be solved with either error recovery with long jump as described in example 2 below or with asynchronously raised error with instruction `ProcerrRecovery`.

Example 2 - No limitations

```
VAR intnum int_move_stop;
VAR errnum err_move_stop := -1;
...
PROC test_move_stop()
  BookErrNo err_move_stop;
  CONNECT int_move_stop WITH trap_move_stop;
  ISignalDI di1, 1, int_move_stop;
  MoveJ p10, v200, z20, gripper;
  MoveL p20, v200, z20, gripper;
  ERROR (err_move_stop)
     StopMove;
     ClearPath;
     StartMove;
     StorePath;
     MoveJ p10, v200, z20, gripper;
     RestoPath;
     RETRY;
ENDPROC

TRAP trap_move_stop
  RAISE err_move_stop;
  ERROR
     RAISE;
ENDTRAP
```

This is an example of how to use error recovery with long jump together with `ClearPath` without any limitation. During the robot movement to `p10` and `p20`, the ongoing movement is stopped. The motion path is cleared, and because of error recovery through execution level boundaries, break off is done of the active instruction `MoveJ p10` or `MoveL p20`. So the ongoing movement will be interrupted and the robot will go to `p10` in the `ERROR handler`, and once more execute the interrupted instruction `MoveJ p10` or `MoveL p20` in the `PROC test_move_stop`.

Syntax

```
ClearPath ';'
```

Continues on next page

Related information

For information about	See
Stop robot movements	*StopMove - Stops robot movement on page 515*
Error recovery	*Technical reference manual - RAPID overview* *Technical reference manual - RAPID kernel*
Asynchronously raised error	*ProcerrRecovery - Generate and recover from process-move error on page 325*

1.17. ClearRawBytes - Clear the contents of rawbytes data

Usage

`ClearRawBytes` is used to set all the contents of a `rawbytes` variable to 0.

Basic examples

A basic example of the instruction is illustrated below.

Example 1

```
VAR rawbytes raw_data;
VAR num integer := 8
VAR num float := 13.4;

PackRawBytes integer, raw_data, 1 \IntX := DINT;
PackRawBytes float, raw_data, (RawBytesLen(raw_data)+1) \Float4;

ClearRawBytes raw_data \FromIndex := 5;
```

In the first 4 bytes the value of `integer` is placed (from index 1) and in the next 4 bytes starting from index 5 the value of `float`.

The last instruction in the example clears the contents of `raw_data`, starting at index 5, i.e. `float` will be cleared, but `integer` is kept in `raw_data`. Current length of valid bytes in `raw_data` is set to 4.

Arguments

```
ClearRawBytes RawData [ \FromIndex ]
```

`RawData`

Data type: `rawbytes`

`RawData` is the data container which will be cleared.

`[ \FromIndex ]`

Data type: `num`

With `\FromIndex` it is specified where to start clearing the contents of `RawData`. Everything is cleared to the end.

If `\FromIndex` is not specified, all data starting at index 1 is cleared.

Program execution

Data from index 1 (default) or from `\FromIndex` in the specified variable is reset to 0.

The current length of valid bytes in the specified variable is set to 0 (default) or to (`FromIndex` - 1) if `\FromIndex` is programmed.

Syntax

```
ClearRawBytes
  [RawData ':=' ] < variable (VAR) of rawbytes>
  ['\'FromIndex ':=' <expression (IN) of num>]';'
```


Continues on next page

Related information

For information about	See
`rawbytes` data	*rawbytes - Raw data on page 1165*
Get the length of `rawbytes` data	*RawBytesLen - Get the length of rawbytes data on page 940*
Copy the contents of `rawbytes` data	*CopyRawBytes - Copy the contents of rawbytes data on page 67*
Pack DeviceNet header into `rawbytes` data	*PackDNHeader - Pack DeviceNet Header into rawbytes data on page 287*
Pack data into `rawbytes` data	*PackRawBytes - Pack data into rawbytes data on page 290*
Write `rawbytes` data	*WriteRawBytes - Write rawbytes data on page 725*
Read `rawbytes` data	*ReadRawBytes - Read rawbytes data on page 352*
Unpack data from `rawbytes` data	*UnpackRawBytes - Unpack data from rawbytes data on page 658*

1.18. ClkReset - Resets a clock used for timing

Usage

`ClkReset` is used to reset a clock that functions as a stop-watch used for timing.

This instruction can be used before using a clock to make sure that it is set to 0.

Basic examples

A basic example of the instruction `ClkReset` is illustrated below.

Example 1

```
ClkReset clock1;
```

The clock `clock1` is reset.

Arguments

```
ClkReset Clock
```

`Clock`

Data type: `clock`

The name of the clock to reset.

Program execution

When a clock is reset, it is set to 0.

If a clock is running it will be stopped and then reset.

Syntax

```
ClkReset
  [ Clock ':=' ] < variable (VAR) of clock > ';'
```

Related Information

For information about	See
Other clock instructions	*Technical reference manual - RAPID overview*

1.19. ClkStart - Starts a clock used for timing

Usage

`ClkStart` is used to start a clock that functions as a stop-watch used for timing.

Basic examples

A basic example of the instruction `ClkStart` is illustrated below.

Example 1

```
ClkStart clock1;
```

The clock `clock1` is started.

Arguments

```
ClkStart Clock
```

`Clock`

Data type: `clock`

The name of the clock to start.

Program execution

When a clock is started, it will run and continue counting seconds until it is stopped.

A clock continues to run when the program that started it is stopped. However, the event that you intended to time may no longer be valid. For example, if the program was measuring the waiting time for an input, the input may have been received while the program was stopped. In this case, the program will not be able to “see” the event that occurred while the program was stopped.

A clock continues to run when the robot is powered down as long as the battery back-up retains the program that contains the clock variable.

If a clock is running it can be read, stopped, or reset.

More examples

More examples of the instruction `ClkStart` are illustrated below.

Example 1

```
VAR clock clock2;
VAR num time;

ClkReset clock2;
ClkStart clock2;
WaitUntil di1 = 1;
 ClkStop clock2;
time:=ClkRead(clock2);
```

The waiting time for `di1` to become 1 is measured.

Continues on next page

Error handling

If the clock runs for 4,294,967 seconds (49 days 17 hours 2 minutes 47 seconds) it becomes overflowed and the system variable `ERRNO` is set to `ERR_OVERFLOW`.

The error can be handled in the error handler.

Syntax

```
ClkStart
  [ Clock ':=' ] < variable (VAR) of clock >';'
```

Related Information

For information about	See
Other clock instructions	*Technical reference manual - RAPID overview*

1.20. ClkStop - Stops a clock used for timing

Usage

`ClkStop` is used to stop a clock that functions as a stop-watch used for timing.

Basic examples

A basic example of the instruction `ClkStop` is illustrated below.

```
ClkStop clock1;
```

The clock `clock1` is stopped.

Arguments

```
ClkStop Clock
```

`Clock`

Data type: `clock`

The name of the clock to stop.

Program execution

When a clock is stopped, it will stop running.

If a clock is stopped, it can be read, started again, or reset.

Error handling

If the clock runs for 4,294,967 seconds (49 days 17 hours 2 minutes 47 seconds) it becomes overflowed and the system variable ERRNO is set to ERR_OVERFLOW.

The error can be handled in the error handler.

Syntax

```
ClkStop
[ Clock ':=' ] < variable (VAR) of clock >';'
```

Related Information

For information about	See
Other clock instructions	*Technical reference manual - RAPID overview*
More examples	*ClkStart - Starts a clock used for timing on page 52*

1.21. Close - Closes a file or serial channel

Usage

`Close` is used to close a file or serial channel.

Basic examples

A basic example of the instruction `Close` is illustrated below.

Example 1

```
Close channel2;
```

The serial channel referred to by `channel2` is closed.

Arguments

```
Close IODevice
```

`IODevice`

Data type: `iodev`

The name (reference) of the file or serial channel to be closed.

Program execution

The specified file or serial channel is closed and must be re-opened before reading or writing. If it is already closed the instruction is ignored.

Syntax

```
Close
  [IODevice ':='] <variable (VAR) of iodev>';'
```

Related information

For information about	See
Opening a file or serial channel	*Technical reference manual - RAPID overview*

1.22. CloseDir - Close a directory

Usage

`CloseDir` is used to close a directory in balance with `OpenDir`.

Basic examples

A basic example of the instruction `CloseDir` is illustrated below.

Example 1

```
PROC lsdir(string dirname)
  VAR dir directory;
  VAR string filename;
  OpenDir directory, dirname;
  WHILE ReadDir(directory, filename) DO
     TPWrite filename;
ENDWHILE
CloseDir directory;
ENDPROC
```

This example prints out the names of all files or subdirectories under the specified directory.

Arguments

```
CloseDir Dev
```

`Dev`

Data type: `dir`

A variable with reference to the directory fetched with instruction `OpenDir`.

Syntax

```
CloseDir
  [ Dev ':=' ] < variable (VAR) of dir>';'
```

Related information

For information about	See
Directory	*dir - File directory structure on page 1103*
Make a directory	*MakeDir - Create a new directory on page 218*
Open a directory	*OpenDir - Open a directory on page 285*
Read a directory	*ReadDir - Read next entry in a directory on page 944*
Remove a directory	*RemoveDir - Delete a directory on page 355*
Remove a file	*RemoveFile - Delete a file on page 356*
Rename a file	*RenameFile - Rename a file on page 357*

1.23. Comment - Comment

Usage

`Comment` is only used to make the program easier to understand. It has no effect on the execution of the program.

Basic examples

A basic example of the instruction `Comment` is illustrated below.

Example 1

```
! Goto the position above pallet
MoveL p100, v500, z20, tool1;
```

A comment is inserted into the program to make it easier to understand.

Arguments

```
! Comment
```

`Comment`

Text string

Any text.

Program execution

Nothing happens when you execute this instruction.

Syntax

```
(EBNF)
'!' {<character>} <newline>
```

Related information

For information about	See
Characters permitted in a comment	*Technical reference manual - RAPID overview*
Comments within data and routine declarations	*Technical reference manual - RAPID overview*

1.24. Compact IF - If a condition is met, then... (one instruction)

Usage

`Compact IF` is used when a single instruction is only to be executed if a given condition is met.

If different instructions are to be executed, depending on whether the specified condition is met or not, the `IF` instruction is used.

Basic examples

Basic examples of the instruction `CompactIF` are illustrated below.

Example 1

```
IF reg1 > 5 GOTO next;
```

If `reg1` is greater than `5`, program execution continues at the `next` label.

Example 2

```
IF counter > 10 Set do1;
```

The `do1` signal is set if `counter > 10`.

Arguments

```
IF Condition ...
```

Condition

Data type: `bool`

The condition that must be satisfied for the instruction to be executed.

Syntax

```
(EBNF)
IF <conditional expression> ( <instruction> | <SMT>) ';'
```

Related information

For information about	See
Conditions (logical expressions	*Technical reference manual - RAPID overview*
IF with several instructions	*IF - If a condition is met, then ...; otherwise ... on page 129*

1.25. ConfJ - Controls the configuration during joint movement

Usage

`ConfJ` (*Configuration Joint*) is used to specify whether or not the robot's configuration is to be controlled during joint movement. If it is not controlled, the robot can sometimes use a different configuration than that which was programmed.

With `ConfJ \Off`, the robot cannot switch main axis configuration - it will search for a solution with the same main axis configuration as the current one, but it moves to the closest wrist configuration for axes 4 and 6.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Basic examples

Basic examples of the instruction `ConfJ` are illustrated below.

Example 1

```
ConfJ \Off;
MoveJ *, v1000, fine, tool1;
```

The robot moves to the programmed position and orientation. If this position can be reached in several different ways, with different axis configurations, the closest possible position is chosen.

Example 2

```
ConfJ \On;
MoveJ *, v1000, fine, tool1;
```

The robot moves to the programmed position, orientation and axis configuration. If this is not possible, program execution stops.

Arguments

```
ConfJ [\On] | [\Off]
```

`[ \On ]`

Data type: `switch`

The robot always moves to the programmed axis configuration. If this is not possible using the programmed position and orientation, program execution stops.

The IRB5400 robot will move to the programmed axis configuration or to an axis configuration close the the programmed one. Program execution will not stop if it is impossible to reach the programmed axis configuration.

`[ \Off ]`

Data type: `switch`

The robot always moves to the closest axis configuration.

Continues on next page

Program execution

If the argument `\On` (or no argument) is chosen, the robot always moves to the programmed axis configuration. If this is not possible using the programmed position and orientation, program execution stops before the movement starts.

If the argument `\Off` is chosen, the robot always moves to the closest axis configuration. This may be different to the programmed one if the configuration has been incorrectly specified manually, or if a program displacement has been carried out.

To control the configuration (`ConfJ \On`) is active by default. This is automatically set:

- At a cold start-up.
- When a new program is loaded.
- When starting program execution from the beginning.

Syntax

```
ConfJ
  [ '\' On] | [ '\' Off]';'
```

Related information

For information about	See
Handling different configurations	*Technical reference manual - RAPID overview*
Robot configuration during linear movement	*ConfL - Monitors the configuration during linear movement on page 61*

1.26. ConfL - Monitors the configuration during linear movement

Usage

`ConfL` (*Configuration Linear*) is used to specify whether or not the robot's configuration is to be monitored during linear or circular movement. If it is not monitored, the configuration at execution time may differ from that at programmed time. It may also result in unexpected sweeping robot movements when the mode is changed to joint movement.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

NOTE!

For the IRB 5400 robot monitoring is always off independent of what is specified in `ConfL`.

Basic examples

Basic examples of the instruction `ConfL` are illustrated below.

Example 1

```
ConfL \On;
MoveL *, v1000, fine, tool1;
```

Program execution stops when the programmed configuration is not possible to reach from the current position.

Example 2

```
SingArea \Wrist;
ConfL \On;
MoveL *, v1000, fine, tool1;
```

The robot moves to the programmed position, orientation and wrist axis configuration. If this is not possible, program execution stops.

Example 3

```
ConfL \Off;
MoveL *, v1000, fine, tool1;
```

The robot moves to the programmed position and orientation but to the closest possible axis configuration, which can be different from the programmed.

Arguments

```
ConfL [\On] | [\Off]
```

`[ \On ]`

Data type: `switch`

The robot configuration is monitored.

`[ \Off ]`

Data type: `switch`

The robot configuration is not monitored.

Continues on next page

Program execution

During linear or circular movement, the robot always moves to the programmed position and orientation that has the closest possible axis configuration. If the argument `\On` (or no argument) is chosen, then the program execution stops as soon as there's a risk that the configuration of the programmed position will not be attained from the current position.

However, it is possible to restart the program again, although the wrist axes may continue to be the wrong configuration. At a stop point, the robot will check that the configurations of all axes are achieved, not only the wrist axes.

If `SingArea\Wrist` is also used, the robot always moves to the programmed wrist axis configuration and at a stop point the remaining axes configurations will be checked.

If the argument `\Off` is chosen, there is no monitoring.

A simple rule to avoid problems, both for `ConfL\On` and `\Off`, is to insert intermediate points to make the movement of each axis less than 90 degrees between points. More precisely, the sum of movements for any of the par of axes (1+4), (1+6), (3+4) or (3+6) should not exceed 180 degrees.

If `ConfL\Off` is used with a big movement, it can cause stops directly or later in the program with error `50050 Position outside` reach or `50080 Position not compatible`. In a program with `ConfL\Off` it is recommended to have movements to known configurations points with“`ConfJ\On` + `MoveJ`” or “`ConfL\On` + `SingArea\Wrist` + `MoveL`” as start points for different program parts.

Monitoring is active by default. This is automatically set:

- At a cold start-up.
- When a new program is loaded.
- When starting program execution from the beginning.

Syntax

```
ConfL
  [ '\' On] | [ '\' Off]';'
```

Related information

For information about	See
Handling different configurations	*Technical reference manual - RAPID overview*
Robot configuration during joint movement	*ConfJ - Controls the configuration during joint movement on page 59*
Define interpolation around singular points	*SingArea - Defines interpolation around singular points on page 447*

1.27. CONNECT - Connects an interrupt to a trap routine

Usage

`CONNECT` is used to find the identity of an interrupt and connect it to a trap routine.

The interrupt is defined by ordering an interrupt event and specifying its identity. Thus, when that event occurs, the trap routine is automatically executed.

Basic examples

A basic example of the instruction `CONNECT` is illustrated below.

Example 1

```
VAR intnum feeder_low;
CONNECT feeder_low WITH feeder_empty;
ISignalDI di1, 1 , feeder_low;
```

An interrupt identity `feeder_low` is created which is connected to the trap routine `feeder_empty`. There will be an interrupt when input `di1` is getting high. In other words, when this signal becomes high, the `feeder_empty` trap routine is executed.

Arguments

```
CONNECT Interrupt WITH Trap routine
```

`Interrupt`

Data type: `intnum`

The variable that is to be assigned the identity of the interrupt. This must not be declared within a routine (routine data).

`Trap routine`

Identifier

The name of the trap routine.

Program execution

The variable is assigned an interrupt identity which shall be used when ordering or disabling interrupts. This identity is also connected to the specified trap routine.

NOTE!

All interrupts in a task are cancelled when program pointer is set to main for that task and must be reconnected. The interrupts will not be affected by a power fail or a warm start.

Limitations

An interrupt (interrupt identity) cannot be connected to more than one trap routine. Different interrupts, however, can be connected to the same trap routine.

When an interrupt has been connected to a trap routine, it cannot be reconnected or transferred to another routine; it must first be deleted using the instruction `IDelete`.

Interrupts that come or have not been handled when program execution is stopped will be neglected. The interrupts are not considered when stopping the program.

Continues on next page

Error handling

If the interrupt variable is already connected to a `TRAP` routine, the system variable `ERRNO` is set to `ERR_ALRDYCNT`.

If the interrupt variable is not a variable reference, the system variable `ERRNO` is set to `ERR_CNTNOTVAR`.

If no more interrupt numbers are available, the system variable `ERRNO` is set to `ERR_INOMAX`.

These errors can be handled in the `ERROR` handler.

Syntax

```
(EBNF)
CONNECT <connect target> WITH <trap>';'

<connect target> ::= <variable>
                  | <parameter>
                  | <VAR>
<trap> ::= <identifier>
```

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*
More information on interrupt management	*Technical reference manual - RAPID overview*
Data type for interrupt	*intnum - Interrupt identity on page 1125*
Cancelling an interrupt	*IDelete - Cancels an interrupt on page 123*

1.28. CopyFile - Copy a file

Usage

`CopyFile` is used to make a copy of an existing file.

Basic examples

A basic example of the instruction `CopyFile` is illustrated below.

Example 1

CopyFile "HOME:/myfile", "HOME:/yourfile";

The file `myfile` is copied to `yourfile`. Both files are then identical.

```
CopyFile "HOME:/myfile", "HOME:/mydir/yourfile";
```

The file `myfile` is copied to `yourfile` in directory `mydir`.

Arguments

```
CopyFile OldPath NewPath
```

`OldPath`

Data type: `string`

The complete path of the file to be copied from.

`NewPath`

Data type: `string`

The complete path where the file is to be copied to.

Program execution

The file specified in `OldPath` will be copied to the file specified in `NewPath`.

Error Handling

If the file specified in `NewPath` already exists, the system variable `ERRNO` is set to `ERR_FILEEXIST`. This error can then be handled in the error handler.

Syntax

```
CopyFile
[ OldPath ':=' ] < expression (IN) of string > ','
[ NewPath ':=' ] < expression (IN) of string >';'
```


Continues on next page

Related information

For information about	See
Make a directory	*MakeDir - Create a new directory on page 218*
Remove a directory	*RemoveDir - Delete a directory on page 355*
Rename a file	*RenameFile - Rename a file on page 357*
Remove a file	*RemoveFile - Delete a file on page 356*
Check file type	*IsFile - Check the type of a file on page 878*
Check file size	*FileSize - Retrieve the size of a file on page 842*
Check file system size	*FSSize - Retrieve the size of a file system on page 848*

1.29. CopyRawBytes - Copy the contents of rawbytes data

Usage

`CopyRawBytes` is used to copy all or part of the contents from one `rawbytes` variable to another.

Basic examples

A basic example of the instruction `CopyRawBytes` is illustrated below.

Example 1

```
VAR rawbytes from_raw_data;
VAR rawbytes to_raw_data;
VAR num integer := 8
VAR num float := 13.4;

ClearRawBytes from_raw_data;
PackRawBytes integer, from_raw_data, 1 \IntX := DINT;
PackRawBytes float, from_raw_data, (RawBytesLen(from_raw_data)+1)
     \Float4;
CopyRawBytes from_raw_data, 1, to_raw_data, 3,
     RawBytesLen(from_raw_data);
```

In this example the variable `from_raw_data` of type `rawbytes` is first cleared,that is all bytes set to 0. Then in the first 4 bytes the value of `integer` is placed and in the next 4 bytes the value of `float`.

After having filled `from_raw_data` with data, the contents (8 bytes) is copied to `to_raw_data`, starting at position `3`.

Arguments

```
CopyRawBytes FromRawData FromIndex ToRawData
     ToIndex [ \NoOfBytes ]
```

`FromRawData`

Data type: `rawbytes`

`FromRawData` is the data container from which the `rawbytes` data shall be copied.

`FromIndex`

Data type: `num`

`FromIndex` is the position in `FromRawData` where the data to be copied starts. Indexing starts at 1.

`ToRawData`

Data type: `rawbytes`

`ToRawData` is the data container to which the `rawbytes` data shall be copied.

`ToIndex`

Data type: `num`

`ToIndex` is the position in `ToRawData` where the data to be copied will be placed. Everything is copied to the end. Indexing starts at 1.

Continues on next page

`[\NoOfBytes]`

Data type: `num`

The value specified with `\NoOfBytes` is the number of bytes to be copied from `FromRawData` to `ToRawData`.

If `\NoOfBytes` is not specified, all bytes from `FromIndex` to the end of current length of valid bytes in `FromRawData` is copied.

Program execution

During program execution data is copied from one `rawbytes` variable to another.

The current length of valid bytes in the `ToRawData` variable is set to:

- (`ToIndex` + copied_number_of_bytes - 1)
- The current length of valid bytes in the `ToRawData` variable is not changed, if the complete copy operation is done inside the old current length of valid bytes in the `ToRawData` variable.

Limitations

`CopyRawBytes` can not be used to copy some data from one `rawbytes` variable to other part of the same `rawbytes` variable.

Syntax

```
CopyRawBytes
  [FromRawData ':=' ] < variable (VAR) of rawbytes> ','
  [FromIndex ':=' ] < expression (IN) of num> ','
  [ToRawData ':=' ] < variable (VAR) of rawbytes> ','
  [ToIndex ':=' ] < expression (IN) of num>
  ['\'NoOfBytes ':=' < expression (IN) of num> ]';'
```


Continues on next page

Related information

For information about	See
`rawbytes` data	*rawbytes - Raw data on page 1165*
Get the length of `rawbytes` data	*RawBytesLen - Get the length of rawbytes data on page 940*
Clear the contents of `rawbytes` data	*ClearRawBytes - Clear the contents of rawbytes data on page 49*
Pack DeviceNet header into `rawbytes` data	*PackDNHeader - Pack DeviceNet Header into rawbytes data on page 287*
Pack data into `rawbytes` data	*PackRawBytes - Pack data into rawbytes data on page 290*
Write `rawbytes` data	*WriteRawBytes - Write rawbytes data on page 725*
Read `rawbytes` data	*ReadRawBytes - Read rawbytes data on page 352*
Unpack data from `rawbytes` data	*UnpackRawBytes - Unpack data from rawbytes data on page 658*

1.30. CorrClear - Removes all correction generators

Descriptions

`CorrClear` is used to remove all connected correction generators. The instruction can be used to remove all offsets provided earlier by all correction generators.

Basic examples

Basic examples of the instruction `CorrClear` are illustrated below.

Example 1

CorrClear;

The instruction removes all connected correction generators.

NOTE!

An easy way to ensure that all correction generators (with corrections) are removed at program start, is to run `CorrClear` in a `START` event routine.

See *Technical reference manual - System parameters*, topic *Controller*.

Syntax

```
CorrClear ';'
```

Related information

For information about	See
Connects to a correction generator	*CorrCon - Connects to a correction generator on page 71*
Disconnects from a correction generator	*CorrDiscon - Disconnects from a correction generator on page 76*
Writes to a correction generator	*CorrWrite - Writes to a correction generator on page 77*
Reads the current total offsets	*CorrRead - Reads the current total offsets on page 803*
Correction descriptor	*corrdescr - Correction generator descriptor on page 1099*

1.31. CorrCon - Connects to a correction generator

Usage

`CorrCon` is used to connect to a correction generator.

Basic examples

A basic example of the instruction `CorrCon` is illustrated below.

See also *More examples on page 71*.

Example1

```
VAR corrdescr id;
...
CorrCon id;
```

The correction generator reference corresponds to the variable `id` reservation.

Arguments

```
CorrCon Descr
```

`Descr`

Data type: `corrdescr`

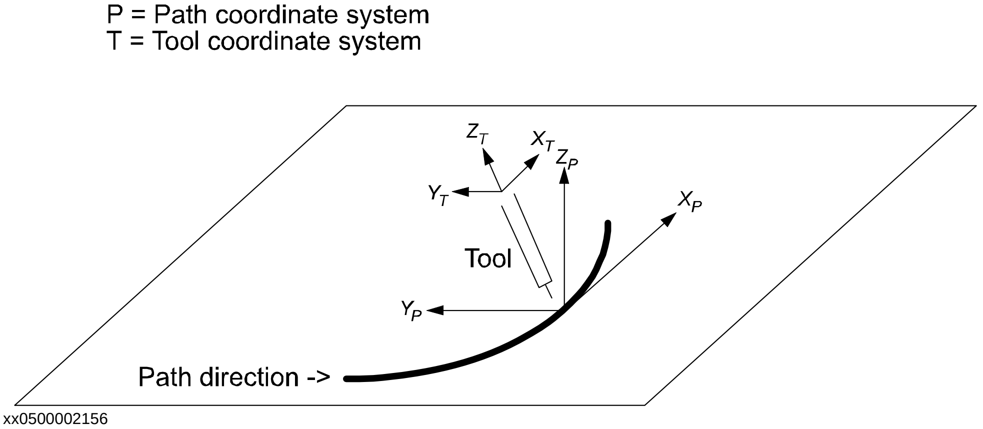
Descriptor of the correction generator.

More examples

More examples of the instruction `CorrCon` are illustrated below.

Path coordinate system

All path corrections (offsets on the path) are added in the path coordinate system. The path coordinate system is defined as illustrated below:



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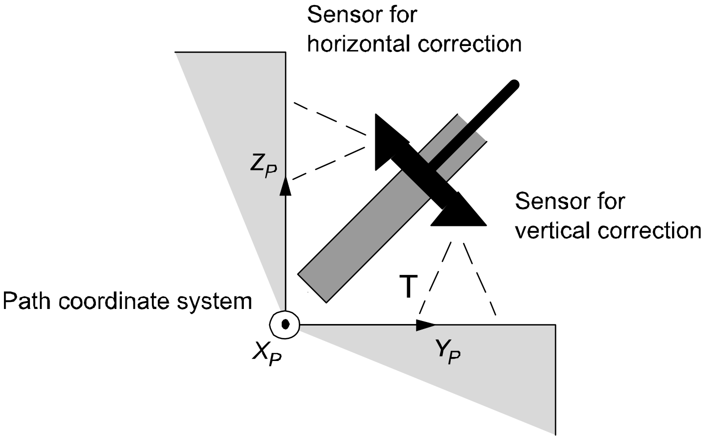
- Path coordinate axis X is given as the tangent of the path.
- Path coordinate axis Y is derived as the cross product of tool coordinate axis Z and path coordinate axis X.
- Path coordinate axis Z is derived as the cross product of path coordinate axis X and path coordinate axis Y.

Continues on next page

Application example

An example of an application using path corrections is a robot holding a tool with two sensors mounted on it to detect the vertical and horizontal distances to a work object. The figure below illustrates a path correction device.



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Program example

```
NOTE! hori_sig and vert_sig are analog signals defined in system
     parameters.

CONST num TARGET_DIST := 5;
CONST num SCALE_FACTOR := 0.5;
VAR intnum intno1;
VAR corrdescr hori_id;
VAR corrdescr vert_id;
VAR pos total_offset;
VAR pos write_offset;
VAR bool conFlag;

PROC PathRoutine()

  ! Connect to the correction generators for horizontal and
      vertical correction.
  CorrCon hori_id;
  CorrCon vert_id;
  conFlag := TRUE;

  ! Setup a 5 Hz timer interrupt. The trap routine will read the
      sensor values and
  ! compute the path corrections.
  CONNECT intno1 WITH ReadSensors;
  ITimer\Single, 0.2, intno1;

  ! Position for start of contour tracking
  MoveJ p10,v100,z10,tool1;
  ! Run MoveL with both vertical and horizontal correction.
  MoveL p20,v100,z10,tool1\Corr;
```


Continues on next page

```
  ! Read the total corrections added by all connected correction
       generators.
  total_offset := CorrRead();
  ! Write the total vertical correction on the FlexPendant.
  TPWrite "The total vertical correction is:"
       \Num:=total_offset.z;

  ! Disconnect the correction generator for vertical correction.
  ! Horizontal corrections will be unaffected.
  CorrDiscon vert_id;
  conFlag := FALSE;

  ! Run MoveL with only horizontal interrupt correction.
  MoveL p30,v100,z10,tool1\Corr;
  ! Remove all outstanding connected correction generators.
  ! In this case, the only connected correction generator is the
       one for horizontal
  ! correction.
  CorrClear;
  ! Remove the timer interrupt.
  IDelete intno1;
ENDPROC

TRAP ReadSensors
  VAR num horiSig;
  VAR num vertSig;

  ! Compute the horizontal correction values and execute the
       correction.
  horiSig := hori_sig;
  write_offset.x := 0;
  write_offset.y := (hori_sig - TARGET_DIST)*SCALE_FACTOR;
  write_offset.z := 0;
  CorrWrite hori_id, write_offset;

  IF conFlag THEN
     ! Compute the vertical correction values and execute the
          correction.
     write_offset.x := 0;
     write_offset.y := 0;
     write_offset.z := (vert_sig - TARGET_DIST)*SCALE_FACTOR;
     CorrWrite vert_id, write_offset;
  ENDIF
  !Setup interrupt again
  IDelete intnol;
  CONNECT intno1 WITH ReadSensors;
  ITimer\single, 0.2, intno1;
ENDTRAP
```

Continues on next page

Program explanation

Two correction generators are connected with the instruction `CorrCon`. Each correction generator is referenced by a unique descriptor (`hori_id` and `vert_id`) of the type `corrdescr`. The two sensors will use one correction generator each.

A timer interrupt is set up to call the trap routine `ReadSensors` with a frequency of 5 Hz. The offsets, needed for path correction, are computed in the trap routine and written to the corresponding correction generator (referenced by the descriptors `hori_id` and `vert_id`) by the instruction `CorrWrite`. All the corrections will have immediate effect on the path.

The `MoveL` instruction must be programmed with the switch argument `Corr` when path corrections are used. Otherwise, no corrections will be executed.

When the first `MoveL` instruction is ready, the function `CorrRead` is used to read the sum of all the corrections (the total path correction) given by all the connected correction generators. The result of the total vertical path correction is written to the FlexPendant with the instruction `TPWrite`.

`CorrDiscon` will then disconnect the correction generator for vertical correction (referenced by the descriptor `vert_id`). All corrections added by this correction generator will be removed from the total path correction. The corrections added by the correction generator for horizontal correction will still be preserved.

Finally, the function `CorrClear` will remove all remaining connected correction generators and their previously added corrections. In this case, it is only the correction generator for horizontal correction that will be removed. The timer interrupt will also be removed by the instruction `IDelete`.

The correction generators

The figure below illustrates the correction generators.

x	y	z	Path coordinate axis.
0	0	3	Vertical correction generator, with the sum of all its own path corrections
0	1	0	Horizontal correction generator with the sum of all its own path corrections
-	-	-	Not connected correction generator.
-	-	-	Not connected correction generator.
-	-	-	Not connected correction generator.
0	1	3	The sum of all corrections done by all connected correction generators.

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Limitations

A maximum number of 5 correction generators can be connected simultaneously.

Connected Correction Generators do not survive a controller restart.

Syntax

```
CorrCon
  [ Descr ':=' ] < variable (VAR) of corrdescr > ';'
```

Continues on next page

Related information

For information about	See
Disconnects from a correction generator	*CorrDiscon - Disconnects from a correction generator on page 76*
Writes to a correction generator	*CorrWrite - Writes to a correction generator on page 77*
Reads the current total offsets	*CorrRead - Reads the current total offsets on page 803*
Removes all correction generators	*CorrClear - Removes all correction generators on page 70*
Correction generator descriptor	*corrdescr - Correction generator descriptor on page 1099*

1.32. CorrDiscon - Disconnects from a correction generator

Description

`CorrDiscon` is used to disconnect from a previously connected correction generator. The instruction can be used to remove corrections given earlier.

Basic examples

A basic example of the instruction `CorrDiscon` is illustrated below.

See also *More examples on page 76*.

Example 1

```
VAR corrdescr id;
...
CorrCon id;
...
CorrDiscon id;
```

`CorrDiscon` disconnects from the previously connected correction generator referenced by the descriptor id.

Arguments

```
CorrDiscon Descr
```

`Descr`

Data type: `corrdescr`

Descriptor of the correction generator.

More examples

For more examples of the instruction CorrDiscon, see *CorrCon - Connects to a correction generator on page 71*.

Syntax

```
CorrDiscon
  [ Descr ':=' ] < variable (VAR) of corrdescr > ';'
```

Related information

For information about	See
Connects to a correction generator	*CorrCon - Connects to a correction generator on page 71*
Writes to a correction generator	*CorrWrite - Writes to a correction generator on page 77*
Reads the current total offsets	*CorrRead - Reads the current total offsets on page 803*
Removes all correction generators	*CorrClear - Removes all correction generators on page 70*
Correction descriptor	*corrdescr - Correction generator descriptor on page 1099*

1.33. CorrWrite - Writes to a correction generator

Description

`CorrWrite` is used to write offsets in the path coordinate system to a correction generator.

Basic examples

A basic example of the instruction `CorrWrite` is illustrated below.

Example 1

```
VAR corrdescr id;
VAR pos offset;
...
CorrWrite id, offset;
```

The current offsets, stored in the variable offset, are written to the correction generator referenced by the descriptor id.

Arguments

```
CorrWrite Descr Data
```

Descr

Data type: `corrdescr`

Descriptor of the correction generator.

Data

Data type: `pos`

The offset to be written.

More examples

For more examples of the instruction CorrWrite, see *CorrCon - Connects to a correction generator on page 71*.

Limitations

The best performance is achieved on straight paths. As the speed and angles between consecutive linear paths increase, the deviation from the expected path will also increase. The same applies to circles with decreasing circle radius.

Syntax

```
CorrWrite
  [ Descr ':=' ] < variable (VAR) of corrdescr > ','
  [ Data ':=' ] < expression (IN) of pos > ';'
```


Continues on next page

Related information

For information about	See
Connects to a correction generator	*CorrCon - Connects to a correction generator on page 71*
Disconnects from a correction generator	*CorrDiscon - Disconnects from a correction generator on page 76*
Reads the current total offsets	*CorrRead - Reads the current total offsets on page 803*
Removes all correction generators	*CorrClear - Removes all correction generators on page 70*
Correction generator descriptor	*corrdescr - Correction generator descriptor on page 1099*

1.34. DeactUnit - Deactivates a mechanical unit

Usage

`DeactUnit` is used to deactivate a mechanical unit.

It can be used to determine which unit is to be active when, for example, common drive units are used.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Examples

Basic examples of the instruction `DeactUnit` are illustrated below.

Example 1

```
DeactUnit orbit_a;
```

Deactivation of the `orbit_a` mechanical unit.

Example 2

```
MoveL p10, v100, fine, tool1;
DeactUnit track_motion;
MoveL p20, v100, z10, tool1;
MoveL p30, v100, fine, tool1;
ActUnit track_motion;
MoveL p40, v100, z10, tool1;
```

The unit `track_motion` will be stationary when the robot moves to `p20` and `p30`. After this, both the robot and `track_motion` will move to `p40`.

Example 3

```
MoveL p10, v100, fine, tool1;
DeactUnit orbit1;
ActUnit orbit2;
MoveL p20, v100, z10, tool1;
```

The unit `orbit1` is deactivated and `orbit2` is activated.

Arguments

```
DeactUnit MechUnit
```

MechUnit

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit that is to be deactivated.

Program execution

When the robot's and external axes' actual path is ready, the path on current path level is cleared and the specified mechanical unit is deactivated. This means that it will neither be controlled nor monitored until it is re-activated.

If several mechanical units share a common drive unit, deactivation of one of the mechanical units will also disconnect that unit from the common drive unit.

Continues on next page

Limitations

Instruction `DeactUnit` cannot be used when one of the mechanical unit is in independent mode.

If this instruction is preceded by a move instruction, that move instruction must be programmed with a stop point (zonedata `fine`), not a fly-by point, otherwise restart after power failure will not be possible.

`DeactUnit` cannot be executed in a RAPID routine connected to any of following special system events: PowerOn, Stop, QStop, Restart or Step.

It is possible to use `ActUnit - DeactUnit` on `StorePath` level, but the same mechanical units must be active when doing `RestoPath` as when `StorePath` was done. If such operation the Path Recorder and the path on the base level will be intact, but the path on the `StorePath` level will be cleared.

Syntax

```
DeactUnit
  [MechUnit ':='] < variable (VAR) of mecunit> ';'
```

Related information

For information about	See
Activating mechanical units	*ActUnit - Activates a mechanical unit on page 17*
Mechanical units	*mecunit - Mechanical unit on page 1139*
Path Recorder	*PathRecMoveBwd - Move path recorder backwards on page 298* *mecunit - Mechanical unit on page 1139*

1.35. Decr - Decrements by 1

Usage

`Decr` is used to subtract 1 from a numeric variable or persistent.

Basic examples

A basic example of the instruction `Decr` is illustrated below.

See also *More examples on page 81*.

Example 1

```
Decr reg1;
```

`1` is subtracted from `reg1`, that is `reg1:=reg1-1`.

Arguments

```
Decr Name | Dname
```

`Name`

Data type: `num`

The name of the variable or persistent to be decremented.

`Dname`

Data type: `dnum`

The name of the variable or persistent to be decremented.

More examples

More examples of the instruction `Decr` are illustrated below.

Example 1

```
VAR num no_of_parts:=0;
...
TPReadNum no_of_parts, "How many parts should be produced? ";
WHILE no_of_parts>0 DO
  produce_part;
  Decr no_of_parts;
ENDWHILE
```

The operator is asked to input the number of parts to be produced. The variable `no_of_parts` is used to count the number that still have to be produced.

Example 2

```
VAR dnum no_of_parts:=0;
...
TPReadDnum no_of_parts, "How many parts should be produced? ";
WHILE no_of_parts>0 DO
  produce_part;
  Decr no_of_parts;
ENDWHILE
```

The operator is asked to input the number of parts to be produced. The variable `no_of_parts` is used to count the number that still have to be produced.

Continues on next page

Syntax

```
Decr
  [ Name ':=' ] < var or pers (INOUT) of num >
  | [ Dname ':=' ] < var or pers (INOUT) of dnum >' ;'
```

Related information

For information about	See
Incrementing a variable by 1	*Incr - Increments by 1 on page 131*
Subtracting any value from a variable	*Add - Adds a numeric value on page 19*
Changing data using an arbitrary expression, e.g. multiplication	*":=" - Assigns a value on page 24*

1.36. DitherAct - Enables dither for soft servo

Usage

`DitherAct` is used to enable the dither functionality, which will reduce the friction in soft servo for IRB 7600.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Basic examples

Basic examples of the instruction `DitherAct` are illustrated below.

Example 1

```
SoftAct \MechUnit:=ROB_1, 2, 100;
WaitTime 2;
DitherAct \MechUnit:=ROB_1, 2;
WaitTime 1;
DitherDeact;
SoftDeact;
```

Dither is enabled only for one second while in soft servo.

Example 2

```
DitherAct \MechUnit:=ROB_1, 2;
SoftAct \MechUnit:=ROB_1, 2, 100;
WaitTime 1;
MoveL p1, v50, z20, tool1;
SoftDeact;
DitherDeact;
```

Dither is enabled for axis 2. Movement is delayed for one second to allow sufficient transition time for the `SoftAct` ramp. If `DitherAct` is called before `SoftAct`, dither will start whenever a `SoftAct` is executed for that axis. If no `DitherDeact` is called, dither will stay enabled for all subsequent `SoftAct` calls.

Arguments

```
DitherAct [\MechUnit] Axis [\Level]
```

`[ \MechUnit ]`

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit. If argument is omitted, it means activation of the soft servo for specified robot axis.

`Axis`

Data type: `num`

Axis number (1-6).

Continues on next page

`[ \Level ]`

Data type: `num`

Amplitude of dither (50-150%). At 50%, oscillations are reduced (increased friction). At 150%, amplitude is maximum (may result in vibrations of endeffector). The default value is 100%.

Program execution

`DitherAct` can be called before, or after `SoftAct`. Calling `DitherAct` after `SoftAct` is faster but it has other limitations.

Dither is usually not required for axis 1 of IRB 7600. Highest effect of friction reduction is on axes 2 and 3.

Dither parameters are self-adjusting. Full dither performance is achieved after three or four executions of `SoftAct` in process position.

Limitations

Calling `DitherAct` after `SoftAct` may cause unwanted movement of the robot. The only way to eliminate this behavior is to call `DitherAct` before `SoftAct`. If there still is movement, `SoftAct` ramp time should be increased.

The transition time is the ramp time, which varies between robots, multiplied with the ramp factor of the `SoftAct`-instruction.

Dithering is not available for axis 6.

Dither is always deactivated when there is a power failure.

The instruction is only to be used for IRB 7600.

WARNING!

When calling `DitherAct` before `SoftAct` the robot **must be in a fine point**. Also, **leaving the fine point is not permitted** until the transition time of the ramp is over. **This might damage the gear boxes**.

Syntax

```
DitherAct
  [ '\' MechUnit ':=' < variable (VAR) of mecunit > ]
  [Axis ':=' ] < expression (IN) of num >
  [ '\' Level ':=' < expression (IN) of num > ] ';'
```

Related information

For information about	See
Activating Soft Servo	*SoftAct - Activating the soft servo on page 473*
Behavior with the soft servo engaged	*Technical reference manual - RAPID overview*
Disable of dither	*DitherDeact - Disables dither for soft servo on page 85*

1.37. DitherDeact - Disables dither for soft servo

Usage

`DitherDeact` is used to disable the dither functionality for soft servo of IRB 7600.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Basic examples

A basic example of the instruction `DitherDeact` is illustrated below.

Example 1

```
DitherDeact;
```

Deactivates dither on all axis.

Program execution

`DitherDeact` can be used at any time. If in soft servo, dither stops immediately on all axes. If not in soft servo, dither will not be active when next `SoftAct` is executed.

The dither is automatically disabled

- at a cold start-up
- when a new program is loaded
- when starting program execution from the beginning.

Syntax

```
DitherDeact';'
```

Related information

For information about	See
Activating dither	*DitherAct - Enables dither for soft servo on page 83*

1.38. DropWObj - Drop work object on conveyor

Usage

`DropWObj` (*Drop Work Object*) is used to disconnect from the current object and the program is ready for the next object on the conveyor.

Basic examples

A basic example of the instruction `DropWObj` is illustrated below.

Example 1

```
MoveL *, v1000, z10, tool, \WObj:=wobj_on_cnv1;
MoveL *, v1000, fine, tool, \WObj:=wobj0;
DropWObj wobj_on_cnv1;
MoveL *, v1000, z10, tool, \WObj:=wobj0;
```

Arguments

```
DropWObj WObj
```

`WObj`

Work Object

Data type: `wobjdata`

The moving work object (coordinate system) to which the robot position in the instruction is related. The mechanical unit conveyor is to be specified by the `ufmec` in the work object.

Program execution

Dropping the work object means that the encoder unit no longer tracks the object. The object is removed from the object queue and cannot be recovered.

Limitations

If the instruction is issued while the robot is actively using the conveyor coordinated work object, then the motion stops.

The instruction may be issued only after a fixed work object has been used in the preceding motion instructions with either a fine point or several (>1) corner zones.

Syntax

```
DropWObj
  [ WObj ':='] < persistent (PERS) of wobjdata>';'
```

Related information

For information about	See
Wait for work objects	*WaitWObj - Wait for work object on conveyor on page 701*
Conveyor tracking	*Application manual - Conveyor tracking*

1.39. EOffsOff - Deactivates an offset for external axes

Usage

`EOffsOff` (*External Offset Off*) is used to deactivate an offset for external axes.

The offset for external axes is activated by the instruction `EOffsSet` or `EOffsOn` and applies to all movements until some other offset for external axes is activated or until the offset for external axes is deactivated.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Basic examples

Basic examples of the instruction `EOffsOff` are illustrated below.

Example 1

```
EOffsOff;
```

Deactivation of the offset for external axes.

Example 2

```
MoveL p10, v500, z10, tool1;
EOffsOn \ExeP:=p10, p11;
MoveL p20, v500, z10, tool1;
MoveL p30, v500, z10, tool1;
EOffsOff;
MoveL p40, v500, z10, tool1;
```

An offset is defined as the difference between the position of each axis at `p10` and `p11`. This displacement affects the movement to `p20` and `p30`, but not to `p40`.

Program execution

Active offsets for external axes are reset.

Syntax

```
EOffsOff ';'
```

Related information

For information about	See
Definition of offset using two positions	*EOffsOn - Activates an offset for external axes on page 88*
Definition of offset using known values	*EOffsSet - Activates an offset for external axes using known values on page 90*
Deactivation of the robot's program displacement	*PDispOff - Deactivates program displacement on page 316*

1.40. EOffsOn - Activates an offset for external axes

Usage

`EOffsOn` (*External Offset On*) is used to define and activate an offset for external axes using two positions.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Basic examples

Basic examples of the instruction `EOffsOn` are illustrated below.

See also *More examples on page 89*.

Example 1

```
MoveL p10, v500, z10, tool1;
EOffsOn \ExeP:=p10, p20;
```

Activation of an offset for external axes. This is calculated for each axis based on the difference between positions `p10` and `p20`.

Example 2

```
MoveL p10, v500, fine \Inpos := inpos50, tool1;
EOffsOn *;
```

Activation of an offset for external axes. Since a stop point that is accurately defined has been used in the previous instruction, the argument `\ExeP` does not have to be used. The displacement is calculated on the basis of the difference between the actual position of each axis and the programmed point (*) stored in the instruction.

Arguments

```
EOffsOn [\ExeP] ProgPoint
```

`[ \ExeP ]`

Executed Point

Data type: `robtarget`

The new position, used for calculation of the offset. If this argument is omitted, the current position of the axes at the time of the program execution is used.

`ProgPoint`

Programmed Point

Data type: `robtarget`

The original position of the axes at the time of programming.

Continues on next page

Program execution

The offset is calculated as the difference between `\ExeP` and `ProgPoint` for each separate external axis. If `\ExeP` has not been specified, the current position of the axes at the time of the program execution is used instead. Since it is the actual position of the axes that is used, the axes should not move when `EOffsOn` is executed.

This offset is then used to displace the position of external axes in subsequent positioning instructions and remains active until some other offset is activated (the instruction `EOffsSet` or `EOffsOn`) or until the offset for external axes is deactivated (the instruction `EOffsOff`).

Only **one** offset for each individual external axis can be activated at the same time. Several `EOffsOn`, on the other hand, can be programmed one after the other and, if they are, the different offsets will be added.

The external axes offset is automatically reset:

- At a cold start-up.
- When a new program is loaded.
- When starting program execution from the beginning.

More examples

More examples of how to use the instruction `EOffsOn` are illustrated below.

Example 1

```
SearchL sen1, psearch, p10, v100, tool1;
PDispOn \ExeP:=psearch, *, tool1;
EOffsOn \ExeP:=psearch, *;
```

A search is carried out in which the searched position of both the robot and the external axes is stored in the position `psearch`. Any movement carried out after this starts from this position using a program displacement of both the robot and the external axes. This is calculated based on the difference between the searched position and the programmed point (*) stored in the instruction.

Syntax

```
EOffsOn
  [ '\' ExeP ':=' < expression (IN) of robtarget> ',']
  [ ProgPoint ':=' ] < expression (IN) of robtarget> ';'
```

Related information

For information about	See
Deactivation of offset for external axes	*EOffsOff - Deactivates an offset for external axes on page 87*
Definition of offset using known values	*EOffsSet - Activates an offset for external axes using known values on page 90*
Displacement of the robot's movements	*PDispOn - Activates program displacement on page 317*
Coordinate systems	*Technical reference manual - RAPID overview*

1.41. EOffsSet - Activates an offset for external axes using known values

Usage

`EOffsSet` (*External Offset Set*) is used to define and activate an offset for external axes using known values.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Basic examples

A basic example of the instruction `EOffsSet` is illustrated below.

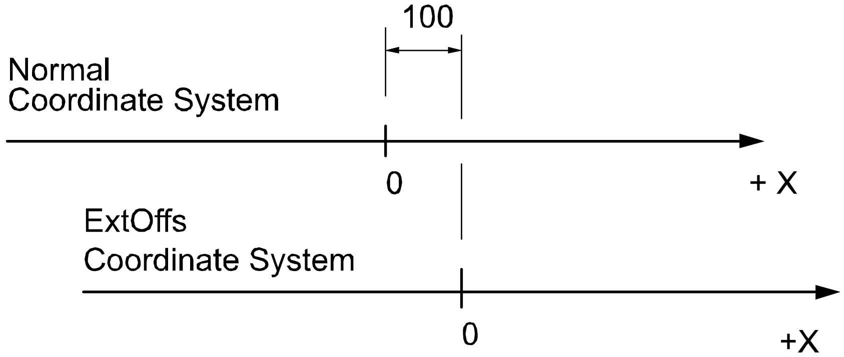
Example 1

```
VAR extjoint eax_a_p100 := [100, 0, 0, 0, 0, 0];
...
EOffsSet eax_a_p100;
```

Activation of an offset `eax_a_p100` for external axes, meaning (provided that the logical external axis "a" is linear) that:

- The `ExtOffs` coordinate system is displaced 100 mm for the logical axis "a" (see figure below).
- As long as this offset is active, all positions will be displaced 100 mm in the direction of the x-axis.

The figure shows displacement of an external axis.



xx0500002162

Arguments

```
EOffsSet EAxOffs
```

EAxOffs

External Axes Offset

Data type: `extjoint`

The offset for external axes is defined as data of the type `extjoint`, expressed in:

- mm for linear axes
- degrees for rotating axes

Continues on next page

Program execution

The offset for external axes is activated when the `EOffsSet` instruction is executed and remains active until some other offset is activated (the instruction `EOffsSet` or `EOffsOn`) or until the offset for external axes is deactivated (the instruction `EOffsOff`).

Only one offset for external axes can be activated at the same time. Offsets cannot be added to one another using `EOffsSet`.

The external axes offset is automatically reset:

- At a cold start-up.
- When a new program is loaded.
- When starting program executing from the beginning.

Syntax

```
EOffsSet
  [ EAxOffs ':=' ] < expression (IN) of extjoint> ';'
```

Related information

For information about	See
Activate an offset for external axes	*EOffsOn - Activates an offset for external axes on page 88*
Deactivation of offset for external axes	*EOffsOff - Deactivates an offset for external axes on page 87*
Displacement of the robot's movements	*PDispOn - Activates program displacement on page 317*
Definition of data of the type `extjoint`	*extjoint - Position of external joints on page 1118*
Coordinate systems	*Technical reference manual - RAPID overview*

1.42. EraseModule - Erase a module

Usage

`EraseModule` is used to remove a module from the program memory during execution.

There are no restrictions on how the module was loaded. It could have been loaded manually, from the configuration, or with a combination of the instructions `Load`, `StartLoad`, and `WaitLoad`.

The module cannot be defined as *Shared* in the configuration.

Basic examples

A basic example of the instruction `EraseModule` is illustrated below.

Example 1

```
EraseModule "PART_A";
```

Erase the program module `PART_A` from the program memory.

Arguments

```
EraseModule ModuleName
```

`ModuleName`

Data type: `string`

The name of the module that should be removed. Please note that this is the name of the module, not the name of the file.

Program execution

The program execution waits for the program module to finish the removal process before the execution proceeds with the next instruction.

When the program module is removed the rest of the program modules will be linked.

Limitations

It is not allowed to remove a program module that is executing.

TRAP routines, system I/O events, and other program tasks cannot execute during the removal process.

Avoid ongoing robot movements during the removal.

Program stop during execution of `EraseModule` instruction results in guard stop with motors off and error message "20025 Stop order timeout" on the FlexPendant.

Error handling

If the file in the `EraseModule` instruction cannot be removed because it was not found, the system variable ERRNO is set to ERR_MODULE. This error can then be handled in the error handler.

Syntax

```
EraseModule
[ModuleName':=']<expression (IN) of string>';'
```

Continues on next page

Related information

For information about	See
Unload a program module	*UnLoad - UnLoad a program module during execution on page 655*
Load a program module in parallel with another program execution	*StartLoad - Load a program module during execution on page 482* *WaitLoad - Connect the loaded module to the task on page 682*
Accept unresolved reference	*Technical reference manual - System parameters*, section *Controller*

1.43. ErrLog - Write an error message

Usage

`ErrLog` is used to display an error message on the FlexPendant and write it in the event log. Error number and five error arguments must be stated. The message is stored in the process domain in the robot log. `ErrLog` can also be used to display warnings and information messages.

Basic examples

Basic examples of the instruction `ErrLog` are illustrated below.

Example 1

In case you do not want to make your own .xml file, you can use `ErrorId 4800` like in the example below:

```
VAR errstr my_title := "myerror";
VAR errstr str1 := "errortext1";
VAR errstr str2 := "errortext2";
VAR errstr str3 := "errortext3";
VAR errstr str4 := "errortext4";

ErrLog 4800, my_title, str1,str2,str3,str4;
```

On the FlexPendant the message will look like this:

Event Message: 4800

myerror

errortext1

errortext2

errortext3

errortext4

Example 2

An `ErrorId` must be declared in an .xml file. The number must be between 5000 - 9999. The error message is written in the .xml file and the arguments to the message is sent in by the `ErrLog` instruction. The `ErrorId` in the .xml file is the same stated in the `ErrLog` instruction.

NOTE: If using an ErrorId between 5000-9999 you have to install your own xml file.

Example of message in .xml file:

```
<Message number="5210" eDefine="ERR_INPAR_RDONLY">
  <Title>Parameter error</Title>
  <Description>Task:<arg format="%s" ordinal="1" />
     <p />Symbol <arg format="%s" ordinal="2" />is read-only
     <p />Context:<arg format="%s" ordinal="3" /><p />
  </Description>
</Message>
```


Continues on next page

Example of instruction:

```
MODULE MyModule
  PROC main()
    VAR num errorid := 5210;
    VAR errstr arg := "P1";
    ErrLog errorid, ERRSTR_TASK, arg,
         ERRSTR_CONTEXT,ERRSTR_UNUSED, ERRSTR_UNUSED;
    ErrLog errorid \W, ERRSTR_TASK, arg,
         ERRSTR_CONTEXT,ERRSTR_UNUSED, ERRSTR_UNUSED;
  ENDPROC
ENDMODULE
```

On the FlexPendant the message will look like this:

Event Message: 5210

Parameter error

Task: T_ROB1

Symbol P1 is read-only.

Context: MyModule/main/ErrLog

The first `ErrLog` instruction generates an error message. The message is stored in the robot log in the process domain. It is also shown on the FlexPendant display.

The second instruction is a warning. A message is stored in the robot log only.

The program will in both cases continue its execution when the instruction is done.

Arguments

```
ErrLog ErrorID [\W] | [\I] Argument1 Argument2 Argument3 Argument4
     Argument5
```

`ErrorId`

Data type: `num`

The number of a specific error that is to be monitored. The error number must be in interval 4800-4814 if using the preinstalled xml file, and between 5000 - 9999 if using an own xml file.

`[ \W ]`

Warning

Data type: `switch`

Gives a warning that is stored in the robot event log only (not shown directly on the FlexPendant display).

`[ \I ]`

Information

Data type: `switch`

Gives an information message that is stored in the event log only (not shown directly on the FlexPendant display).

If none of the arguments `\W` or `\I` are specified then the instruction will generate an error message directly on the flexpendant and also store it in the event log.

Continues on next page

`Argument1`

Data type: `errstr`

First argument in the error message. Any string or predefined data of type `errstr` can be used.

`Argument2`

Data type: `errstr`

Second argument in the error message. Any string or predefined data of type `errstr` can be used.

`Argument3`

Data type: `errstr`

Third argument in the error message. Any string or predefined data of type `errstr` can be used

`Argument4`

Data type: `errstr`

Fourth argument in the error message. Any string or predefined data of type `errstr` can be used.

`Argument5`

Data type: `errstr`

Fifth argument in the error message. Any string or predefined data of type `errstr` can be used.

Program execution

An error message (max 5 lines) is displayed on the FlexPendant and written in the event log.

In the case of argument `\W` or argument `\I` a warning or an information message is written in the event log.

`ErrLog` generates program errors between 4800-4814 if using the xml file that are installed by the system, and between 5000-9999 if installing an own xml file. The error generated depends on the `ErrorID` indicated.

The message is stored in the process domain in the event log.

How to install an own xml file is described in the *Additional options* manual, see Related information below.

Limitations

Total string length (Argument1-Argument5) is limited to 195 characters.

Continues on next page

Syntax

```
ErrLog
  [ErrorId ':=' ] < expression (IN) of num> ','
  [ '\'W ] | [' \' I ] ','
  [Argument1 ':=' ] < expression (IN) of errstr> ','
  [Argument2 ':=' ] < expression (IN) of errstr> ','
  [Argument3 ':=' ] < expression (IN) of errstr> ','
  [Argument4 ':=' ] < expression (IN) of errstr> ','
  [Argument5 ':=' ] < expression (IN) of errstr> ';'
```

Related information

For information about	See
Predefined data of type errstr	*errstr - Error string on page 1114*
Display message on the FlexPendant	*TPWrite - Writes on the FlexPendant on page 568* *UIMsgBox - User Message Dialog Box type basic on page 644*
Event log	*Operating manual - IRC5 with FlexPendant*
Event log messages, explanation of xml-file	*Application manual - Additional options*, section *Event log messages*
How to install XML files when using additional options	*Application manual - Additional options*

1.44. ErrRaise - Writes a warning and calls an error handler

Usage

`ErrRaise` is used to create an error in the program and then call the error handler of the routine. A warning is written in the event log. `ErrRaise` can also be used in the error handler to propagate the current error to the error handler of the calling routine.

Error name, error number, and five error arguments must be stated. The message is stored in the process domain in the robot log.

Basic examples

Basic examples of the instruction `ErrRaise` is illustrated below.

Example 1

In case you do not want to make your own .xml file, you can use `ErrorId 4800` like in the example below:

```
MODULE MyModule
  VAR errnum ERR_BATT:=-1;
  PROC main()
    VAR num errorid := 4800;
    VAR errstr my_title := "Backup battery status";
    VAR errstr str1 := "Bacup battery is fully charged";
    BookErrNo ERR_BATT;
    ErrRaise "ERR_BATT", errorid, my_title, ERRSTR_TASK, str1,
         ERRSTR_CONTEXT,ERRSTR_EMPTY;
    ERROR
    IF ERRNO = ERR_BATT THEN
      TRYNEXT;
    ENDIF
  ENDPROC
ENDMODULE
```

On the FlexPendant the message will look like this (warning and/or an error):

Event Message: 4800

Backup battery status

Task: main

Backup battery is fully charged

Context: MyModule/main/ErrRaise

An error number must be booked with the instruction `BookErrNo`. Corresponding string is stated as the first argument, `ErrorName`, in the `ErrRaise`.

`ErrRaise` creates an error and then calls the error handler. If the error is taken care of, a warning is generated in the event log, in the process domain. Otherwise a fatal error is generated and the program stops.

`ErrRaise` can also be used in an error handler in a subroutine. In this case the execution continues in the error handler of the calling routine.

Continues on next page

Example 2

An `ErrorId` must be declared in an .xml file. The number must be between 5000 - 9999. The error message is written in the .xml file and the arguments to the message are sent in by the `ErrRaise` instruction. The `ErrorId` in the .xml file is the same stated in the `ErrRaise` instruction.

NOTE: If using an ErrorId between 5000-9999 you have to install your own xml file.

Example of message in .xml file:

```
<Message number="7055" eDefine="SYS_ERR_ARL_INPAR_RDONLY">
  <Title>Parameter error</Title>
  <Description>Task:<arg format="%s" ordinal="1" />
     <p />Symbol <arg format="%s" ordinal="2" />is read-only
     <p />Context:<arg format="%s" ordinal="3" /><p /></
          Description>
</Message>
```

Example of instruction:

```
MODULE MyModule
  VAR errnum ERR_BATT:=-1;
  PROC main()
     VAR num errorid := 7055;
     BookErrNo ERR_BATT;
     ErrRaise "ERR_BATT", errorid, ERRSTR_TASK,
          ERRSTR_CONTEXT,ERRSTR_UNUSED, ERRSTR_UNUSED,
          ERRSTR_UNUSED;
     ERROR
     IF ERRNO = ERR_BATT THEN
        TRYNEXT;
     ENDIF
  ENDPROC
ENDMODULE
```

On the FlexPendant the message will look like this (warning and/or an error):

Event Message: 7055

Backup battery status

Task: main

Backup battery is fully charged

Context: MyModule/main/ErrRaise

An error number must be booked with the instruction `BookErrNo`. Corresponding string is stated as the first argument, `ErrorName`, in the `ErrRaise`.

`ErrRaise` creates an error and then calls the error handler. If the error is taken care of, a warning is generated in the event log, in the process domain. Otherwise a fatal error is generated and the program stops.

`ErrRaise` can also be used in an error handler in a subroutine. In this case the execution continues in the error handler of the calling routine.

Continues on next page

Arguments

```
ErrRaise ErrorName ErrorId Argument1 Argument2 Argument3 Argument4
    Argument5
```

`ErrorName`

Data type: `string`

An error number must be booked using the instruction `BookErrNo`. Corresponding variable is stated as `ErrorName`.

`ErrorId`

Data type: `num`

The number of a specific error that is to be monitored. The error number must be in interval 4800-4814 if using the preinstalled xml file, and between 5000 - 9999 if using an own xml file.

`Argument1`

Data type: `errstr`

First argument in the error message. Any string or predefined data of type `errstr` can be used.

`Argument2`

Data type: `errstr`

Second argument in the error message. Any string or predefined data of type `errstr` can be used.

`Argument3`

Data type: `errstr`

Third argument in the error message. Any string or predefined data of type `errstr` can be used

`Argument4`

Data type: `errstr`

Fourth argument in the error message. Any string or predefined data of type `errstr` can be used.

`Argument5`

Data type: `errstr`

Fifth argument in the error message. Any string or predefined data of type `errstr` can be used.

Continues on next page

Program execution

`ErrRaise` generates program warningss between 4800-4814 if using the xml file that are installed by the system, and between 5000-9999 if installing an own xml file. The error generated depends on the `ErrorID` indicated. A warning is written in the robot message log in the domain process.

When the `ErrRaise` is executed the behavior depends on where it is executed:

- When executing instruction in the routine body, a warning is generated, and the execution continues in the error handler.
- When executing instruction in an error handler, the old warning is skipped, a new one is generated, and the control is raised to calling instruction.

Limitations

Total string length (Argument1-Argument5) is limited to 195 characters.

More examples

More examples of how to use the instruction `ErrRaise` are illustrated below.

Example 1

```
VAR errnum ERR_BATT:=-1;
VAR errnum ERR_NEW_ERR:=-1;

PROC main()
  testerrraise;
ENDPROC

PROC testerrraise()
  BookErrNo ERR_BATT;
  BookErrNo ERR_NEW_ERR;
  ErrRaise "ERR_BATT",7055,ERRSTR_TASK,ERRSTR_CONTEXT,
       ERRSTR_UNUSED,ERRSTR_UNUSED,ERRSTR_UNUSED;
  ERROR
  IF ERRNO = ERR_BATT THEN
     ErrRaise "ERR_NEW_ERR",7156,ERRSTR_TASK,ERRSTR_CONTEXT,
          ERRSTR_UNUSED,ERRSTR_UNUSED, ERRSTR_UNUSED;
  ENDIF
ENDPROC
```

Generate new warning 7156 from error handler. Raise control to calling routine and stop execution.

Continues on next page

Syntax

```
ErrRaise
  [ErrorName ':=' ] < expression (IN) of string> ','
  [ErrorId ':=' ] < expression (IN) of num> ','
  [Argument1 ':=' ] < expression (IN) of errstr> ','
  [Argument2 ':=' ] < expression (IN) of errstr> ','
  [Argument3 ':=' ] < expression (IN) of errstr> ','
  [Argument4 ':=' ] < expression (IN) of errstr> ','
  [Argument5 ':=' ] < expression (IN) of errstr> ';'
```

Related information

For information about	See
Predefined data of type errstr	*errstr - Error string on page 1114*
Booking error numbers	*BookErrNo - Book a RAPID system error number on page 30*
Error handling	*Technical reference manual - RAPID overview*

1.45. ErrWrite - Write an error message

Usage

`ErrWrite` (*Error Write*) is used to display an error message on the FlexPendant and write it in the event log. It can also be used to display warnings and information messages.

Basic examples

Basic examples of the instruction `ErrWrite` are illustrated below.

Example 1

```
ErrWrite "PLC error", "Fatal error in PLC" \RL2:="Call service";
Stop;
```

A message is stored in the robot log. The message is also shown on the FlexPendant display.

Example 2

```
ErrWrite \W, "Search error", "No hit for the first search";
RAISE try_search_again;
```

A message is stored in the robot log only. Program execution then continues.

Arguments

```
ErrWrite [ \W ] | [\I] Header Reason [ \RL2] [ \RL3] [ \RL4]
```

`[ \W ]`

Warning

Data type: `switch`

Gives a warning that is stored in the robot error message log only (not shown directly on the FlexPendant display).

`[ \I ]`

Information

Data type: `switch`

Gives an information message that is stored in the event log only (not shown directly on the FlexPendant display).

If none of the arguments `\W` or `\I` are specified then the instruction will generate an error message directly on the flexpendant and also store it in the event log.

`Header`

Data type: `string`

Error message heading (max. 46 characters).

`Reason`

Data type: `string`

Reason for error.

`[ \RL2]`

Reason Line 2

Data type: `string`

Reason for error.

Continues on next page

`[ \RL3]`

Reason Line 3

Data type: `string`

Reason for error.

`[ \RL4]`

Reason Line 4

Data type: `string`

Reason for error.

Program execution

An error message (max. 5 lines) is displayed on the FlexPendant and written in the robot message log.

In the case of argument `\W` or argument `\I` a warning or an information message is written in the event log.

`ErrWrite` generates the program error no. 80001 for an error, no. 80002 for a warning (`\W`) and no. 80003 for an information message `(\I)`.

Limitations

Total string length (Header+Reason+\RL2+\RL3+\RL4) is limited to 195 characters.

Syntax

```
ErrWrite
  [ '\'W ] | [ '\' I ] ','
  [ Header ':=' ] < expression (IN) of string>','
  [ Reason ':=' ] < expression (IN) of string>
  [ '\'RL2 ':=' < expression (IN) of string> ]
  [ '\'RL3 ':=' < expression (IN) of string> ]
  [ '\'RL4 ':=' < expression (IN) of string> ] ';'
```

Related information

For information about	See
Predefined data of type errstr	*errstr - Error string on page 1114*
Display message on the FlexPendant	*TPWrite - Writes on the FlexPendant on page 568* *UIMsgBox - User Message Dialog Box type basic on page 644*
Event log	*Operating manual - IRC5 with FlexPendant*
Write error message - Err Log	*ErrLog - Write an error message on page 94*

1.46. EXIT - Terminates program execution

Usage

`EXIT` is used to terminate program execution. Program restart will then be blocked, that is the program can only be restarted from the first instruction of the main routine.

The `EXIT` instruction should be used when fatal errors occur or when program execution is to be stopped permanently. The `Stop` instruction is used to temporarily stop program execution. After execution of the instruction `EXIT` the program pointer is gone. To continue program execution, the program pointer must be set.

Basic examples

A basic example of the instruction `EXIT` is illustrated below.

Example 1

```
ErrWrite "Fatal error","Illegal state";
EXIT;
```

Program execution stops and cannot be restarted from that position in the program.

Syntax

```
EXIT ';'
```

Related information

For information about	See
Stopping program execution temporarily	*Stop - Stops program execution on page 510*

1.47. ExitCycle - Break current cycle and start next

Usage

`ExitCycle` is used to break the current cycle and move the program pointer (PP) back to the first instruction in the main routine.

If the program is executed in continuous mode, it will start to execute the next cycle.

If the execution is in cycle mode, the execution will stop at the first instruction in the main routine.

Basic examples

Basic examples of the instruction `ExitCycle` are illustrated below.

Example 1

```
VAR num cyclecount:=0;
VAR intnum error_intno;

PROC main()
  IF cyclecount = 0 THEN
     CONNECT error_intno WITH error_trap;
     ISignalDI di_error,1,error_intno;
  ENDIF
  cyclecount:=cyclecount+1;
  ! start to do something intelligent
  ...
ENDPROC

TRAP error_trap
  TPWrite "ERROR, I will start on the next item";
  ExitCycle;
ENDTRAP
```

This will start the next cycle if the signal `di_error` is set.

Program execution

Execution of `ExitCycle` in a program task controlling mechanical units results in the following in the actual task:

- On-going robot movements stops.
- All robot paths that are not performed at all path levels (both normal and `StorePath` level) are cleared.
- All instructions that are started but not finished at all execution levels (both normal and `TRAP` level) are interrupted.
- The program pointer is moved to the first instruction in the main routine.
- The program execution continues to execute the next cycle.

Continues on next page

Execution of `ExitCycle` in some other program task, not controlling mechanical units, results in the following in the actual task:

- All instructions that are started but not finished on all execution levels (both normal and `TRAP` level) are interrupted.
- The program pointer is moved to the first instruction in the main routine.
- The program execution continues to execute the next cycle.

All other modal things in the program and system are **not** affected by `ExitCycle` such as:

- The actual value of variables or persistents.
- Any motion settings such as `StorePath-RestoPath` sequence, world zones, etc.
- Open files, directories, etc.
- Defined interrupts, etc.

When using `ExitCycle` in routine calls and the entry routine is defined with “Move PP to Routine ...” or “Call Routine ...”, `ExitCycle` breaks the current cycle and moves the program pointer back to the first instruction in the entry routine (instead of the main routine as specified above).

Syntax

```
ExitCycle';'
```

Related information

For information about	See
Stopping after a fatal error	*EXIT - Terminates program execution on page 105*
Terminating program execution	*EXIT - Terminates program execution on page 105*
Stopping for program actions	*Stop - Stops program execution on page 510*
Finishing execution of a routine	*RETURN - Finishes execution of a routine on page 365*

1.48. FOR - Repeats a given number of times

Usage

`FOR` is used when one or several instructions are to be repeated a number of times.

Basic examples

A basic example of the instruction `FOR` is illustrated below.

See also *More examples on page 108*.

Example 1

```
FOR i FROM 1 TO 10 DO
  routine1;
ENDFOR
```

Repeats the `routine1` procedure `10` times.

Arguments

```
FOR Loop counter FROM Start value TO End value  [STEP Step value]
     DO ... ENDFOR
```

`Loop counter`

Identifier

The name of the data that will contain the value of the current loop counter. The data is declared automatically.

If the loop counter name is the same as any data that already exists in the actual scope, the existing data will be hidden in the `FOR` loop and not affected in any way.

`Start value`

Data type: `Num`

The desired start value of the loop counter. (usually integer values)

`End value`

Data type: `Num`

The desired end value of the loop counter. (usually integer values)

`Step value`

Data type: `Num`

The value by which the loop counter is to be incremented (or decremented) each loop. (usually integer values)

If this value is not specified, the step value will automatically be set to 1 (or -1 if the start value is greater than the end value).

More examples

More examples of how to use the instruction `FOR` are illustrated below.

Example 1

```
FOR i FROM 10 TO 2 STEP -2 DO
  a{i} := a{i-1};
ENDFOR
```

The values in an array are adjusted upwards so that `a{10}:=a{9}`, `a{8}:=a{7}` etc.

Continues on next page

Program execution

1. The expressions for the start, end, and step values are evaluated.
2. The loop counter is assigned the start value.
3. The value of the loop counter is checked to see whether its value lies between the start and end value, or whether it is equal to the start or end value. If the value of the loop counter is outside of this range, the `FOR` loop stops and program execution continues with the instruction following `ENDFOR`.
4. The instructions in the `FOR` loop are executed.
5. The loop counter is incremented (or decremented) in accordance with the step value.
6. The `FOR` loop is repeated, starting from point 3.

Limitations

The loop counter (of data type `num`) can only be accessed from within the `FOR` loop and consequently hides other data and routines that have the same name. It can only be read (not updated) by the instructions in the `FOR` loop.

Decimal values for start, end, or stop values, in combination with exact termination conditions for the `FOR` loop, cannot be used (undefined whether or not the last loop is running).

Remarks

If the number of repetitions is to be repeated as long as a given expression is evaluated to a `TRUE` value, the `WHILE` instructions should be used instead.

Syntax

```
(EBNF)
FOR <loop variable> FROM <expression> TO <expression>
  [ STEP <expression> ] DO
  <instruction list>
ENDFOR
<loop variable> ::= <identifier>
```

Related information

For information about	See
Expressions	*Technical reference manual - RAPID overview*
Repeats as long as...	*WHILE - Repeats as long as ... on page 705*
Identifiers	*Technical reference manual - RAPID overview*

1.49. GetDataVal - Get the value of a data object

Usage

`GetDataVal` (*Get Data Value*) makes it possible to get a value from a data object that is specified with a string variable.

Basic examples

Basic examples of the instruction `GetDataVal` are illustrated below.

Example 1

```
VAR num value;
...
GetDataVal "reg"+ValToStr(ReadNum(mycom)),value;
```

This will get the value of a register, with a number which is received from the serial channel `mycom`. The value will be stored in the variable `value`.

Example 2

```
VAR datapos block;
VAR string name;
VAR num valuevar;
...
SetDataSearch "num" \Object:="my.*" \InMod:="mymod";
WHILE GetNextSym(name,block) DO
  GetDataVal name\Block:=block,valuevar;
  TPWrite name+" "\Num:=valuevar;
ENDWHILE
```

This session will print out all `num` variables that begin with `my` in the module `mymod` with its value to the FlexPendant.

Example 3

```
VAR num NumArrConst_copy{2};
...
GetDataVal "NumArrConst", NumArrConst_copy;
TPWrite "Pos1 = " \Num:=NumArrConst_copy{1};
TPWrite "Pos2 = " \Num:=NumArrConst_copy{2};
```

This session will print out the `num` variables in the array `NumArrConst`.

Arguments

```
GetDataVal Object [\Block]|[\TaskRef]|[\TaskName] Value
```

`Object`

Data type: `string`

The name of the data object.

Continues on next page

`[ \Block ]`

Data type: `datapos`

The enclosed block to the data object. This can only be fetched with the `GetNextSym` function.

If this argument is omitted, the value of the visible data object in the current program execution scope will be fetched.

`[\TaskRef]`

Task Reference

Data type: `taskid`

The program task identity in which to search for the data object specified. When using this argument, you may search for `PERS` or `TASK PERS` declarations in other tasks, any other declarations will result in an error.

For all program tasks in the system the predefined variables of the data type `taskid` will be available. The variable identity will be "taskname"+"Id", e.g. for the `T_ROB1` task the variable identity will be `T_ROB1Id`.

`[\TaskName]`

Data type: `string`

The program task name in which to search for the data object specified. When using this argument, you may search for `PERS` or `TASK PERS` declarations in other tasks, any other declarations will result in an error.

`Value`

Data type: `anytype`

Variable for storage of the get value. The data type must be the same as the data type for the data object to find. The get value can be fetched from a constant, variable, or persistent but must be stored in a variable.

Error handling

The system variable `ERRNO` is set to `ERR_SYM_ACCESS` if:

- the data object is non-existent
- the data object is routine data or routine parameter and is not located in the current active routine
- searching in other tasks for other declarations then `PERS` or `TASK PERS`

When using the arguments `TaskRef` or `TaskName` you may search for `PERS` or `TASK PERS` declarations in other tasks, any other declarations will result in an error and the system variable `ERRNO` is set to `ERR_SYM_ACCESS`. Searching for a `PERS` declared as `LOCAL` in other tasks will also result in an error and the system variable `ERRNO` is set to `ERR_SYM_ACCESS`.

The system variable `ERRNO` is set to `ERR_INVDIM` if the data object and the variable used in argument `Value` have different dimensions.

The error can be handled in the error handler of the routine.

Continues on next page

Limitations

For a semivalue data type, it is not possible to search for the associated value data type. E.g. if searching for `dionum`, no search hit for signals `signaldi` will be obtained and if searching for `num`, no search hit for signals `signalgi` or `signalai` will be obtained.

It is not possible to get the value of a variable declared as `LOCAL` in a built in RAPID module.

Syntax

```
GetDataVal
  [ Object ':=' ] < expression (IN) of string >
  ['\'Block' :='<variable (VAR) of datapos>]
  |[ '\'TaskRef' :=' <variable (VAR) of taskid>]
  |[ '\'TaskName' :=' <expression (IN) of string>] ',']
  [ Value ':=' ] <variable (VAR) of anytype>]';'
```

Related information

For information about	See
Define a symbol set in a search session	*SetDataSearch - Define the symbol set in a search sequence on page 433*
Get next matching symbol	*GetNextSym - Get next matching symbol on page 855*
Set the value of a data object	*SetDataVal - Set the value of a data object on page 437*
Set the value of many data objects	*SetAllDataVal - Set a value to all data objects in a defined set on page 429*
The related data type datapos	*datapos - Enclosing block for a data object on page 1101*

1.50. GetSysData - Get system data

Usage

`GetSysData` fetches the value and the optional symbol name for the current system data of specified data type.

With this instruction it is possible to fetch data and the name of the current active Tool, Work Object, or PayLoad for the robot in actual or connected motion task.

Basic examples

Basic examples of the instruction `GetSysData` are illustrated below.

Example 1

```
PERS tooldata curtoolvalue := [TRUE, [[0, 0, 0], [1, 0, 0, 0]],
     [2, [0, 0, 2], [1, 0, 0, 0], 0, 0, 0]];
VAR string curtoolname;
GetSysData curtoolvalue;
```

Copy current active tool data value to the persistent variable `curtoolvalue`.

Example 2

```
GetSysData curtoolvalue \ObjectName := curtoolname;
```

Also copy current active tool name to the variable `curtoolname`.

Arguments

```
GetSysData DestObject [\ ObjectName ]
```

`DestObject`

Data type: `anytype`

Persistent variable for storage of current active system data value.

The data type of this argument also specifies the type of system data (Tool, Work Object, or PayLoad) to fetch.

Data type	Type of system data
tooldata	Tool
wobjdata	Work Object
loaddata	Payload

Array or record component can not be used.

`[\ObjectName]`

Data type: `string`

Option argument (variable or persistent) to also fetch the current active system data name.

Continues on next page

Program execution

When running the instruction `GetSysData` the current data value is stored in the specified persistent variable in argument `DestObject`.

If argument `\ObjectName` is used, the name of the current data is stored in the specified variable or persistent in argument `ObjectName`.

Current system data for Tool or Work Object is activated by execution of any move instruction. Payload is activated by execution of the instruction `GripLoad`.

Syntax

```
GetSysData
  [ DestObject ':='] < persistent(PERS) of anytype>
  ['\'ObjectName' ':=' < variable or persistent (INOUT) of string>
       ] ';'
```

Related information

For information about	See
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Definition of payload	*loaddata - Load data on page 1132*
Set system data	*SetSysData - Set system data on page 445*

1.51. GetTrapData - Get interrupt data for current TRAP

Usage

`GetTrapData` is used in a trap routine to obtain all information about the interrupt that caused the trap routine to be executed.

To be used in trap routines generated by instruction `IError`, before use of the instruction `ReadErrData`.

Basic examples

Basic examples of the instruction `GetTrapData` are illustrated below.

See also *More examples on page 115*.

Example 1

```
VAR trapdata err_data;
GetTrapData err_data;
```

Store interrupt information in the non-value variable `err_data`.

Arguments

```
GetTrapData TrapEvent
```

`TrapEvent`

Data type: `trapdata`

Variable for storage of the information about what caused the trap to be executed.

Limitation

This instruction can only be used in a `TRAP` routine.

More examples

More examples of the instruction `GetTrapData` are illustrated below.

Example 1

```
VAR errdomain err_domain;
VAR num err_number;
VAR errtype err_type;
VAR trapdata err_data;
...
TRAP trap_err
  GetTrapData err_data;
  ReadErrData err_data, err_domain, err_number, err_type;
ENDTRAP
```

When an error is trapped to the trap routine `trap_err`, the error domain, the error number, and the error type are saved into appropriate non-value variables of the type `trapdata`.

Syntax

```
GetTrapData
  [TrapEvent ':='] <variable (VAR) of trapdata>';'
```


Continues on next page

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupts*
More information on interrupt management	*Technical reference manual - RAPID overview*, section *Basic characteristics- Interrupts*
Interrupt data for current TRAP	*trapdata - Interrupt data for current TRAP on page 1212*
Orders an interrupt on errors	*IError - Orders an interrupt on errors on page 126*
Gets information about an error	*ReadErrData - Gets information about an error on page 349*

1.52. GOTO - Goes to a new instruction

Usage

`GOTO` is used to transfer program execution to another line (a label) within the same routine.

Basic examples

Basic examples of the instruction `GOTO` are illustrated below.

Example 1

```
GOTO next;
...
next:
```

Program execution continues with the instruction following next.

Example 2

```
reg1 := 1;
next:
...
reg1 := reg1 + 1;
IF reg1<=5 GOTO next;
```

The execution will be transferred to `next` four times (for `reg1=` 2, 3, 4, 5).

Example 3

```
IF reg1>100 THEN
  GOTO highvalue
ELSE
  GOTO lowvalue
ENDIF
lowvalue:
...
GOTO ready;
highvalue:
...
ready:
```

If `reg1` is greater than `100`, the execution will be transferred to the label `highvalue`, otherwise the execution will be transferred to the label `lowvalue`.

Arguments

```
GOTO Label
```

`Label`

Identifier

The label from where program execution is to continue.

Continues on next page

Limitations

It is only possible to transfer program execution to a label within the same routine.

It is only possible to transfer program execution to a label within an `IF` or `TEST` instruction if the `GOTO` instruction is also located within the same branch of that instruction.

It is only possible to transfer program execution to a label within a `FOR` or `WHILE` instruction if the `GOTO` instruction is also located within that instruction.

Syntax

```
(EBNF)
GOTO <identifier>';'
```

Related information

For information about	See
Label	*Label - Line name on page 207*
Other instructions that change the program flow	*Technical reference manual - RAPID overview*, section *RAPID summary - Controlling the program flow*

1.53. GripLoad - Defines the payload for the robot

Usage

`GripLoad` is used to define the payload which the robot holds in its gripper.

Description

When incorrect load data is specified, it can often lead to the following consequences:

If the value in the specified load data is greater than that of the value of the true load;

- The robot will not be used to its maximum capacity
- Impaired path accuracy including a risk of overshooting

If the value in the specified load data is less than the value of the true load;

- Impaired path accuracy including a risk of overshooting
- Risk of overloading the mechanical structure

WARNING!

It is important to always define the actual tool load and when used the payload of the robot too. Incorrect definitions of load data can result in overloading the robot mechanical structure.

Basic examples

Basic examples of the instruction `GripLoad` are illustrated below.

Example 1

```
GripLoad piece1;
```

The robot gripper holds a load called `piece1`.

Example 2

```
GripLoad load0;
```

The robot gripper releases all loads.

Arguments

```
GripLoad Load
```

`Load`

Data type: `loaddata`

The load data that describes the current payload.

Program execution

The specified load affects the performance of the robot.

The default load, 0 kg, is automatically set

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

The payload is updated for the mechanical unit that are controlled from current program task. If `GripLoad` is used from a non-motion task, the payload is updated for the mechanical unit controlled by the connected motion task.

Continues on next page

Syntax

```
GripLoad
  [ Load ':=' ] < persistent (PERS) of loaddata > ';'
```

Related information

For information about	See
Load identification of tool or payload	*Operating manual - IRC5 with FlexPendant*, section *Programming and testing - Service routines - Loadidentify, load identification service routine*
Definition of load data	*loaddata - Load data on page 1132*
Definition of tool load	*tooldata - Tool data on page 1207*
Definition of work object load	*wobjdata - Work object data on page 1224*

1.54. HollowWristReset - Reset hollow wrist for IRB5402 and IRB5403

Usage

`HollowWristReset` (*Reset hollow wrist*) resets the position of the wrist joints on hollow wrist manipulators, such as IRB5402 and IRB5403.

The instruction makes it possible to avoid rewinding the wrist joints 4 and 5 after they have been wound up one or more revolutions. After executing a `HollowWristReset` instruction, the wrist joints may continue to wind up in the same direction.

Description

`HollowWristReset` makes it easier to make application programs. You do not have to ensure that the wrist position is within ±2 revolutions at the time of programming, and it may save cycle time because the robot does not have to spend time rewinding the wrist. However, there is a limitation of ±144 revolutions for winding up joints 4 and 5 before the wrist position is reset by `HollowWristReset`. The robot programmer must be aware of this limitation and take it into consideration when planning the robot programs. To ensure that the 144 revolution limit is not exceeded after running a “wrist-winding” program several times, you should always let the robot come to a complete stop and reset the absolute position in every program (or cycle/routine/module etc. as necessary). Please note that all axes must remain stopped during the execution of the `HollowWristReset` instruction. As long as these limitations are taken into consideration, joints 4 and 5 can wind indefinitely and independently of joint 6 during program execution.

Please use `HollowWristReset` instead of `IndReset` to reset the hollow wrist as this instruction preserves the joint limits for joint 6 in order to prevent too much twisting of the paint tubes/cables.

Basic examples

Basic examples of the instruction `HollowWristReset` are illustrated below.

Example 1

```
MoveL p10,v800,fine,paintgun1\WObj:=workobject1;
HollowWristReset;
```

All active axes are stopped by a stop point and the wrist is reset.

Limitations

All active axes must be stopped while the `HollowWristReset` instruction is executed.

The wrist joints must be reset before any of them reach the ±144 revolution limit (i.e. 51840 degrees/ 904 rad).

Whenever a program stop, emergency stop, power failure stop, etc. occurs, the controller retains the path context in order to be able to return to the path and let the robot continue program execution from the point on the path at which it was stopped. In manual mode, if the manipulator has been moved out of the path between a stop and a restart, the operator is informed by the following message on the FlexPendant: **“Not on path! Robot has been moved after program stop. Should the robot return to the path on Start? Yes/No/ Cancel”**. This provides an opportunity of returning to the path before restart. In automatic mode, the robot automatically returns to the path.

Continues on next page

`HollowWristReset` removes the path context. This means that it is not possible to return to the path in case of a program restart if the `HollowWristReset` instruction has been executed in the meantime. If this instruction is executed manually (“Debug + Call Service Rout.” in the Program Editor) it should only be executed at a time when returning to the path is not required. That is, after a program is completely finished, or an instruction is completely finished in step-by-step execution and the manipulator is not moved out of the path by jogging, etc.

Syntax

```
HollowWristReset ´;’
```

Related information

For information about	See
Related system parameters	*Technical reference manual - System parameters*, section *Motion - Arm - Independent Joint*
Return to path	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution*

1.55. IDelete - Cancels an interrupt

Usage

`IDelete` (*Interrupt Delete*) is used to cancel (delete) an interrupt subscription.

If the interrupt is to be only temporarily disabled, the instruction `ISleep` or `IDisable` should be used.

Basic examples

Basic examples of the instruction `IDelete` are illustrated below.

Example 1

```
IDelete feeder_low;
```

The interrupt `feeder_low` is cancelled.

Arguments

```
IDelete Interrupt
```

`Interrupt`

Data type: `intnum`

The interrupt identity.

Program execution

The definition of the interrupt is completely erased. To define it again it must first be re-connected to the trap routine.

It is recommended to preceed `IDelete` with a stop point. Otherwise the interrupt will be deactivated before the end point of the movement path is reached.

Interrupts do not have to be erased; this is done automatically when

- a new program is loaded
- the program is restarted from the beginning
- the program pointer is moved to the start of a routine

Syntax

```
IDelete [ Interrupt ´:=' ] < variable (VAR) of intnum > ´;'
```

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupts*
More information about interrupt management	*Technical reference manual - RAPID overview*, section *Basic characteristics - Interrupt*
Temporarily disabling an interrupt	*ISleep - Deactivates an interrupt on page 198*
Temporarily disabling all interrupts	*IDisable - Disables interrupts on page 124*

1.56. IDisable - Disables interrupts

Usage

`IDisable` *(Interrupt Disable)* is used to disable all interrupts temporarily. It may, for example, be used in a particularly sensitive part of the program where no interrupts may be permitted to take place in case they disturb normal program execution.

Basic examples

Basic examples of the instruction `IDisable` are illustrated below.

Example 1

```
IDisable;
FOR i FROM 1 TO 100 DO
  character[i]:=ReadBin(sensor);
ENDFOR
IEnable;
```

No interrupts are permitted as long as the serial channel is reading.

Program execution

Interrupts that occur during the time in which an `IDisable` instruction is in effect are placed in a queue. When interrupts are permitted once more, then the interrupt(s) immediately begin generating, executed in “first in - first out” order in the queue.

`IEnable` is active by default. `IEnable` is automatically set

- at a cold start-up
- when starting program execution from the beginning of `main`
- after executing one cycle (passing `main`) or executing `ExitCycle`

Syntax

```
IDisable´;'
```

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupt*
More information about interrupt management	*Technical reference manual - RAPID overview*, section *Basic characteristics - Interrupt*
Permitting interrupts	*IEnable - Enables interrupts on page 125*

1.57. IEnable - Enables interrupts

Usage

`IEnable` (*Interrupt Enable*) is used to enable interrupts during program execution.

Basic examples

Basic examples of the instruction `IEnable` are illustrated below.

Example 1

```
IDisable;
FOR i FROM 1 TO 100 DO
  character[i]:=ReadBin(sensor);
ENDFOR
IEnable;
```

No interrupts are permitted as long as the serial channel is reading. When it has finished reading interrupts are once more permitted.

Program execution

Interrupts which occur during the time in which an `IDisable` instruction is in effect are placed in a queue. When interrupts are permitted once more (`IEnable`), the interrupt(s) then immediately begin generating, executed in“ first in - first out” order in the queue. Program execution then continues in the ordinary program and interrupts which occur after this are dealt with as soon as they occur.

Interrupts are always permitted when a program is started from the beginning. Interrupts disabled by the `ISleep` instruction are not affected by the `IEnable` instruction.

Syntax

```
IEnable´;'
```

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupts*
More information about interrupt management	*Technical reference manual - RAPID overview*, section *Basic characteristics - Interrupt*
Permitting no interrupts	*IDisable - Disables interrupts on page 124*

1.58. IError - Orders an interrupt on errors

Usage

`IError` (*Interrupt Errors*) is used to order and enable an interrupt when an error occurs.

Error, warning, or state change can be logged with `IError`.

Basic examples

Basic examples of the instruction `IError` are illustrated below.

See also *More examples on page 127*.

Example 1

```
VAR intnum err_int;
...
CONNECT err_int WITH err_trap;
IError COMMON_ERR, TYPE_ALL, err_int;
```

Orders an interrupt in RAPID and execution of the `TRAP` routine `err_trap` each time an error, warning, or state change is generated in the system.

Arguments

```
IError ErrorDomain [\ErrorId] ErrorType Interrupt
```

`ErrorDomain`

Data type: `errdomain`

The error domain that is to be monitored. Refer to predefined data of type `errdomain`. To specify any domain use `COMMON_ERR`.

`[ \ErrorId ]`

Data type: `num`

Optionally, the number of a specific error that is to be monitored. The error number must be specified without the first digit (error domain) of the complete error number.

E.g. 10008 Program restarted, must be specified as 0008 or only 8.

`ErrorType`

Data type: `errtype`

The type of event such as error, warning, or state change that is to be monitored. Refer to predefined data of type `errtype`. To specify any type use `TYPE_ALL`.

`Interrupt`

Data type: `intnum`

The interrupt identity. This should have been previously connected to a trap routine by means of the instruction `CONNECT`.

Program execution

The corresponding trap routine is automatically called when an error occurs in the specified domain of the specified type and optionally with the specified error number. When this has been executed, program execution continues from where the interrupt occurred.

Continues on next page

More examples

More examples of the instruction `IError` are illustrated below.

```
VAR intnum err_interrupt;
VAR trapdata err_data;
VAR errdomain err_domain;
VAR num err_number;
VAR errtype err_type;
...
CONNECT err_interrupt WITH trap_err;
IError COMMON_ERR, TYPE_ERR, err_interrupt;
...
IDelete err_interrupt;
...
TRAP trap_err
  GetTrapData err_data;
  ReadErrData err_data, err_domain, err_number, err_type;
  ! Set domain no 1 ... 11
  SetGO go_err1, err_domain;
  ! Set error no 1 ...9999
  SetGO go_err2, err_number;
ENDTRAP
```

When an error occurs (only error, not warning or state change) the error number is retrieved in the trap routine, and its value is used to set 2 groups of digital output signals.

Limitation

It is not possible to order an interrupt on internal errors.

In a task of type `NORMAL` the event will be thrown away during program stop so not all events can be fetched in a NORMAL task. To fetch all events the task must be of static or semi-static type.

The same variable for interrupt identity cannot be used more than once without first deleting it. Interrupts should therefore be handled as shown in one of the alternatives below.

```
PROC main ( )
  VAR intnum err_interrupt;
  CONNECT err_interrupt WITH err_trap;
  IError COMMON_ERR, TYPE_ERR, err_interupt;
  WHILE TRUE DO
  :
  :
  ENDWHILE
ENDPROC
```


Continues on next page

Interrupts are activated at the beginning of the program. These instructions in the beginning are then kept outside the main flow of the program.

```
PROC main ( )
  VAR intnum err_interrupt;
  CONNECT err_interrupt WITH err_trap;
  IError COMMON_ERR, TYPE_ERR, err_interupt;
  :
  :
  IDelete err_interrupt;
ENDPROC
```

The interrupt is deleted at the end of the program and is then reactivated. It should be noted, in this case, that the interrupt is inactive for a short period.

Syntax

```
IError
  [ErrorDomain ':='] <expression (IN) of errdomain>
  ['\'ErrorId':=' <expression (IN) of num>\\ ','
  [ErrorType' :='] <expression (IN) of errtype> ´,'
  [Interrupt' :='] <variable (VAR) of intnum>';'
```

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupts*
More information on interrupt management	*Technical reference manual - RAPID overview*, section *Basic characteristics- Interrupts*
Error domains, predefined constants	*errdomain - Error domain on page 1106*
Error types, predefined constants	*errtype - Error type on page 1115*
Get interrupt data for current TRAP	*GetTrapData - Get interrupt data for current TRAP on page 115*
Gets information about an error	*ReadErrData - Gets information about an error on page 349*

1.59. IF - If a condition is met, then ...; otherwise ...

Usage

`IF` is used when different instructions are to be executed depending on whether a condition is met or not.

Basic examples

Basic examples of the instruction `IF` are illustrated below.

See also *More examples on page 130*.

Example 1

```
IF reg1 > 5 THEN
  Set do1;
  Set do2;
ENDIF
```

The `do1 and do2` signals are set only if `reg1` is greater than `5`.

Example 2

```
IF reg1 > 5 THEN
  Set do1;
  Set do2;
ELSE
  Reset do1;
  Reset do2;
ENDIF
```

The `do1` and `do2` signals are set or reset depending on whether `reg1` is greater than `5` or not.

Arguments

```
IF Condition THEN ...
  {ELSEIF Condition THEN ...}
[ELSE ...]
ENDIF
```

`Condition`

Data type: `bool`

The condition that must be satisfied for the instructions between `THEN` and `ELSE/ELSEIF` to be executed.

Continues on next page

More examples

More examples of how to use the instruction `IF` are illustrated below.

Example 1

```
IF counter > 100 THEN
  counter := 100;
ELSEIF counter < 0 THEN
  counter := 0;
ELSE
  counter := counter + 1;
ENDIF
```

`Counter` is incremented by `1`. However, if the value of `counter` is outside the limit `0-100`, `counter` is assigned the corresponding limit value.

Program execution

The conditions are tested in sequential order, until one of them is satisfied. Program execution continues with the instructions associated with that condition. If none of the conditions are satisfied, program execution continues with the instructions following `ELSE`. If more than one condition is met, only the instructions associated with the first of those conditions are executed.

Syntax

```
(EBNF)
IF <conditional expression> THEN
  <instruction list>
{ELSEIF <conditional expression> THEN <instruction list> | <EIT>}
[ELSE
  <instruction list>]
ENDIF
```

Related information

For information about	See
Conditions (logical expressions)	*Technical reference manual - RAPID overview*, section *Basic characteristics - Expressions*

1.60. Incr - Increments by 1

Usage

`Incr` is used to add 1 to a numeric variable or persistent.

Basic examples

Basic examples of the instruction `Incr` are illustrated below.

See also *More examples on page 131*.

Example 1

```
Incr reg1;
```

1 is added to `reg1`, i.e. `reg1:=reg1+1`.

Arguments

```
Incr Name | Dname
```

`Name`

Data type: `num`

The name of the variable or persistent to be changed.

`Dname`

Data type: `dnum`

The name of the variable or persistent to be changed.

More examples

More examples of the instruction `Incr` are illustrated below.

Example 1

```
VAR num no_of_parts:=0;
...
WHILE stop_production=0 DO
  produce_part;
  Incr no_of_parts;
  TPWrite "No of produced parts= "\Num:=no_of_parts;
ENDWHILE
```

The number of parts produced is updated each cycle on the FlexPendant. Production continues to run as long as the input signal `stop_production` is not set.

Example 2

```
VAR dnum no_of_parts:=0;
...
WHILE stop_production=0 DO
  produce_part;
  Incr no_of_parts;
  TPWrite "No of produced parts= "\Dnum:=no_of_parts;
ENDWHILE
```

The number of parts produced is updated each cycle on the FlexPendant. Production continues to run as long as the input signal `stop_production` is not set.

Continues on next page

Syntax

```
Incr
  [ Name ':=' ] < var or pers (INOUT) of num >
  | [ Dname' :=' ] < var or pers (INOUT) of dnum >' ;'
```

Related information

For information about	See
Decrementing a variable by 1	*Decr - Decrements by 1 on page 81*
Adding any value to a variable	*Add - Adds a numeric value on page 19*
Changing data using an arbitrary expression, e.g. multiplication	*":=" - Assigns a value on page 24*

1.61. IndAMove - Independent absolute position movement

Usage

`IndAMove` (*Independent Absolute Movement*) is used to change an axis to independent mode and move the axis to a specific position.

An independent axis is an axis moving independently of other axes in the robot system. As program execution immediately continues, it is possible to execute other instructions (including positioning instructions) during the time the independent axis is moving.

If the axis is to be moved within a revolution, the instruction `IndRMove` should be used instead. If the move is to occur a short distance from the current position, the instruction `IndDMove` must be used.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `IndAMove` are illustrated below.

See also *More examples on page 135*.

Example 1

```
IndAMove Station_A,2\ToAbsPos:=p4,20;
```

Axis `2` of `Station_A` is moved to the position `p4` at the speed `20` degrees/s.

Arguments

```
IndAMove MecUnit Axis [\ToAbsPos] | [\ToAbsNum] Speed [\Ramp]
```

`MecUnit`

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit.

`Axis`

Data type: `num`

The number of the current axis for the mechanical unit (1-6)

`[\ToAbsPos]`

To Absolute Position

Data type: `robtarget`

Axis position specified as a `robtarget`. Only the component for this specific `Axis` is used. The value is used as an absolute position value in degrees (mm for linear axes).

The axis position will be affected if the axis is displaced using the instruction `EOffsSet` or `EOffsOn`.

For robot axes the argument `\ToAbsNum` is to be used instead.

Continues on next page

`[\ToAbsNum]`

To Absolute Numeric value

Data type: `num`

Axis position defined in degrees (mm for linear axis).

Using this argument, the position will NOT be affected by any displacement, e.g. `EOffsSet` or `PDispOn`.

Same function as `\ToAbsPos` but the position is defined as a numeric value to make it easy to manually change the position.

`Speed`

Data type: `num`

Axis speed in degrees/s (mm/s for linear axis).

`[\Ramp]`

Data type: `num`

Decrease acceleration and deceleration from maximum performance
(1 - 100%, 100% = maximum performance).

Program execution

When `IndAMove` is executed the specified axis moves with the programmed speed to the specified axis position. If `\Ramp` is programmed there will be a reduction of acceleration/ deceleration.

To change the axis back to normal mode the `IndReset` instruction is used. In connection with this the logical position of the axis can be changed so that a number of revolutions are erased from the position, for example, to avoid rotating back for the next movement.

The speed can be altered by executing another `IndAMove` instruction (or another `IndXMove` instruction). If a speed in the opposite direction is selected the axis stops and then accelerates to the new speed and direction.

For stepwise execution of the instruction the axis is set in independent mode only. The axis begins its movement when the next instruction is executed and continues as long as program execution takes place. For more information see *RAPID reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution - Independent axes*.

When the program pointer is moved to the start of the program or to a new routine all axes are automatically set to normal, without changing the measurement system (equivalent to executing the instruction `IndReset\Old`).

NOTE!

An `IndAMove` instruction after an `IndCMove` operation can result in the axis spinning back to the movement performed in the `IndCMove` instruction. To prevent this, use an `IndReset` instruction before the `IndAMove`, or use an `IndRMove` instruction.

Continues on next page

Limitations

Axes in independent mode cannot be jogged. If an attempt is made to execute the axis manually, the axis will not move and an error message will be displayed. Execute an `IndReset` instruction or move the program pointer to main in order to leave independent mode.

If a power fail occurs when an axis is in independent mode the program cannot be restarted. An error message is displayed and the program must be started from the beginning.

The instruction is not advisable for coupled robot wrist axes (see *RAPID reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution - Independent axes*).

More examples

More examples of the instruction `IndAMove` are illustrated below.

Example 1

```
ActUnit Station_A;
weld_stationA;
IndAMove Station_A,1\ToAbsNum:=90,20\Ramp:=50;
ActUnit Station_B;
weld_stationB_1;
WaitUntil IndInpos(Station_A,1 ) = TRUE;
WaitTime 0.2;
DeactUnit Station_A;
weld_stationB_2;
```

`Station_A` is activated and the welding is started in station A.

`Station_A` (axis 1) is then moved to the 90 degrees position while the robot is welding in station B. The speed of the axis is 20 degrees/s. The speed is changed with acceleration/deceleration reduced to 50% of max performance.

When station A reaches this position it is deactivated, and reloading can take place in the station at the same time as the robot continues to weld in station B.

Error handling

If the axis is not activated the system variable `ERRNO` is set to `ERR_AXIS_ACT`. This error can then be handled in the error handler.

Syntax

```
IndAMove
  [ MecUnit':=' ] < variable (VAR) of mecunit>' ,'
  [ Axis':=' ] < expression (IN) of num>
  [ '\'ToAbsPos':=' < expression (IN) of robtarget> ]
  | [ '\' ToAbsNum':=' < expression (IN) of num> ] ','
  [ Speed ':=' ] < expression (IN) of num>
  [ '\' Ramp':=' < expression (IN) of num > ] ';'
```


Continues on next page

Related information

For information about	See
Independent axes in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - Positioning during program execution - Independent axes*
Change back to normal mode	*IndReset - Independent reset on page 144*
Reset the measurement system	*IndReset - Independent reset on page 144*
Other independent axis movement	*IndRMove - Independent relative position movement on page 149* *IndDMove - Independent delta position movement on page 141* *IndCMove - Independent continuous movement on page 137*
Check the speed status for independent axes	*IndSpeed - Independent speed status on page 873*
Check the position status for independent axes	*IndInpos - Independent axis in position status on page 871*
Defining independent joints	*Technical reference manual - System parameters*, section *Motion - Arm - Independent Joint*

1.62. IndCMove - Independent continuous movement

Usage

`IndCMove` (*Independent Continuous Movement*) is used to change an axis to independent mode and start the axis moving continuously at a specific speed.

An independent axis is an axis moving independently of other axes in the robot system. As program execution continues immediately it is possible to execute other instructions (including positioning instructions) during the time the independent axis is moving.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `IndCMove` are illustrated below.

See also *More examples on page 139*.

Example 1

```
IndCMove Station_A,2,-30.5;
```

Axis `2` of `Station_A` starts to move in a negative direction at a speed of `30.5` degrees/s.

Arguments

```
IndCMove MecUnit Axis Speed [\Ramp]
```

`MecUnit`

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit.

`Axis`

Data type: num

The number of the current axis for the mechanical unit (1-6).

`Speed`

Data type: `num`

Axis speed in degrees/s (mm/s for linear axis).

The direction of movement is specified with the sign of the speed argument.

`[\Ramp]`

Data type: `num`

Decrease acceleration and deceleration from maximum performance
(1 - 100%, 100% = maximum performance).

Continues on next page

Program execution

When `IndCMove` is executed the specified axis starts to move with the programmed speed. The direction of movement is specified as the sign of the speed argument. If `\Ramp` is programmed there will be a reduction of acceleration/deceleration.

To change the axis back to normal mode the `IndReset` instruction is used. The logical position of the axis can be changed in connection with this - a number of full revolutions can be erased, for example, to avoid rotating back for the next movement.

The speed can be changed by executing a further `IndCMove` instruction. If a speed in the opposite direction is ordered the axis stops and then accelerates to the new speed and direction. To stop the axis, speed argument 0 can be used. It will then still be in independent mode.

During stepwise execution of the instruction the axis is set in independent mode only. The axis starts its movement when the next instruction is executed and continues as long as program execution continues. For more information see *RAPID reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution - Independent axes*.

When the program pointer is moved to the beginning of the program or to a new routine, all axes are set automatically to normal mode without changing the measurement system (equivalent to executing the instruction `IndReset\Old`).

Limitations

The resolution of the axis position worsens the further it is moved from its logical zero position (usually the middle of the working area). To achieve high resolution again the logical working area can be set to zero with the instruction `IndReset`. For more information see *RAPID reference manual - RAPID overview*, section *Motion and I/O Principles - Positioning during program execution - Independent axes*.

Axes in independent mode cannot be jogged. If an attempt is made to execute the axis manually, the axis will not move, and an error message will be displayed. Execute an `IndReset` instruction or move the program pointer to main in order to leave independent mode.

If a power fail occurs when the axis is in independent mode the program cannot be restarted. An error message is displayed, and the program must be started from the beginning.

The instruction is not advisable for coupled robot wrist axes (see *RAPID Reference Manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution - Independent Axes*).

Continues on next page

More examples

More examples of the instruction `IndCMove` are illustrated below.

```
IndCMove Station_A,2,20;
WaitUntil IndSpeed(Station_A,2 \InSpeed) = TRUE;
WaitTime 0.2;
MoveL p10, v1000, fine, tool1;
IndCMove Station_A,2,-10\Ramp:=50;
MoveL p20, v1000, z50, tool1;
IndRMove Station_A,2 \ToRelPos:=p1 \Short,10;
MoveL p30, v1000, fine, tool1;
WaitUntil IndInpos(Station_A,2 ) = TRUE;
WaitTime 0.2;
IndReset Station_A,2 \RefPos:=p40\Short;
MoveL p40, v1000, fine, tool1;
```

Axis `2` of `Station_A` starts to move in a positive direction at a speed of `20` degrees/s. When this axis has reached the selected speed the robot axes start to move.

When the robot reaches position `p10` the external axis changes direction and rotates at a speed of `10` degrees/s. The change of speed is performed with acceleration/deceleration reduced to `50`% of maximum performance. At the same time, the robot executes towards `p20`.

Axis `2` of `Station_A` is then stopped as quickly as possible in position `p1` within the current revolution.

When axis 2 has reached this position, and the robot has stopped in position `p30`, axis `2` returns to normal mode again. The measurement system offset for this axis is changes a whole number of axis revolutions so that the actual position is as close as possible to `p40`.

When the robot is then moved to position `p40`, axis `2` of `Station_A` will be moved by the instruction `MoveL p40` via the shortest route to position `p40` (max ±180 degrees).

Error handling

If the axis is not activated the system variable `ERRNO` is set to `ERR_AXIS_ACT`. This error can then be handled in the error handler.

Syntax

```
IndCMove
  [ MecUnit':=' ] < variable (VAR) of mecunit> ','
  [ Axis':=' ] < expression (IN) of num> ','
  [ Speed ':=' ] < expression (IN) of num>
  [ '\' Ramp':=' < expression (IN) of num > ] ';'
```


Continues on next page

Related information

For information about	See
Independent axes in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution - Independent axes*
Change back to normal mode	*IndReset - Independent reset on page 144*
Reset the measurement system	*IndReset - Independent reset on page 144*
Other independent axis movement	*IndAMove - Independent absolute position movement on page 133* *IndRMove - Independent relative position movement on page 149* *IndDMove - Independent delta position movement on page 141*
Check the speed status for independent axes	*IndSpeed - Independent speed status on page 873*
Check the position status for independent axes	*IndInpos - Independent axis in position status on page 871*
Defining independent joints	*Technical reference manual - System parameters*, section *Motion - Arm - Independent Joint*

1.63. IndDMove - Independent delta position movement

Usage

`IndDMove` (*Independent Delta Movement*) is used to change an axis to independent mode and move the axis to a specific distance.

An independent axis is an axis moving independently of other axes in the robot system. As program execution continues immediately it is possible to execute other instructions (including positioning instructions) during the time the independent axis is moving.

If the axis is to be moved to a specific position, the instruction `IndAMove` or `IndRMove` must be used instead.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `IndDMove` are illustrated below.

See also *More examples on page 142*.

Example 1

```
IndDMove Station_A,2,-30,20;
```

Axis `2` of `Station_A` is moved `30` degrees in a negative direction at a speed of `20` degrees/s.

Arguments

```
IndDMove MecUnit Axis Delta Speed [\Ramp]
```

`MecUnit`

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit.

`Axis`

Data type: `num`

The number of the current axis for the mechanical unit (1-6).

`Delta`

Data type: `num`

The distance which the current axis is to be moved, expressed in degrees (mm for linear axes). The sign specifies the direction of movement.

`Speed`

Data type: `num`

Axis speed in degrees/s (mm/s for linear axis).

`[ \Ramp ]`

Data type: `num`

Decrease acceleration and deceleration from maximum performance
(1 - 100%, 100% = maximum performance).

Continues on next page

Program execution

When `IndDMove` is executed the specified axis moves with the programmed speed to the specified distance. The direction of movement is specified as the sign of the `Delta` argument. If `\Ramp` is programmed there will be a reduction of acceleration/deceleration.

If the axis is moving the new position is calculated from the momentary position of the axis when the instruction `IndDMove` is executed. If an `IndDMove` instruction with distance 0 is executed and the axis is already moving position, the axis will stop and then move back to the position which the axis had when the instruction was executed.

To change the axis back to normal mode the `IndReset` instruction is used. The logical position of the axis can be changed in connection with this - a number of full revolutions can be erased from the position, for example, to avoid rotating back for the next movement.

The speed can be changed by running a further `IndDMove` instruction (or another `IndXMove` instruction). If a speed in the opposite direction is selected the axis stops and then accelerates to the new speed and direction.

During stepwise execution of the instruction the axis is set in independent mode only. The axis starts its movement when the next instruction is executed and continues as long as program execution continues. For more information see *RAPID reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution - Independent axes*.

When the program pointer is moved to the beginning of the program, or to a new routine, all axes are automatically set to normal mode without changing the measurement system (equivalent to running the instruction `IndReset \Old`).

Limitations

Axes in independent mode cannot be jogged. If an attempt is made to execute the axis manually the axis will not move, and an error message will be displayed. Execute an `IndReset` instruction or move the program pointer to main in order to leave independent mode.

If a loss of power fail occurs when the axis is in independent mode the program cannot be restarted. An error message is displayed, and the program must be started from the beginning.

The instruction is not advisable for coupled robot wrist axes (see *RAPID reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution - Independent axes*.

More examples

More examples of the instruction `IndDMove` are illustrated below.

Example 1

```
IndAMove ROB_1,6\ToAbsNum:=90,20;
WaitUntil IndInpos(ROB_1,6) = TRUE;
WaitTime 0.2;
IndDMove Station_A,2,-30,20;
WaitUntil IndInpos(ROB_1,6) = TRUE;
WaitTime 0.2;
IndDMove ROB_1,6,400,20;
```


Continues on next page

Axis 6 of the robot is moved to the following positions:

- 90 degrees
- 60 degrees
- 460 degrees (1 revolution + 100 degrees)

Error handling

If the axis is not activated, the system variable `ERRNO` is set to `ERR_AXIS_ACT`. This error can then be handled in the error handler.

Syntax

```
IndDMove
[ MecUnit':=' ] < variable (VAR) of mecunit> ','
[ Axis':=' ] < expression (IN) of num> ','
[ Delta':=' ] < expression (IN) of num>','
[ Speed ':=' ] < expression (IN) of num>
[ '\' Ramp':=' < expression (IN) of num > ] ';'
```

Related information

For information about	See
Independent axes in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution - Independent axes*
Change back to normal mode	*IndReset - Independent reset on page 144*
Reset the measurement system	*IndReset - Independent reset on page 144*
Other independent axis movement	*IndAMove - Independent absolute position movement on page 133* *IndRMove - Independent relative position movement on page 149* *IndCMove - Independent continuous movement on page 137*
Check the speed status for independent axes	*IndSpeed - Independent speed status on page 873*
Check the position status for independent axes	*IndInpos - Independent axis in position status on page 871*
Defining independent joints	*Technical reference manual - System parameters*, section *Motion - Arm - Independent Joint*

1.64. IndReset - Independent reset

Usage

`IndReset` (*Independent Reset*) is used to change an independent axis back to normal mode. At the same time, the measurement system for rotational axes can be moved a number of axis revolutions.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `IndReset` are illustrated below.

See also *More examples on page 147*.

```
IndCMove Station_A,2,5;
MoveL *,v1000,fine,tool1;
IndCMove Station_A,2,0;
WaitUntil IndSpeed(Station_A,2\ZeroSpeed);
WaitTime 0.2
IndReset Station_A,2;
```

Axis `2` of `Station_A` is first moved in independent mode and then changed back to normal mode. The axis will keep its position.

NOTE!

The current independent axis and the normal axes should not move when the instruction `IndReset` is executed. That is why previous position is a stop point, and an `IndCMove` instruction is executed at zero speed. Furthermore, a pause of `0.2` seconds is used to ensure that the correct status has been achieved.

Arguments

```
IndReset MecUnit Axis [\RefPos] | [\RefNum] [\Short] | [\Fwd]
      |[\Bwd] | \Old]
```

`MecUnit`

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit.

`Axis`

Data type: `num`

The number of the current axis for the mechanical unit (1-6).

Continues on next page

`[ \RefPos ]`

Reference Position

Data type: `robtarget`

Reference axis position specified as a `robtarget`. Only the component for this specific `Axis` is used. The position must be inside the normal working range.

For robot axes, the argument `\RefNum` is to be used instead.

The argument is only to be defined together with the argument `\Short`, `\Fwd` or `\Bwd`. It is not allowed together with the argument `\Old`.

`[ \RefNum ]`

Reference Numeric value

Data type: `num`

Reference axis position defined in degrees (mm for linear axis). The position must be inside the normal working range.

The argument is only to be defined together with the argument `\Short`, `\Fwd` or `\Bwd`. It is not allowed together with the argument `\Old`.

Same function as `\RefPos` but the position is defined as a numeric value to make it easy to change the position manually.

`[ \Short ]`

Data type: `switch`

The measurement system will change a whole number of revolutions on the axis side so that the axis will be as close as possible to the specified `\RefPos` or `\RefNum` position. If a positioning instruction with the same position is executed after `IndReset` the axis will travel the shortest route, less than ±180 degrees, in order to reach the position.

`[ \Fwd ]`

Forward

Data type: `switch`

The measurement system will change a whole number of revolutions on the axis side so that the reference position will be on the positive side of the specified `\RefPos` or `\RefNum` position. If a positioning instruction with the same position is executed after `IndReset`, the axis will turn in a positive direction less than 360 degrees in order to reach the position.

`[ \Bwd ]`

Backward

Data type: `switch`

The measurement system will change a whole number of revolutions on the axis side so that the reference position will be on the negative side of the specified `\RefPos` or `\RefNum` position. If a positioning instruction with the same position is executed after `IndReset`, the axis will turn in a negative direction less than 360 degrees in order to reach the position.

Continues on next page

`[ \Old ]`

Data type: `switch`

Keeps the old position.

NOTE!

Resolution is decreased in positions far away from zero.

If no argument `\Short`, `\Fwd`, `\Bwd` or `\Old` is specified - `\Old` is used as default value.

Program execution

When `IndReset` is executed it changes the independent axis back to normal mode. At the same time the measurement system for the axis can be moved by a whole number of axis revolutions.

The instruction may also be used in normal mode in order to change the measurement system.

NOTE!

The position is used only to adjust the measurement system - the axis will not move to the position.

Limitations

The instruction may only be executed when all active axes running in normal mode are standing still. All active axis in every mechanical unit connected to the same motion planner need to stand still. The independent mode axis which is going to be changed to normal mode must also be stationary. For axes in normal mode this is achieved by executing a move instruction with the argument `fine`. The independent axis is stopped by an `IndCMove` with `Speed`:=0 (followed by a wait period of 0.2 seconds), `IndRMove`, `IndAMove`, or `IndDMove` instruction.

The resolution of positions is decreased when moving away from logical position 0. An axis which progressively rotates further and further from the position 0 should thus be set to zero using the instruction `IndReset` with an argument other than `\Old`.

The measurement system cannot be changed for linear axes.

To ensure a proper start after `IndReset` of an axis with a relative measured measurement system (synchronization switches) an extra time delay of 0.12 seconds must be added after the `IndReset` instruction.

Only robot axis 6 can be used as independent axis. The `IndReset` instruction can also be used for axis 4 on models IRB2400 and IRB 4400. If `IndReset` is used on robot axis 4 then axis 6 must not be in the independent mode.

If this instruction is preceded by a move instruction, that move instruction must be programmed with a stop point (zonedata `fine`), not a fly-by point. Otherwise restart after power failure will not be possible.

`IndReset` cannot be executed in a RAPID routine connected to any of following special system events: PowerOn, Stop, QStop, Restart or Step.

`IndReset` only switches the independent state for an axis. It cannot be used to stop an Independent movement. To stop an independent motion it has to reach a stop condition ot the user has to for example move PP to main.

Continues on next page

More examples

More examples of the instruction `IndReset` are illustrated below.

Example 1

```
IndAMove Station_A,1\ToAbsNum:=750,50;
WaitUntil IndInpos(Station_A,1);
WaitTime 0.2;
IndReset Station_A,1 \RefNum:=0 \Short;.
IndAMove Station_A,1\ToAbsNum:=750,50;
WaitUntil IndInpos(Station_A,1);
WaitTime 0.2;
IndReset Station_A,1 \RefNum:=300 \Short;
```

Axis `1` in `Station_A` is first moved independently to the `750` degrees position (2 revolutions and 30 degrees). At the same time as it changes to normal mode the logical position is set to 30 degrees.

Axis `1` in `Station_A` is subsequently moved to the `750` degrees position (2 revolutions and 30 degrees). At the same time as it changes to normal mode the logical position is set to 390 degrees (1 revolution and 30 degrees).

Error handling

If the axis is moving the system variable `ERRNO` is set to `ERR_AXIS_MOVING`.

If the axis is not activated the system variable `ERRNO` is set to `ERR_AXIS_ACT`. This error can then be handled in the error handler.

Syntax

```
IndReset
  [ MecUnit':=' ] < variable (VAR) of mecunit> ','
  [ Axis':=' ] < expression (IN) of num>
  [ '\' RefPos':=' < expression (IN) of robtarget> ] |
  [ '\' RefNum':=' < expression (IN) of num> ]
  [ '\' Short ] | [ '\' Fwd ] | [ '\' Bwd ] | [ '\' Old ]';'
```


Continues on next page

Related information

For information about	See
Independent axes in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution - Independent axes*
Change an axis to independent mode	*IndAMove - Independent absolute position movement on page 133* *IndCMove - Independent continuous movement on page 137* *IndDMove - Independent delta position movement on page 141* *IndRMove - Independent relative position movement on page 149*
Check the speed status for independent axes	*IndSpeed - Independent speed status on page 873*
Check the position status for independent axes	*IndInpos - Independent axis in position status on page 871*
Defining independent joints	*Technical reference manual - System parameters*, section *Motion - Arm - Independent Joint*

1.65. IndRMove - Independent relative position movement

Usage

`IndRMove` (*Independent Relative Movement*) is used to change a rotational axis to independent mode and move the axis to a specific position within one revolution.

An independent axis is an axis moving independently of other axes in the robot system. As program execution continues immediately it is possible to execute other instructions (including positioning instructions) during the time the independent axis is moving.

If the axis is to be moved to an absolute position (several revolutions) or if the axis is linear, the instruction `IndAMove` is used instead. If the movement is to take place a certain distance from the current position the instruction `IndDMove` must be used.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `IndRMove` are illustrated below.

See also *More examples on page 152*.

Example 1

```
IndRMove Station_A,2\ToRelPos:=p5 \Short,20;
```

Axis `2` of `Station_A` is moved the shortest route to position `p5` within one revolution (maximum rotation ± 180 degrees) at a speed of `20` degrees/s.

Arguments

```
IndRMove MecUnit Axis [\ToRelPos] | [\ToRelNum] [\Short] | [\Fwd]
      | [\Bwd] Speed [\Ramp]
```

`MecUnit`

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit.

`Axis`

Data type: `num`

The number of the current axis for the mechanical unit (1-6).

`[ \ToRelPos ]`

To Relative Position

Data type: `robtarget`

Axis position specified as a `robtarget`. Only the component for this specific `Axis` is used. The value is used as a position value in degrees within one axis revolution. This means that the axis moves less than one revolution.

The axis position will be affected if the axis is displaced using the instruction `EOffsSet` or `EOffsOn`.

For robot axes the argument `\ToRelNum` is to be used instead.

Continues on next page

`[ \ToRelNum ]`

To Relative Numeric value

Data type: `num`

Axis position defined in degrees.

Using this argument the position will NOT be affected by any displacement, e.g. `EOffsSet` or `PDispOn`.

Same function as `\ToRelPos` but the position is defined as a numeric value to make it easy to change the position manually.

`[ \Short ]`

Data type: `switch`

The axis is moved the shortest route to the new position. This means that the maximum rotation will be 180 degrees in any direction. The direction of movement therefore depends on the current location of the axis.

`[ \Fwd ]`

Forward

Data type: `switch`

The axis is moved in a positive direction to the new position. This means that the maximum rotation will be 360 degrees and always in a positive direction (increased position value).

`[ \Bwd ]`

Backward

Data type: `switch`

The axis is moved in a negative direction to the new position. This means that the maximum rotation will be 360 degrees and always in a negative direction (decreased position value).

If `\Short`, `\Fwd` or `\Bwd` argument is omitted, `\Short` is used as default value.

`Speed`

Data type: `num`

Axis speed in degrees/s.

`[ \Ramp ]`

Data type: `num`

Decrease acceleration and deceleration from maximum performance
(1 - 100%, 100% = maximum performance).

Continues on next page

Program execution

When `IndRMove` is executed the specified axis moves with the programmed speed to the specified axis position, but only a maximum of one revolution. If `\Ramp` is programmed there will be a reduction of acceleration/deceleration.

To change the axis back to normal mode the `IndReset` instruction is used. The logical position of the axis can be changed in connection with this - a number of full revolutions can be erased from the position, for example, to avoid rotating back for the next movement.

The speed can be changed by running a further `IndRMove` instruction (or another `IndXMove` instruction). If a speed in the opposite direction is selected the axis stops and then accelerates to the new speed and direction.

During stepwise execution of the instruction the axis is set in independent mode only. The axis starts its movement when the next instruction is executed and continues as long as program execution continues. For more information see *RAPID reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution - Independent axes*.

When the program pointer is moved to the beginning of the program or to a new routine, all axes are automatically set to normal mode without changing the measurement system (equivalent to running the instruction `IndReset \Old`).

Limitations

Axes in independent mode cannot be jogged. If an attempt is made to execute the axis manually the axis will not move, and an error message will be displayed. Execute an `IndReset` instruction or move the program pointer to main in order to leave independent mode.

If a power fail occurs when the axis is in independent mode the program cannot be restarted. An error message is displayed, and the program must be started from the beginning.

The instruction is not advisable for coupled robot wrist axes (see *RAPID reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution - Independent axes*).

Continues on next page

More examples

More examples of the instruction `IndRMove` are illustrated below.

Example 1

```
IndRMove Station_A,1\ToRelPos:=p5 \Fwd,20\Ramp:=50;
```

Axis `1` of `Station_A` starts to move in a positive direction to the position `p5` within one revolution (maximum rotation 360 degrees) at a speed of `20` degrees/s. The speed is changed with acceleration/deceleration reduced to `50`% of maximum performance.

```
IndAMove Station_A,1\ToAbsNum:=90,20;
WaitUntil IndInpos(Station_A,1 ) = TRUE;
IndRMove Station_A,1\ToRelNum:=80 \Fwd,20;
WaitTime 0.2;
WaitUntil IndInpos(Station_A,1 ) = TRUE;
WaitTime 0.2;
IndRMove Station_A,1\ToRelNum:=50 \Bwd,20;
WaitUntil IndInpos(Station_A,1 ) = TRUE;
WaitTime 0.2;
IndRMove Station_A,1\ToRelNum:=150 \Short,20;
WaitUntil IndInpos(Station_A,1 ) = TRUE;
WaitTime 0.2;
IndAMove Station_A,1\ToAbsNum:=10,20;
```

Axis `1` of `Station_A` is moved to the following positions:

- 90 degrees
- 440 degrees (1 revolution + 80 degrees)
- 410 degrees (1 revolution + 50 degrees)
- 510 degrees (1 revolution + 150 degrees)
- 10 degrees

Error handling

If the axis is not activated the system variable `ERRNO` is set to `ERR_AXIS_ACT`. This error can then be handled in the error handler.

Syntax

```
IndRMove
  [ MecUnit':=' ] < variable (VAR) of mecunit> ','
  [ Axis':=' ] < expression (IN) of num>
  [ '\'ToRelPos':=' < expression (IN) of robtargets> ]
  | [ '\'ToRelNum':=' < expression (IN) of num> ]
  [ '\'Short ] | [ '\' Fwd ] | [ '\' Bwd ] ','
  [ Speed ':=' ] < expression (IN) of num>
  [ '\'Ramp':=' < expression (IN) of num > ] ';'
```


Continues on next page

Related information

For information about	See
Independent axes in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution - Independent axes*
Change back to normal mode	*IndReset - Independent reset on page 144*
Reset the measurement system	*IndReset - Independent reset on page 144*
Other independent axis movement	*IndAMove - Independent absolute position movement on page 133* *IndDMove - Independent delta position movement on page 141* *IndCMove - Independent continuous movement on page 137*
Check the speed status for independent axes	*IndSpeed - Independent speed status on page 873*
Check the position status for independent axes	*IndInpos - Independent axis in position status on page 871*
Defining independent joints	*Technical reference manual - System parameters*, section *Motion - Arm - Independent Joint*

1.66. InvertDO - Inverts the value of a digital output signal

Usage

`InvertDO` (*Invert Digital Output*) inverts the value of a digital output signal (0 -> 1 and 1 -> 0).

Basic examples

Basic examples of the instruction `InvertDO` are illustrated below.

Example 1

```
InvertDO do15;
```

The current value of the signal `do15` is inverted.

Arguments

```
InvertDO Signal
```

`Signal`

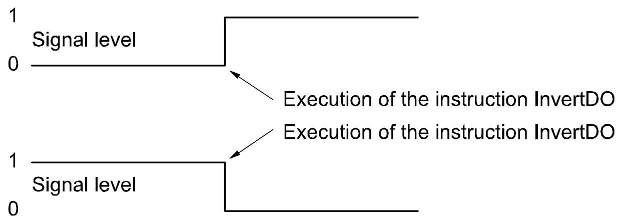
Data type: `signaldo`

The name of the signal to be inverted.

Program execution

The current value of the signal is inverted (see figure below).

The figure below shows inversion of digital output signal.



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Error handling

The following recoverable error can be generated. The error can be handled in an error handler. If there is no contact with the unit the system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

Syntax

```
InvertDO
  [ Signal ':=' ] < variable (VAR) of signaldo > ';'
```

Related information

For information about	See
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Input and output signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - I/O principles*
Configuration of I/O	*Technical reference manual - System parameters*

1.67. IOBusStart - Start of I/O bus

Usage

`IOBusStart` is used to start a certain I/O bus.

Basic examples

Basic example of the instruction `IOBusStart` is illustrated below.

Example 1

```
IOBusStart "IBS";
```

The instruction start the bus with the name `IBS`.

Arguments

```
IOBusStart BusName
```

`BusName`

Data type: `string`

The name of bus to start.

Program execution

Start the bus with the name specified in the parameter `BusName`.

Error handling

The system variable `ERRNO` will be set to `ERR_NAME_INVALID` if the bus name does not exist.That error can be handled in an `ERROR` handler.

Syntax

```
IOBusStart
  [ BusName ':=' ] < expression (IN) of string>';'
```

Related information

For information about	See
How to get I/O bus state	*IOBusState - Get current state of I/O bus on page 156*
Configuration of I/O	*Technical reference manual - System parameters*

1.68. IOBusState - Get current state of I/O bus

Usage

`IOBusState` is used to read the state of a certain I/O bus. Its physical state and logical state define the status for an I/O bus.

Basic examples

Basic examples of the instruction `IOBusState` are illustrated below.

Example 1

```
VAR busstate bstate;

IOBusState "IBS", bstate \Phys;
TEST bstate
CASE IOBUS_PHYS_STATE_RUNNING:
  ! Possible to access the signals on the IBS bus
DEFAULT:
  ! Actions for not up and running IBS bus
ENDTEST
```

The instruction returns the physical bus state of `IBS` in the `bstate` variable of type `busstate`.

Example 2

```
VAR busstate bstate;

IOBusState "IBS", bstate \Logic;
TEST bstate
CASE IOBUS_LOG_STATE_STARTED:
  ! The IBS bus is started
DEFAULT:
  ! Actions for stopped IBS bus
ENDTEST
```

The instruction returns the logical bus state of `IBS` in the `bstate` variable of type `busstate`.

Arguments

```
IOBusState BusName State [\Phys] | [\Logic]
```

`BusName`

Data type: `string`

The name of bus to get state about.

`State`

Data type: `busstate`

The variable in which the bus state is returned. See predefined data of type `busstate` below at Program execution.

Continues on next page

`[\Phys]`

Physical

Data type: `switch`

If using this parameter the physical state of the bus is read.

`[\Logic]`

Logical

Data type: `switch`

If using this parameter the logical state of the bus is read.

Program execution

Returning in parameter `State` the state of the bus is specified in parameter `BusName`.

The I/O bus logical states describe the state a user can order the bus into. The state of the I/O bus is defined in the table below when using optional argument `\Logic`.

Return value	Symbolic constant	Comment
10	IOBUS_LOG_STATE_STOPPED	Bus is stopped due to error 2)
11	IOBUS_LOG_STATE_STARTED	Bus is started 1)

The I/O bus physical state describes the state that the fieldbus driver can order the bus into. The state of the I/O bus is defined in the table below when using optional argument `\Phys`.

Return value	Symbolic constant	Comment
20	IOBUS_PHYS_STATE_HALTED	Bus is halted 3)
21	IOBUS_PHYS_STATE_RUNNING	Bus is up and running 1)
22	IOBUS_PHYS_STATE_ERROR	Bus is not working 2)
23	IOBUS_PHYS_STATE_STARTUP	Bus is in start up mode, is not communicating with any units.
24	IOBUS_PHYS_STATE_INIT	Bus is only created 3)

-

NOTE!

For RobotWare 5.08 and earlier versions it is not possible to use the instruction `IOBusState` with optional argument `\Phys` or `\Logic`. From RobotWare 5.09 it is recommended to use the optional argument `\Phys` or `\Logic`.

Continues on next page

The state of the I/O bus is defined in the table below when not using any of the optional argument `\Phys` or `\Logic`.

Return value	Symbolic constant	Comment
0	BUSSTATE_HALTED	Bus is halted [3)]
1	BUSSTATE_RUN	Bus is up and running [1)]
2	BUSSTATE_ERROR	Bus is not working [2)]
3	BUSSTATE_STARTUP	Bus is in start up mode, is not communicating with any units.
4	BUSSTATE_INIT	Bus is only created [3)]

[1)] If the bus is up and running the state returned in argument `State` in instruction `IOBusState` can be either `IOBUS_LOG_STATE_STARTED`, `IOBUS_PHYS_STATE_RUNNING`, or `BUSSTATE_RUN` depending on if optional parameters are used or not in `IOBusState`.

[2)] If the bus is stopped due to some error the state returned in argument `State` can be either `IOBUS_LOG_STATE_STOPPED`, `IOBUS_PHYS_STATE_ERROR`, or `BUSSTATE_ERROR` depending on if optional parameters are used or not in `IOBusState`.

[3)] Not possible to get this state in the RAPID program with current version of Robotware - OS.

Error handling

The system variable `ERRNO` will be set to `ERR_NAME_INVALID` if the bus name does not exist.That error can be handled in an `ERROR` handler

Syntax

```
IOBusState
  [ BusName ':=' ] < expression (IN) of string> ','
  [ State ':=' ] < variable (VAR) of busstate>
  [ '\' Phys] | [ '\' Logic]';'
```

Related information

For information about	See
Definition of bus state	*busstate - State of I/O bus on page 1088*
Start of I/O bus	*IOBusStart - Start of I/O bus on page 155*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles -I/O principles*
Configuration of I/O	*Technical reference manual - System parameters*

1.69. IODisable - Disable I/O unit

Usage

`IODisable` is used to deactivate an I/O unit during program execution.

I/O units are automatically activated after start-up if they are defined in the system parameters. When required for some reason, I/O units can be deactivated or activated during program execution.

NOTE!

It is not possible to deactivate a unit with Trustlevel set to Required.

Basic examples

Basic examples of the instruction `IODisable` are illustrated below.

See also *More examples on page 160*.

Example 1

```
CONST string cell1:="cell1";
IODisable cell1, 5;
```

Deactivate an I/O unit with name `cell1`. Wait max. `5` s.

Arguments

```
IODisable UnitName MaxTime
```

`UnitName`

Data type: `string`

A name of an I/O unit (the unit name must be present in the system parameters).

`MaxTime`

Data type: `num`

The maximum period of waiting time permitted expressed in seconds. If this time runs out before the I/O unit has finished the deactivation steps the error handler will be called, if there is one, with the error code `ERR_IODISABLE`. If there is no error handler the program execution will be stopped. However, the I/O unit deactivationprocess will always continue regardless of the `MaxTime` or error.

To deactivate an I/O unit takes about 0-5 s.

Program execution

The specified I/O unit starts the deactivation steps. The instruction is ready when the deactivation steps are finished. If the `MaxTime` runs out before the I/O unit has finished the deactivation steps, a recoverable error will be generated.

After deactivation of an I/O unit, any setting of outputs in this unit will result in an error.

Continues on next page

Error handling

The following recoverable errors can be generated. The errors can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_IODISABLE`	if the time out time runs out before the unit is deactivated.
`ERR_TRUSTLEVEL`	if the trustlevel on the unit is set to 0, then the unit can´t be deactivated.
`ERR_NAME_INVALID`	if the unit name don’t exist or if the unit isn’t allowed to be deactivated.

More examples

More examples of the instruction `IODisable` are illustrated below.

Example 1

```
PROC go_home()
  VAR num recover_flag :=0;
  ...
  ! Start to disable I/O unit cell1
  recover_flag := 1;
  IODisable "cell1", 0;
  ! Move to home position
  MoveJ home, v1000,fine,tool1;
  ! Wait until deactivation of I/O unit cell1 is ready
  recover_flag := 2;
  IODisable "cell1", 5;
  ...
  ERROR
    IF ERRNO = ERR_IODISABLE THEN
      IF recover_flag = 1 THEN
        TRYNEXT;
      ELSEIF recover_flag = 2 THEN
        RETRY;
      ENDIF
    ELSEIF ERRNO <> ERR_EXCRTYMAX THEN
      RAISE;
    ELSE
      ErrWrite "IODisable error", "Not possible to disable I/O
          unit cell1";
      Stop;
    ENDIF
ENDPROC
```

To save cycle time the I/O unit `cell1` is deactivated during robot movement to the `home` position. With the robot at the `home` position a test is done to establish whether or not the I/O unit `cell1` is fully deactivated. After the max. number of retries (5 with a waiting time of `5` s), the robot execution will stop with an error message.

The same principle can be used with `IOEnable` (this will save more cycle time compared with `IODisable`).

Continues on next page

Syntax

```
IODisable
  [ UnitName ':=' ] < expression (IN) of string> ','
  [ MaxTime ':=' ] < expression (IN) of num> ';'
```

Related information

For information about	See
Enabling an I/O unit	*IOEnable - Enable I/O unit on page 162*
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and output signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - I/O Principles*
Configuration of I/O	*Technical reference manual - System parameters*

1.70. IOEnable - Enable I/O unit

Usage

`IOEnable` is used to activate an I/O unit during program execution.

I/O units are automatically activated after start-up if they are defined in the system parameters. When required for some reason I/O units can be deactivated or activated during program execution.

The controller action when activating a unit depends on the set unit Trustlevel. See System Parameters Unit Trustlevel.

Basic examples

Basic examples of the instruction `IOEnable` are illustrated below.

See also *More examples on page 163*.

Example 1

```
CONST string cell1:="cell1";
IOEnable cell1, 5;
```

Enable I/O unit with name `cell1`. Wait max. `5` s.

Arguments

```
IOEnable UnitName MaxTime
```

`UnitName`

Data type: `string`

A name of an I/O unit (the unit name must be present in the system parameters).

`MaxTime`

Data type: `num`

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the I/O unit has finished the activation steps the error handler will be called, if there is one, with the error code `ERR_IOENABLE`. If there is no error handler the execution will be stopped. The I/O unit activation process will however always continue regardless of `MaxTime` or error.

To activate an I/O unit takes about 2-5 s.

Program execution

The specified I/O unit starts the activation steps. The instruction is ready when the activation steps are finished. If the `MaxTime` runs out before the I/O unit has finished the activation steps a recoverable error will be generated.

After a sequence of `IODisable` - `IOEnable`, all outputs for the current I/O unit will be set to the old values (before `IODisable`).

Continues on next page

Error handling

The following recoverable errors can be generated. The errors can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_IOENABLE`	if the time out time runs out before the unit is activated.
`ERR_NAME_INVALID`	if the unit name don't exist or if the unit isn't allowed to be activated.
`ERR_BUSSTATE`	if an `IOEnable` is done, and the bus is in error state or enter error state before the unit is activated.

More examples

`IOEnable` can also be used to check whether some I/O unit is disconnected for some reason.

More examples of how to use the instruction `IOEnable` are illustrated below.

Example 1

```
VAR num max_retry:=0;
...
IOEnable "cell1", 0;
SetDO cell1_sig3, 1;
...
ERROR
  IF ERRNO = ERR_IOENABLE THEN
       WaitTime 1;
       RETRY;
     ELSEIF ERRNO <> Err_EXCRTYMAX THEN
       RAISE;
     ELSE
       ErrWrite "IOEnable error", "Not possible to enable I/O
       unit cell";
       Stop;
     ENDIF
  ENDIF
```

Before using signals on the I/O unit `cell1`, a test is done by trying to activate the I/O unit with timeout after `0` sec. If the test fails a jump is made to the error handler. In the error handler the program execution waits for `1` sec. and a new retry is made. After `5` retry attempts the error `ERR_IOENABLE` is propagated to the caller of this routine.

Syntax

```
IOEnable
  [ UnitName ':=' ] < expression (IN) of string>' ,'
  [ MaxTime' :=' ] < expression (IN) of num > ';'
```


Continues on next page

Related information

For information about	See
Disabling an I/O unit	*IODisable - Disable I/O unit on page 159*
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and Output Signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - I/O principles*
Configuration of I/O	*Technical reference manual - System parameters*

1.71. IPers - Interrupt at value change of a persistent variable

Usage

`IPers` (*Interrupt Persistent*) is used to order and enable interrupts to be generated when the value of a persistent variable is changed.

Basic examples

Basic examples of the instruction `IPers` are illustrated below.

Example 1

```
VAR intnum pers1int;
PERS num counter := 0;

PROC main()
  CONNECT pers1int WITH iroutine1;
  IPers counter, pers1int;
  ...
  Idelete pers1int;
ENDPROC

TRAP iroutine1
  TPWrite "Current value of counter = " \Num:=counter;
ENDTRAP
```

Orders an interrupt which is to occur each time the persistent variable `counter` is changed. A call is then made to the `iroutine1` trap routine.

Arguments

```
IPers Name Interrupt
```

`Name`

Data type: `anytype`

The persistent variable that is to generate interrupts.

All type of data could be used such as atomic, record, record component, array, or array element.

`Interrupt`

Data type: `intnum`

The interrupt identity. This should have previously been connected to a trap routine by means of the instruction `CONNECT`.

Program execution

When the persistent variable changes value a call is made to the corresponding trap routine. When this routine has been executed program execution continues from where the interrupt occurred.

If the persistent variable changes value during a program stop no interrupt will occur when the program starts again.

Continues on next page

Limitations

The same variable for interrupt identity cannot be used more than once without first deleting it. See Instructions - `ISignalDI`.

If subscribed on data such as record component or array element specified in parameter `Name`, the interrupt will occur every time any part of the data is changed.

When executing the trap routine and reading the value of the persistent, there is no guarantee that the value read is the one that triggered the interrupt.

Syntax

```
IPers
  [ Name ':=' ] < persistent (PERS) of anytype > ','
  [ Interrupt' :=' ] < variable (VAR) of intnum > ';'
```

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupts*
Interrupt from an input signal	*ISignalDI - Orders interrupts from a digital input signal on page 186*
More information about interrupt management	*Technical reference manual - RAPID overview*, section *Basic characteristics - Interrupts*
Interrupt identity	*intnum - Interrupt identity on page 1125*

1.72. IRMQMessage - Orders RMQ interrupts for a data type

Usage

`IRMQMessage` (*Interrupt RAPID Message Queue Message*) is used to order and enable interrupts for a specific data type when using RMQ functionality.

Basic examples

Basic examples of the instruction `IRMQMessage` are illustrated below.

See also *More Examples*.

Example 1

```
VAR intnum rmqint;
VAR string dummy;
...
CONNECT rmqint WITH iroutine1;
IRMQMessage dummy, rmqint;
```

Orders an interrupt which is to occur each time a new `rmqmessage` containing the data type `string` is received. A call is then made to the `iroutine1` TRAP routine.

Arguments

```
IRMQMessage InterruptDataType Interrupt
```

`InterruptDataType`

Data type: `anytype`

A reference to a variable, persistent or constant of a data type that will generate an interrupt when a `rmqmessage` with the specified data type is received.

`Interrupt`

Data type: `intnum`

The interrupt identity. This should have previously been connected to a TRAP routine by means of the instruction `CONNECT`.

Continues on next page

Program execution

When the RMQ message with the specified data type is received, a call is made to the corresponding TRAP routine. When this has been executed, program execution continues from where the interrupt occurred.

All messages containing data of the same data type regardless of number of dimensions will be handled by the same interrupt. If using different dimensions, use `RMQGetMsgHeader` to adapt for this.

Any message containing data of a data type that no interrupt is connected to will genererate a warning.

The `RMQSendWait` instruction has the highest priority if a message is received and it fits the description for both the expected answer and a message connected to a TRAP routine with instruction `IRMQMessage`.

Not all data types can be used in argument `InterruptDataType` (see limitations).

The interrupt is considered to be a safe interrupt. A safe interrupt can not be put in sleep with instruction `ISleep`. The safe interrupt event will be queued at program stop and stepwise execution, and when starting in continious mode again, the interrupt will be executed. The only time a safe interrupt will be thrown is when the interrupt queue is full. Then an error will be reported. The interrupt will not survive program reset, e.g. PP to main.

More examples

More examples of how to use the instruction `IRMQMessage` are illustrated below.

Example 1

```
MODULE ReceiverMod

  VAR intnum intno1;
  VAR rmqheader rmqheader1;
  VAR rmqslot rmqslot1;
  VAR rmqmessage rmqmessage1;

  PROC main()

     VAR string interrupt_on_str := stEmpty;

     CONNECT intno1 WITH RecMsgs;
     ! Set up interrupts for data type string
     IRMQMessage interrupt_on_str, intno1;

     ! Perform cycle
     WHILE TRUE DO
        ...
     ENDWHILE
  ENDPROC
```


Continues on next page

```
  TRAP RecMsgs

    VAR string receivestr;
    VAR string client_name;
    VAR num userdef;

    ! Get the message from the RMQ
    RMQGetMessage rmqmessage1;
    ! Get information about the message
    RMQGetMsgHeader rmqmessage1 \Header:=rmqheader1
          \SenderId:=rmqslot1 \UserDef:=userdef;

    IF rmqheader1.datatype = "string" AND rmqheader1.ndim = 0 THEN
      ! Get the data received in rmqmessage1
      RMQGetMsgData rmqmessage1, receivestr;
      client_name := RMQGetSlotName(rmqslot1);
      TPWrite "Rec string: " + receivestr;
      TPWrite "User Def: " + ValToStr(userdef);
      TPWrite "From: " + client_name;
    ELSE
      TPWrite "Faulty data received!"
    ENDIF

  ENDTRAP
ENDMODULE
```

The example show how to set up interrupts for a specific data type. When a message is received, the `TRAP RecMsgs` is executed and the received data in the message is printed to the FlexPendant. If the data type received or the dimension of the data is different from the expected, this is printed to the FlexPendant.

Limitations

It is not allowed to execute `IRMQMessage` in synchronous mode. That will cause a fatal runtime error.

It is not possible to setup interrupts, send or receive data instances of data types that are of non-value, semi-value types or data type `motsetdata`.

The same variable for interrupt identity can not be used more than once without first deleting it. Interrupts should therefore be handled as shown in one of the alternatives below.

```
PROC main ()
  VAR intnum rmqint;
  VAR mytype dummy;
  CONNECT rmq1int WITH iroutine1;
  IRMQMessage dummy, rmqint;
  WHILE TRUE DO
  ...
  ENDWHILE
ENDPROC
```


Continues on next page

All activation of interrupts is done at the beginning of the program. These beginning instructions are then kept outside the main flow of the program.

```
PROC main ( )
  VAR intnum rmqint;
  VAR mytype dummy;
  CONNECT rmqint WITH iroutine1;
  IRMQMessage dummy, rmqint;
  ...
  IDelete rmqint;
ENDPROC
```

The interrupt is deleted at the end of the program, and is then reactivated. It should be noted, in this case, that the interrupt is inactive for a short period.

Syntax

```
IRMQMessage
  [ InterruptDataType‘ :=’ ] < reference (REF) of anytype >
  [ Interrupt‘ :=’ ] < variable (VAR) of intnum >‘;‘
```

Related information

For information about	See
Description of the RAPID Message Queue functionality	*Application manual - Robot communication and I/O control*, section *RAPID Message Queue*.
Send data to the queue of a RAPID task or Robot Application Builder client.	*RMQFindSlot - Find a slot identity from the slot name on page 371*
Get the first message from a RAPID Message Queue.	*RMQGetMessage - Get an RMQ message on page 373*
Send data to the queue of a RAPID task or Robot Application Builder client, and wait for an answer from the client.	*RMQSendWait - Send an RMQ data message and wait for a response on page 390*
Extract the header data from a `rmqmessage`.	*RMQGetMsgHeader - Get header information from an RMQ message on page 380*
Send data to the queue of a RAPID task or Robot Application Builder client.	*RMQSendMessage - Send an RMQ data message on page 386*
Extract the data from a `rmqmessage`.	*RMQGetMsgData - Get the data part from an RMQ message on page 377*
Get the slot name from a specified slot identity.	*RMQGetSlotName - Get the name of an RMQ client on page 964*

1.73. ISignalAI - Interrupts from analog input signal

Usage

`ISignalAI` (*Interrupt Signal Analog Input*) is used to order and enable interrupts from an analog input signal.

Basic examples

Basic examples of the instruction `ISignalAI` are illustrated below.

Example 1

```
VAR intnum sig1int;
CONNECT sig1int WITH iroutine1;
ISignalAI \Single, ai1, AIO_BETWEEN, 1.5, 0.5, 0, sig1int;
```

Orders an interrupt which is to occur the first time the logical value of the analog input signal `ai1` is between `0.5` and `1.5`. A call is then made to the `iroutine1` trap routine.

Example 2

```
ISignalAI ai1, AIO_BETWEEN, 1.5, 0.5, 0.1, sig1int;
```

Orders an interrupt which is to occur each time the logical value of the analog input signal `ai1` is between `0.5` and `1.5`, and the absolute signal difference compared to the stored reference value is bigger than `0.1`.

Example 3

```
ISignalAI ai1, AIO_OUTSIDE, 1.5, 0.5, 0.1, sig1int;
```

Orders an interrupt which is to occur each time the logical value of the analog input signal `ai1` is lower than `0.5` or higher than `1.5`, and the absolute signal difference compared to the stored reference value is bigger than `0.1`.

Arguments

```
ISignalAI [\Single] | [\SingleSafe] Signal Condition HighValue
     LowValue DeltaValue [\DPos] | [\DNeg] Interrupt
```

`[\Single]`

Data type: `switch`

Specifies whether the interrupt is to occur once or cyclically. If the argument `Single` is set, the interrupt occurs once at the most. If the `Single` and `SingleSafe` arguments is omitted, an interrupt will occur each time its condition is satisfied.

`[\SingleSafe]`

Data type: `switch`

Specifies that the interrupt is single and safe. For definition of single, see description of `Single` argument. A safe interrupt can not be put in sleep with instruction `ISleep`. The safe interrupt event will be queued at program stop and stepwise execution, and when starting in continious mode again, the interrupt will be executed. The only time a safe interrupt will be thrown is when the interrupt queue is full. Then an error will be reported. The interrupt will not survive program reset, e.g. PP to main.

Continues on next page

`Signal`

Data type: `signalai`

The name of the signal that is to generate interrupts.

`Condition`

Data type: `aiotrigg`

Specifies how `HighValue` and `LowValue` define the condition to be satisfied:

Value	Symbolic constant	Comment
1	`AIO_ABOVE_HIGH`	Signal will generate interrupts if above specified high value
2	`AIO_BELOW_HIGH`	Signal will generate interrupts if below specified high value
3	`AIO_ABOVE_LOW`	Signal will generate interrupts if above specified low value
4	`AIO_BELOW_LOW`	Signal will generate interrupts if below specified low value
5	`AIO_BETWEEN`	Signal will generate interrupts if between specified low and high values
6	`AIO_OUTSIDE`	Signal will generate interrupts if below specified low value or above specified high value
7	`AIO_ALWAYS`	Signal will always generate interrupts

`HighValue`

Data type: `num`

High logical value to define the condition.

`LowValue`

Data type: `num`

Low logical value to define the condition.

`DeltaValue`

Data type: `num`

Defines the minimum logical signal difference before generation of a new interrupt. The current signal value compared to the stored reference value must be greater than the specified `DeltaValue` before generation of a new interrupt.

`[\DPos]`

Data type: `switch`

Specifies that only positive logical signal differences will give new interrupts.

`[\DNeg]`

Data type: `switch`

Specifies that only negative logical signal differences will give new interrupts.

If none of `\DPos` and `\DNeg` argument is used, both positive and negative differences will generate new interrupts.

`Interrupt`

Data type: `intnum`

The interrupt identity. This interrupt should have previously been connected to a trap routine by means of the instruction `CONNECT`.

Continues on next page

Program execution

When the signal fulfils the specified conditions (both `Condition` and `DeltaValue`) a call is made to the corresponding trap routine. When this has been executed, program execution continues from where the interrupt occurred.

Conditions for interrupt generation

Before the interrupt subscription is ordered, each time the signal is sampled, the value of the signal is read, saved, and later used as a reference value for the `DeltaValue` condition.

At the interrupt subscription time if specified `DeltaValue` = 0 and after the interrupt subscription time, the signal is sampled. The signal value is then compared to `HighValue` and `LowValue` according to `Condition` and with consideration to `DeltaValue` to decide if an interrupt should be generated or not. If the new read value satisfies the specified `HighValue` and `LowValue` `Condition`, but its difference compared to the last stored reference value is less or equal to the `DeltaValue` argument, no interrupt occurs. If the signal difference is not in the specified direction no interrupts will occur (argument `\DPos` or `\DNeg`).

The stored reference value for the `DeltaValue` condition is updated with a newly read value for later use at any sample if the following conditions are satisfied:

- Argument `Condition` with specified `HighValue` and `LowValue` (within limits)
- Argument `DeltaValue` (sufficient signal change in any direction independently of specified switch `\DPos` or `\DNeg`)

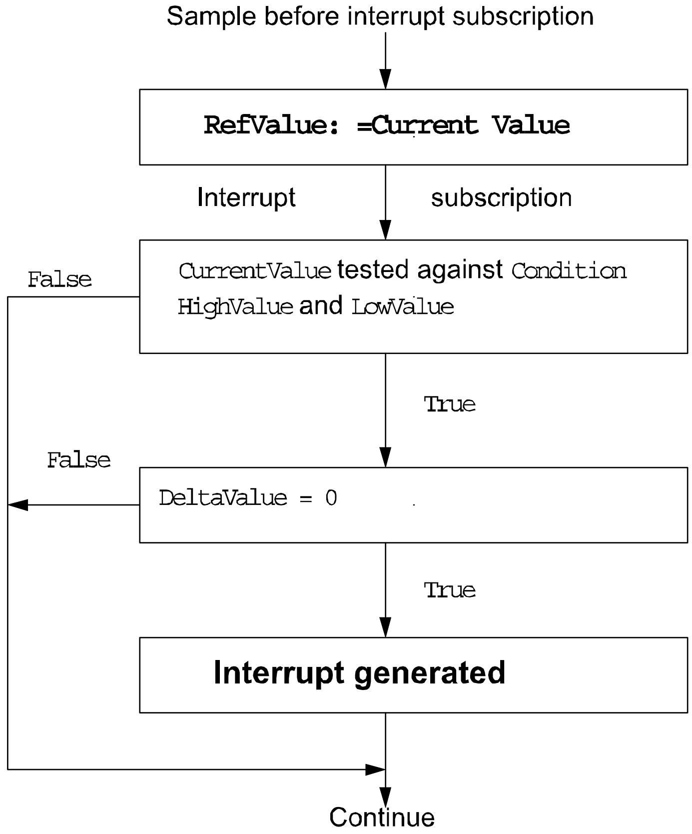
The reference value is only updated at the sample time, not at the interrupt subscription time.

An interrupt is also generated at the sample for update of the reference value if the direction of the signal difference is in accordance with the specified argument (any direction, `\DPos0`, or `\DNeg`).

When the `\Single` switch is used only one interrupt at the most will be generated. If the switch `\Single` (cyclic interrupt) is not used a new test of the specified conditions (both `Condition` and `DeltaValue`) is made at every sample of the signal value. Acomparison is made between the current signal value and the last stored reference value to decide if an interrupt should be generated or not.

Continues on next page

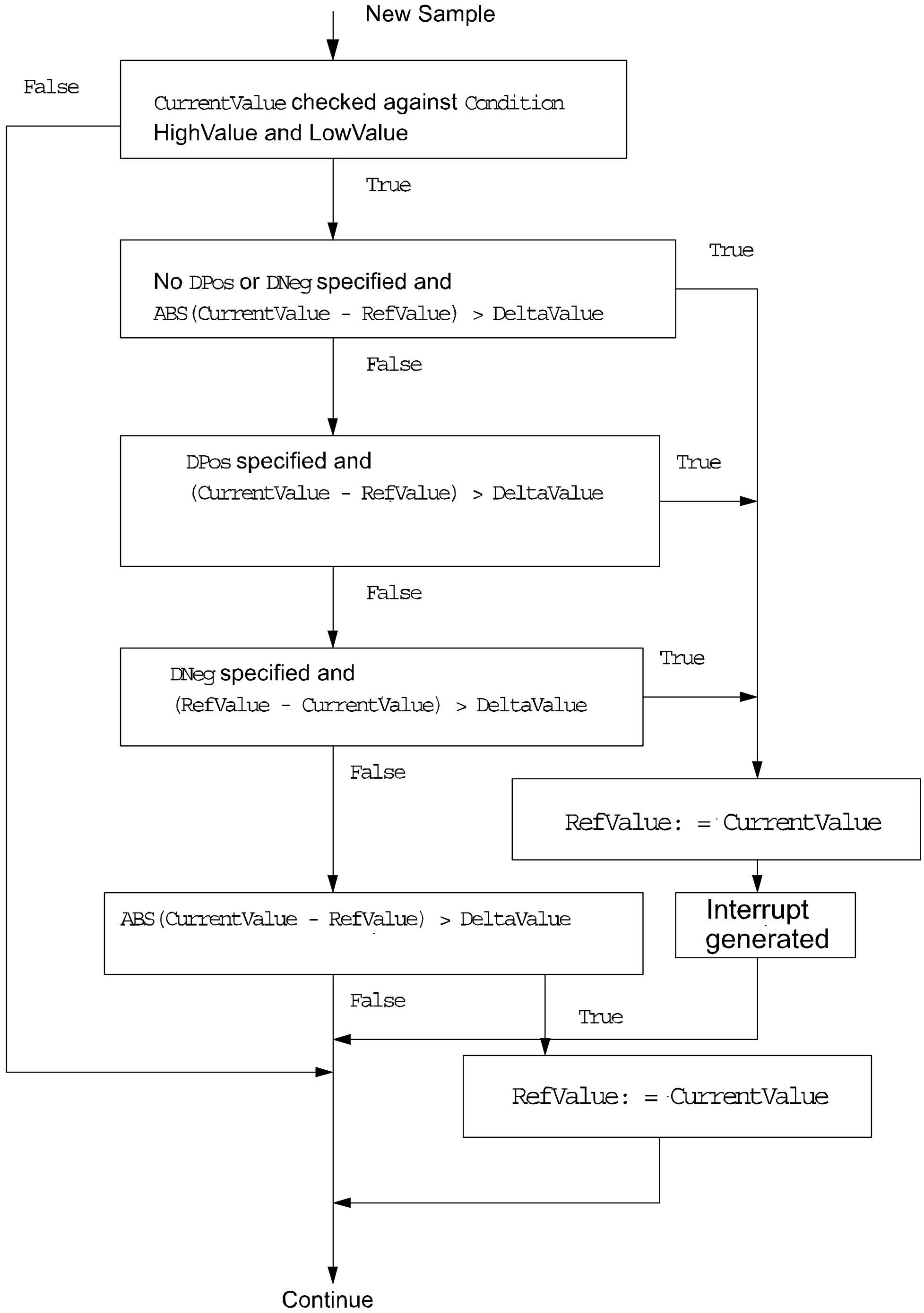
Condition for interrupt generation at interrupt subscription time



xx0500002165

Continues on next page

Condition for interrupt generation at each sample after interrupt subscription



xx0500002166

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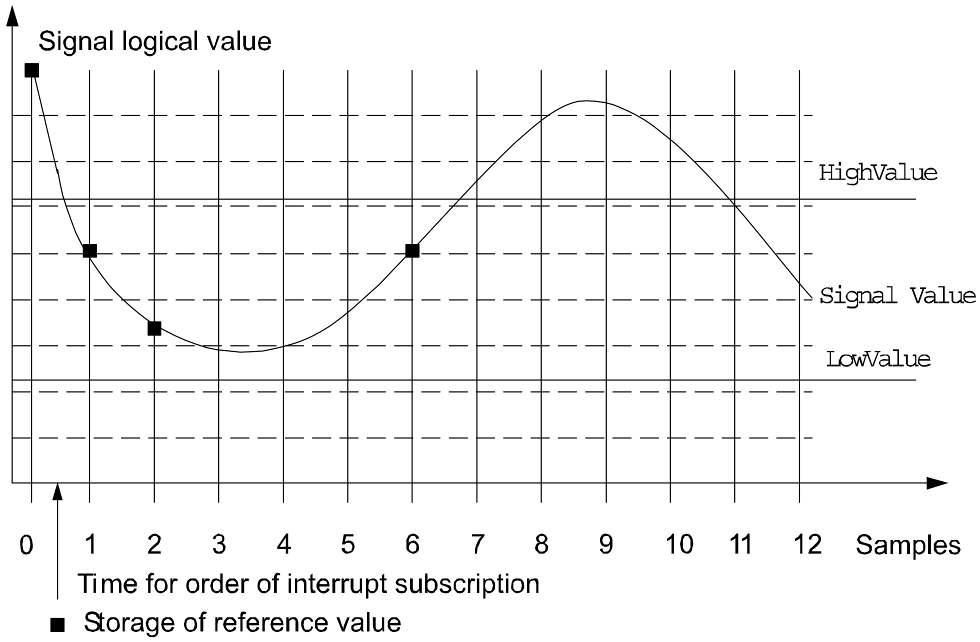
Example 1 of interrupt generation



xx0500002167

Assuming the interrupt is ordered between sample 0 and 1, the following instruction will give the following results:

```
ISignalAI ai1, AIO_BETWEEN, 6.1, 2.2, 1.0, sig1int;
```

Sample 1 will generate an interrupt because the signal value is between `HighValue` and `LowValue` and the signal difference compared to Sample 0 is more than `DeltaValue`.

Sample 2 will generate an interrupt because the signal value is between `HighValue` and `LowValue` and the signal difference compared to Sample 1 is more than `DeltaValue`.

Samples 3, 4, 5 will not generate any interrupt because the signal difference is less than `DeltaValue`.

Sample 6 will generate an interrupt.

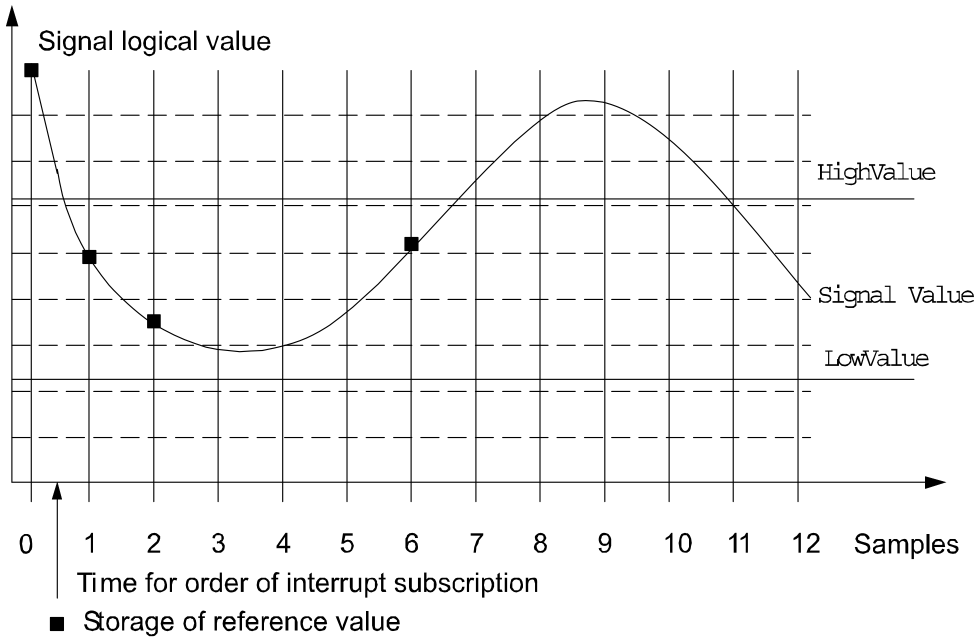
Samples 7 to 10 will not generate any interrupt because the signal is above `HighValue`.

Sample 11 will not generate any interrupt because the signal difference compared to Sample 6 is equal to `DeltaValue`.

Sample 12 will not generate any interrupt because the signal difference compared to Sample 6 is less than `DeltaValue`.

Continues on next page

Example 2 of interrupt generation



xx0500002168

Assuming the interrupt is ordered between sample 0 and 1, the following instruction will give the following results:

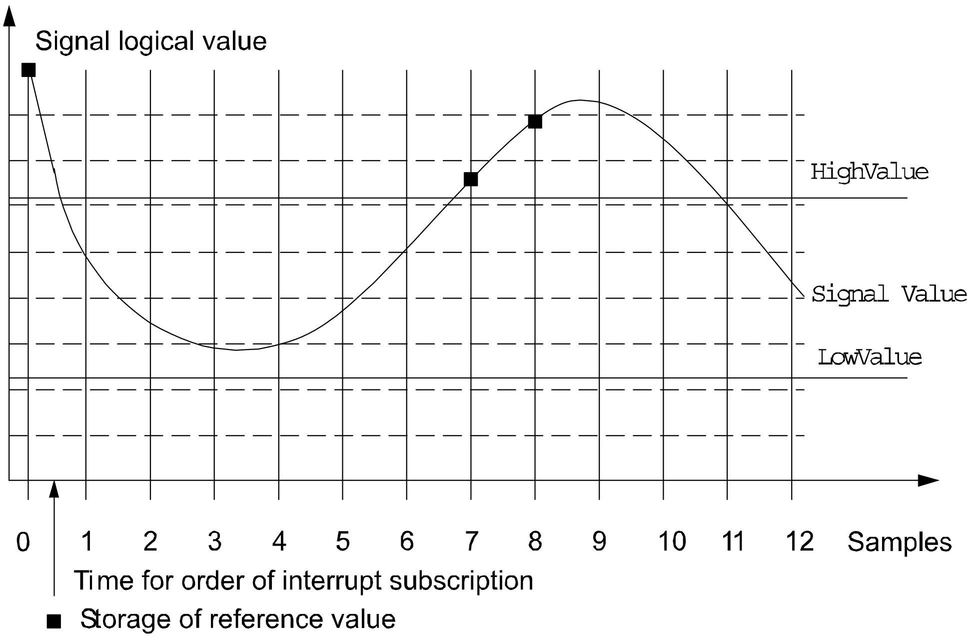
```
ISignalAI ai1, AIO_BETWEEN, 6.1, 2.2, 1.0 \DPos, sig1int;
```

A new reference value is stored at sample 1 and 2 because the signal is within limits and the absolute signal difference between the current value and the last stored reference value is greater than 1.0. No interrupt will be generated because the signal changes are in the negative direction.

Sample 6 will generate an interrupt because the signal value is between `HighValue` and `LowValue`, and the signal difference in the positive direction compared to sample 2 is more than `DeltaValue`.

Continues on next page

Example 3 of interrupt generation



xx0500002169

Assuming the interrupt is ordered between sample 0 and 1, the following instruction will give the following results:

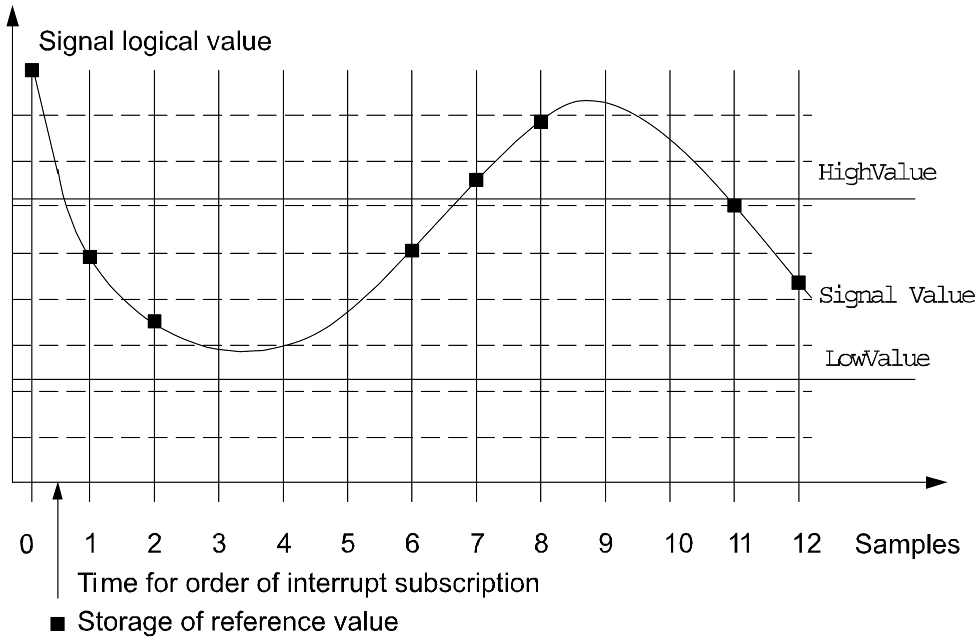
```
ISignalAI \Single, ai1, AIO_OUTSIDE, 6.1, 2.2, 1.0 \DPos, sig1int;
```

A new reference value is stored at sample 7 because the signal is within limits and the absolute signal difference between the current value and the last stored reference value is greater than 1.0

sample 8 will generate an interrupt because the signal value is above `HighValue`, and the signal difference in the positive direction compared to sample 7 is more than `DeltaValue`.

Continues on next page

Example 4 of interrupt generation



xx0500002170

Assuming the interrupt is ordered between sample 0 and 1, the following instruction will give the following results:

```
ISignalAI ai1, AIO_ALWAYS, 6.1, 2.2, 1.0 \DPos, sig1int;
```

A new reference value is stored at sample 1 and 2 because the signal is within limits and the absolute signal difference between the current value and the last stored reference value is greater than 1.0

Sample 6 will generate an interrupt because the signal difference in the positive direction compared to sample 2 is more than `DeltaValue`.

Sample 7 and 8 will generate an interrupt because the signal difference in the positive direction compared to previous sample is more than `DeltaValue`.

A new reference value is stored at sample 11 and 12 because the signal is within limits, and the absolute signal difference between the current value and the last stored reference value is greater than 1.0

Continues on next page

Error handling

If there is a subscription of interrupt on an analog input signal, an interrupt will be given for every change in the analog value that satisfies the condition specified when ordering the interrupt subscription. If the analog value is noisy many interrupts can be generated even if only one or two bits in the analog value are changed.

To avoid generating interrupts for small changes of the analog input value, set the `DeltaValue` to a level greater than 0. Then no interrupts will be generated until a change of the analog value is greater than the specified `DeltaValue`.

Following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the unit.

`ERR_AO_LIM`

if the programmed `HighValue` or `LowValue` argument for the specified analog input signal `Signal` is outside limits.

Limitations

The `HighValue` and `LowValue` arguments should be in the range: logical maximum value, logical minimum value defined for the signal.

`HighValue` must be above `LowValue`.

`DeltaValue` must be 0 or positive.

The limitations for the interrupt identity are the same as for `ISignalDI`.

Syntax

```
ISignalAI
[ '\' Single ] | [ '\' SingleSafe ] ','
[ Signal':=' ]<variable (VAR) of signalai>','
[ Condition':=' ]<expression (IN) of aiotrigg>','
[ HighValue':=' ]<expression (IN) of num>','
[ LowValue':=' ]<expression (IN) of num>','
[ DeltaValue':=' ]<expression (IN) of num>
[['\'DPos] | [ '\'DNeg] ',']
[ Interrupt':=' ]<variable (VAR) of intnum>';'
```


Continues on next page

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupts*
Definition of constants	*aiotrigg - Analog I/O trigger condition on page 1083*
Interrupt from analog output signal	*ISignalAO - Interrupts from analog output signal on page 182*
Interrupt from digital input signal	*ISignalDI - Orders interrupts from a digital input signal on page 186*
Interrupt from digital output signal	*ISignalDO - Interrupts from a digital output signal on page 189*
More information on interrupt management	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Interrupts*
Interrupt identity	*intnum - Interrupt identity on page 1125*
Related system parameters (filter)	*Technical reference manual - System parameters*, section *IO signals*

1.74. ISignalAO - Interrupts from analog output signal

Usage

`ISignalAO` (*Interrupt Signal Analog Output*) is used to order and enable interrupts from an analog output signal.

Basic examples

Basic examples of the instruction `ISignalAO` are illustrated below.

Example 1

```
VAR intnum sig1int;
CONNECT sig1int WITH iroutine1;
ISignalAO \Single, ao1, AIO_BETWEEN, 1.5, 0.5, 0, sig1int;
```

Orders an interrupt which is to occur the first time the logical value of the analog output signal `ao1` is between `0.5` and `1.5`. A call is then made to the `iroutine1` trap routine.

Example 2

```
ISignalAO ao1, AIO_BETWEEN, 1.5, 0.5, 0.1, sig1int;
```

Orders an interrupt which is to occur each time the logical value of the analog output signal `ao1` is between `0.5` and `1.5`, and the absolute signal difference compared to the previous stored reference value is bigger than 0.1.

Example 3

```
ISignalAO ao1, AIO_OUTSIDE, 1.5, 0.5, 0.1, sig1int;
```

Orders an interrupt which is to occur each time the logical value of the analog output signal `ao1` is lower than `0.5` or higher than `1.5`, and the absolute signal difference compared to the previous stored reference value is bigger than 0.1.

Arguments

```
ISignalAO [\Single] | [\SingleSafe] Signal Condition HighValue
     LowValue DeltaValue [\DPos] | [\DNeg] Interrupt
```

`[\Single]`

Data type: `switch`

Specifies whether the interrupt is to occur once or cyclically. If the argument `Single` is set the interrupt occurs once at the most. If the `Single` and `SingleSafe` argument is omitted an interrupt will occur each time its condition is satisfied.

`[\SingleSafe]`

Data type: `switch`

Specifies that the interrupt is single and safe. For definition of single, see description of `Single` argument. A safe interrupt can not be put in sleep with instruction `ISleep`. The safe interrupt event will be queued at program stop and stepwise execution, and when starting in continious mode again, the interrupt will be executed. The only time a safe interrupt will be thrown is when the interrupt queue is full. Then an error will be reported. The interrupt will not survive program reset, e.g. PP to main.

Continues on next page

`Signal`

Data type: `signalao`

The name of the signal that is to generate interrupts.

`Condition`

Data type: `aiotrigg`

Specifies how `HighValue` and `LowValue` define the condition to be satisfied:

Value	Symbolic constant	Comment
1	AIO_ABOVE_HIGH	Signal will generate interrupts if above specified high value
2	AIO_BELOW_HIGH	Signal will generate interrupts if below specified high value
3	AIO_ABOVE_LOW	Signal will generate interrupts if above specified low value
4	AIO_BELOW_LOW	Signal will generate interrupts if below specified low value
5	AIO_BETWEEN	Signal will generate interrupts if between specified low and high values
6	AIO_OUTSIDE	Signal will generate interrupts if below specified low value or above specified high value
7	AIO_ALWAYS	Signal will always generate interrupts

`HighValue`

Data type: `num`

High logical value to define the condition.

`LowValue`

Data type: `num`

Low logical value to define the condition.

`DeltaValue`

Data type: `num`

Defines the minimum logical signal difference before generation of a new interrupt. The current signal value compared to the previous stored reference value must be greater than the specified `DeltaValue` before generation of a new interrupt.

`[\DPos]`

Data type: `switch`

Specifies that only positive logical signal differences will give new interrupts.

`[\DNeg]`

Data type: `switch`

Specifies that only negative logical signal differences will give new interrupts.

If neither of the `\DPos` and `\DNeg` arguments are used, both positive and negative differences will generate new interrupts.

`Interrupt`

Data type: `intnum`

The interrupt identity. This interrupt should have previously been connected to a trap routine by means of the instruction `CONNECT`.

Continues on next page

Program execution

See instruction `ISignalAI` for information about:

- Program execution
- Condition for interrupt generation
- More examples

Same principles are valid for `ISignalAO` as for `ISignalAI`.

Error handling

Following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the unit.

`ERR_AO_LIM`

if the programmed `HighValue` or `LowValue` argument for the specified analog output signal `Signal` is outside limits.

Limitations

The `HighValue` and `LowValue` arguments should be in the range: logical maximum value, logical minimum value, defined for the signal.

`HighValue` must be above `LowValue`.

`DeltaValue` must be 0 or positive.

The limitations for the interrupt identity are the same as for `ISignalDO`.

Syntax

```
ISignalAO
[ '\' Single ] | [ '\' SingleSafe ] ','
[ Signal':=' ]<variable (VAR) of signalao>','
[ Condition':=' ]<expression (IN) of aiotrigg>','
[ HighValue':=' ]<expression (IN) of num>','
[ LowValue':=' ]<expression (IN) of num>','
[ DeltaValue':=' ]<expression (IN) of num>
['\'DPos] | [ '\'DNeg] ',']
[ Interrupt':=' ]<variable (VAR) of intnum>';'
```


Continues on next page

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID Summary - Interrupts*
Definition of constants	*aiotrigg - Analog I/O trigger condition on page 1083*
Interrupt from analog input signal	*ISignalAI - Interrupts from analog input signal on page 171*
Interrupt from digital input signal	*ISignalDI - Orders interrupts from a digital input signal on page 186*
Interrupt from digital output signal	*ISignalDO - Interrupts from a digital output signal on page 189*
More information on interrupt management	*RAPID reference manual - RAPID overview*, section *Basic Characteristics - Interrupts*
Interrupt identity	*intnum - Interrupt identity on page 1125*
Related system parameters (filter)	*Technical reference manual - System parameters*, section *IO signals*

1.75. ISignalDI - Orders interrupts from a digital input signal

Usage

`ISignalDI` (*Interrupt Signal Digital In*) is used to order and enable interrupts from a digital input signal.

Basic examples

Basic examples of the instruction `ISignalDI` are illustrated below.

Example 1

```
VAR intnum sig1int;
CONNECT sig1int WITH iroutine1;
ISignalDI di1,1,sig1int;
```

Orders an interrupt which is to occur each time the digital input signal `di1` is set to `1`. A call is then made to the `iroutine1` trap routine.

Example 2

```
ISignalDI di1,0,sig1int;
```

Orders an interrupt which is to occur each time the digital input signal `di1` is set to `0`.

Example 3

```
ISignalDI \Single, di1,1,sig1int;
```

Orders an interrupt which is to occur only the first time the digital input signal `di1` is set to `1`.

Arguments

```
ISignalDI [ \Single] | [ \SingleSafe] Signal TriggValue Interrupt
```

`[ \Single ]`

Data type: `switch`

Specifies whether the interrupt is to occur once or cyclically.

If the argument `Single` is set, the interrupt occurs once at the most. If the `Single` and `SingleSafe` arguments is omitted, an interrupt will occur each time its condition is satisfied.

`[ \SingleSafe ]`

Data type: `switch`

Specifies that the interrupt is single and safe. For definition of single, see description of `Single` argument. A safe interrupt can not be put in sleep with instruction `ISleep`. The safe interrupt event will be queued at program stop and stepwise execution, and when starting in continious mode again, the interrupt will be executed. The only time a safe interrupt will be thrown is when the interrupt queue is full. Then an error will be reported. The interrupt will not survive program reset, e.g. PP to main.

`Signal`

Data type: `signaldi`

The name of the signal that is to generate interrupts.

Continues on next page

`TriggValue`

Data type: `dionum`

The value to which the signal must change for an interrupt to occur.

The value is specified as 0 or 1 or as a symbolic value (e.g. `high/low`). The signal is edge-triggered upon changeover to 0 or 1.

`TriggValue` 2 or symbolic value `edge` can be used for generation of interrupts on both positive flank (0 -> 1) and negative flank (1 -> 0).

`Interrupt`

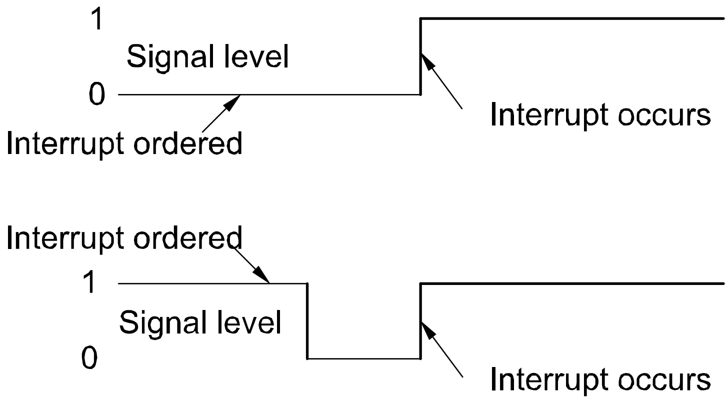
Data type: `intnum`

The interrupt identity. This should have previously been connected to a trap routine by means of the instruction `CONNECT`.

Program execution

When the signal assumes the specified value a call is made to the corresponding trap routine. When this has been executed, program execution continues from where the interrupt occurred.

If the signal changes to the specified value before the interrupt is ordered no interrupt occurs. Interrupts from a digital input signal at signal level 1 is illustrated in the figure below.



xx0500002189

Error handling

Following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the unit.

Continues on next page

Limitations

The same variable for interrupt identity cannot be used more than once without first deleting it. Interrupts should therefore be handled as shown in one of the alternatives below.

```
PROC main ( )
  VAR intnum sig1int;
  CONNECT sig1int WITH iroutine1;
  ISignalDI di1, 1, sig1int;
  WHILE TRUE DO
  ...
  ENDWHILE
ENDPROC
```

All activation of interrupts is done at the beginning of the program. These beginning instructions are then kept outside the main flow of the program.

```
PROC main ( )
  VAR intnum sig1int;
  CONNECT sig1int WITH iroutine1;
  ISignalDI di1, 1, sig1int;
  ...
  IDelete sig1int;
ENDPROC
```

The interrupt is deleted at the end of the program and is then reactivated. It should be noted, in this case, that the interrupt is inactive for a short period.

Syntax

```
ISignalDI
  [ '\' Single ] | [ '\' SingleSafe ] ','
  [ Signal ':=' ] < variable (VAR) of signaldi > ','
  [ TriggValue' :=' ] < expression (IN) of dionum > ','
  [ Interrupt' :=' ] < variable (VAR) of intnum > ';'
```

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID Summary - Interrupts*
Interrupt from an output signal	*ISignalDO - Interrupts from a digital output signal on page 189*
More information on interrupt management	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Interrupts*
Interrupt identity	*intnum - Interrupt identity on page 1125*

1.76. ISignalDO - Interrupts from a digital output signal

Usage

`ISignalDO` (*Interrupt Signal Digital Out*) is used to order and enable interrupts from a digital output signal.

Basic examples

Basic examples of the instruction `ISignalDO` are illustrated below.

Example 1

```
VAR intnum sig1int;
CONNECT sig1int WITH iroutine1;
ISignalDO do1,1,sig1int;
```

Orders an interrupt which is to occur each time the digital output signal `do1` is set to `1`. A call is then made to the `iroutine1` trap routine.

Example 2

```
ISignalDO do1,0,sig1int;
```

Orders an interrupt which is to occur each time the digital output signal `do1` is set to `0`.

Example 3

```
ISignalDO\Single, do1,1,sig1int;
```

Orders an interrupt which is to occur only the first time the digital output signal `do1` is set to `1`.

Arguments

```
ISignalDO [ \Single ] | [ \SingleSafe ] Signal TriggValue Interrupt
```

`[ \Single ]`

Data type: `switch`

Specifies whether the interrupt is to occur once or cyclically.

If the argument `Single` is set, the interrupt occurs once at the most. If the `Single` and `SingleSafe` arguments is omitted, an interrupt will occur each time its condition is satisfied.

`[ \SingleSafe ]`

Data type: `switch`

Specifies that the interrupt is single and safe. For definition of single, see description of `Single` argument. A safe interrupt can not be put in sleep with instruction `ISleep`. The safe interrupt event will be queued at program stop and stepwise execution, and when starting in continious mode again, the interrupt will be executed. The only time a safe interrupt will be thrown is when the interrupt queue is full. Then an error will be reported. The interrupt will not survive program reset, e.g. PP to main.

`Signal`

Data type: `signaldo`

The name of the signal that is to generate interrupts.

Continues on next page

`TriggValue`

Data type: `dionum`

The value to which the signal must change for an interrupt to occur.

The value is specified as 0 or 1 or as a symbolic value (e.g. `high/low`). The signal is edge-triggered upon changeover to 0 or 1.

`TriggValue` 2 or symbolic value `edge` can be used for generation of interrupts on both positive flank (0 -> 1) and negative flank (1 -> 0).

`Interrupt`

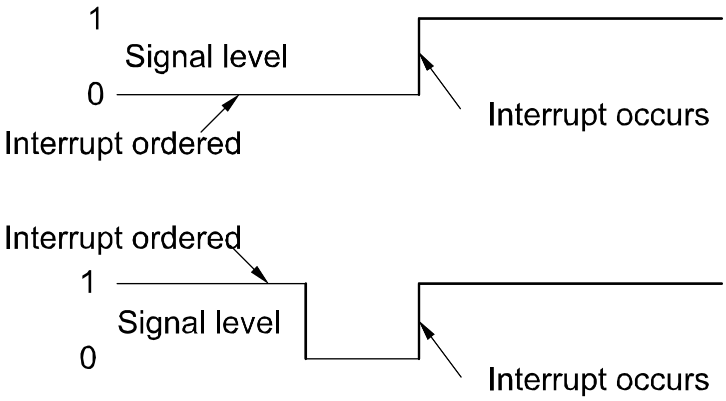
Data type: `intnum`

The interrupt identity. This should have previously been connected to a trap routine by means of the instruction `CONNECT`.

Program execution

When the signal assumes the specified value 0 or 1, a call is made to the corresponding trap routine. When this has been executed program execution continues from where the interrupt occurred.

If the signal changes to the specified value before the interrupt is ordered no interrupt occurs. Interrupts from a digital output signal at signal level 1 is illustrated in the figure below.



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Error handling

Following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the unit.

Continues on next page

Limitations

The same variable for interrupt identity cannot be used more than once without first deleting it. Interrupts should therefore be handled as shown in one of the alternatives below.

```
PROC main ( )
  VAR intnum sig1int;
  CONNECT sig1int WITH iroutine1;
  ISignalDO do1, 1, sig1int;
  WHILE TRUE DO
  ...
  ENDWHILE
ENDPROC
```

All activation of interrupts is done at the beginning of the program. These beginning instructions are then kept outside the main flow of the program.

```
PROC main ( )
  VAR intnum sig1int;
  CONNECT sig1int WITH iroutine1;
  ISignalDO do1, 1, sig1int;
  ...
  IDelete sig1int;
ENDPROC
```

The interrupt is deleted at the end of the program and is then reactivated. It should be noted, in this case, that the interrupt is inactive for a short period.

Syntax

```
ISignalDO
  [ '\' Single ] | [ '\' SingleSafe ] ','
  [ Signal ':=' ] < variable (VAR) of signaldo > ','
  [ TriggValue' :=' ] < expression (IN) of dionum > ','
  [ Interrupt' :=' ] < variable (VAR) of intnum > ';'
```

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID Summary - Interrupts*
Interrupt from an input signal	*ISignalDI - Orders interrupts from a digital input signal on page 186*
More information on interrupt management	*Technical reference manual - RAPID overview*, section *Basic Characteristics-Interrupts*
Interrupt identity	*intnum - Interrupt identity on page 1125*

1.77. ISignalGI - Orders interrupts from a group of digital input signals

Usage

`ISignalGI` (*Interrupt Signal Group Digital In*) is used to order and enable interrupts from a group of digital input signals.

Basic examples

Basic examples of the instruction `ISignalGI` are illustrated below.

Example 1

```
VAR intnum sig1int;
CONNECT sig1int WITH iroutine1;
ISignalGI gi1,sig1int;
```

Orders an interrupt when a digital input group signal changes value.

Arguments

```
ISignalGI [ \Single ] | [ \SingleSafe ] Signal Interrupt
```

`[ \Single ]`

Data type: `switch`

Specifies whether the interrupt is to occur once or cyclically.

If the argument `Single` is set, the interrupt occurs once at the most. If the `Single` and `SingleSafe` arguments is omitted, an interrupt will occur each time its condition is satisfied.

`[ \SingleSafe ]`

Data type: `switch`

Specifies that the interrupt is single and safe. For definition of single, see description of `Single` argument. A safe interrupt can not be put in sleep with instruction `ISleep`. The safe interrupt event will be queued at program stop and stepwise execution, and when starting in continious mode again, the interrupt will be executed. The only time a safe interrupt will be thrown is when the interrupt queue is full. Then an error will be reported. The interrupt will not survive program reset, e.g. PP to main.

`Signal`

Data type: `signalgi`

The name of the group input signal that generates interrupts.

`Interrupt`

Data type: `intnum`

The interrupt identity. This should have previously been connected to a trap routine by means of the instruction `CONNECT`.

Program execution

When the group signal changes value a call is made to the corresponding trap routine. When this has been executed program execution continues from where the interrupt occurred.

If the signal changes before the interrupt is ordered no interrupt occurs.

Continues on next page

Error handling

Following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the unit.

Limitations

Maximum number of signals that can be used for a group is 32.

Numeric value condition can not be used in the instruction to specify that an interrupt should occur on changes to that specific value. This must be handled in the user program by reading the group signal value at execution of the `TRAP`.

The interrupts are generated as bit interrupts, e.g. interrupts on single digital input signal change within the group. If the bits in the group signal change value with a delay between settings, several interrupts will be generated. Knowledege about how the I/O board works is necessary to get right functionality when using `ISignalGI`. If several interrupts are generated at group input settings, use instead `ISignalDI` on a strobe signal that are set when all bits in the group signal have been set.

The same variable for interrupt identity cannot be used more than once without first deleting it. Interrupts should therefore be handled as shown in one of the alternatives below.

```
PROC main ( )
  VAR intnum sig1int;
  CONNECT sig1int WITH iroutine1;
  ISignalGI gi1, sig1int;
  WHILE TRUE DO
  ...
  ENDWHILE
ENDPROC
```

All activation of interrupts is done at the beginning of the program. These beginning instructions are then kept outside the main flow of the program.

```
PROC main ( )
  VAR intnum sig1int;
  CONNECT sig1int WITH iroutine1;
  ISignalGI gi1, sig1int;
  ...
  IDelete sig1int;
ENDPROC
```

The interrupt is deleted at the end of the program and is then reactivated. It should be noted, in this case, that the interrupt is inactive for a short period.

Syntax

```
ISignalGI
  [ '\' Single ] | [ '\' SingleSafe ] ','
  [ Signal ':=' ] < variable (VAR) of signalgi > ','
  [ Interrupt':=' ] < variable (VAR) of intnum > ';'
```


Continues on next page

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID Summary - Interrupts*
Interrupt from an input signal	*ISignalDI - Orders interrupts from a digital input signal on page 186*
Interrupt from group output signals	*ISignalGO - Orders interrupts from a group of digital output signals on page 195*
More information on interrupt management	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Interrupts*
Interrupt identity	*intnum - Interrupt identity on page 1125*

1.78. ISignalGO - Orders interrupts from a group of digital output signals

Usage

`ISignalGO` (*Interrupt Signal Group Digital Out*) is used to order and enable interrupts from a group of digital output signals.

Basic examples

Basic examples of the instruction `ISignalGO` are illustrated below.

Example 1

```
VAR intnum sig1int;
CONNECT sig1int WITH iroutine1;
ISignalGO go1,sig1int;
```

Orders an interrupt when a digital output group signal change value.

Arguments

```
ISignalGO [ \Single ] | [ \SingleSafe ] Signal Interrupt
```

`[ \Single ]`

Data type: `switch`

Specifies whether the interrupt is to occur once or cyclically.

If the argument `\Single` is set, the interrupt occurs once at the most. If the `Single` and `SingleSafe` arguments is omitted, an interrupt will occur each time its condition is satisfied.

`[ \SingleSafe ]`

Data type: `switch`

Specifies that the interrupt is single and safe. For definition of single, see description of `Single` argument. A safe interrupt can not be put in sleep with instruction `ISleep`. The safe interrupt event will be queued at program stop and stepwise execution, and when starting in continious mode again, the interrupt will be executed. The only time a safe interrupt will be thrown is when the interrupt queue is full. Then an error will be reported. The interrupt will not survive program reset, e.g. PP to main.

`Signal`

Data type: `signalgo`

The name of the group output signal that generates interrupts.

`Interrupt`

Data type: `intnum`

The interrupt identity. This should have previously been connected to a trap routine by means of the instruction `CONNECT`.

Program execution

When the group signal changes value a call is made to the corresponding trap routine. When this has been executed program execution continues from where the interrupt occurred.

If the signal changes before the interrupt is ordered no interrupt occurs.

Continues on next page

Error handling

Following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the unit.

Limitations

Maximum number of signals that can be used for a group is 32.

Numeric value condition can not be used in the instruction to specify that an interrupt should occur on changes to that specific value. This must be handled in the user program by reading the group signal value at execution of the `TRAP`.

The same variable for interrupt identity cannot be used more than once without first deleting it. Interrupts should therefore be handled as shown in one of the alternatives below.

```
PROC main ( )
  VAR intnum sig1int;
  CONNECT sig1int WITH iroutine1;
  ISignalGO go1, sig1int;
  WHILE TRUE DO
  ...
  ENDWHILE
ENDPROC
```

All activation of interrupts is done at the beginning of the program. These beginning instructions are then kept outside the main flow of the program.

```
PROC main ( )
  VAR intnum sig1int;
  CONNECT sig1int WITH iroutine1;
  ISignalGO go1, sig1int;
  ...
  IDelete sig1int;
ENDPROC
```

The interrupt is deleted at the end of the program and is then reactivated. It should be noted, in this case, that the interrupt is inactive for a short period.

Syntax

```
ISignalGO
  [ '\' Single ] | [ '\' SingleSafe ] ','
  [ Signal ':=' ] < variable (VAR) of signalgo > ','
  [ Interrupt':=' ] < variable (VAR) of intnum > ';'
```


Continues on next page

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID Summary - Interrupts*
Interrupt from an output signal	*ISignalDO - Interrupts from a digital output signal on page 189*
Interrupt from group input signals	*ISignalGI - Orders interrupts from a group of digital input signals on page 192*
More information on interrupt management	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Interrupts*
Interrupt identity	*intnum - Interrupt identity on page 1125*

1.79. ISleep - Deactivates an interrupt

Usage

`ISleep` (*Interrupt Sleep*) is used to deactivate an individual interrupt temporarily.

During the deactivation time any generated interrupts of the specified type are discarded without any trap execution.

Basic examples

Basic examples of the instruction are illustrated below.

See also *More examples on page 198*.

Example 1

```
ISleep sig1int;
```

The interrupt `sig1int` is deactivated.

Arguments

```
ISleep Interrupt
```

`Interrupt`

Data type: `intnum`

The variable (interrupt identity) of the interrupt.

Program execution

Any generated interrupts of the specified type are discarded without any trap execution until the interrupt has been re-activated by means of the instruction `IWatch`. Interrupts which are generated while `ISleep` is in effect are ignored.

More examples

More examples of the instruction `ISleep` are illustrated below.

Example 1

```
VAR intnum timeint;
CONNECT timeint WITH check_serialch;
ITimer 60, timeint;
...
ISleep timeint;
WriteBin ch1, buffer, 30;
IWatch timeint;
...
TRAP check_serialch
  WriteBin ch1, buffer, 1;
  IF ReadBin(ch1\Time:=5) < 0 THEN
     TPWrite "The serial communication is broken";
     EXIT;
  ENDIF
ENDTRAP
```


Continues on next page

Communication across the ch1 serial channel is monitored by means of interrupts which are generated every `60` seconds. The trap routine checks whether the communication is working. When, however, communication is in progress these interrupts are not permitted.

Error handling

Interrupts which have neither been ordered nor enabled are not permitted. If the interrupt number is unknown the system variable `ERRNO` will be set to `ERR_UNKINO` (see *errnum - Error number on page 1108*). If trying to deactivate a safe interrupt temporarily with `ISleep`, the system variable `ERRNO` is set to `ERR_INOISSAFE`. These errors can be handled in an error handler.

Syntax

```
ISleep
  [ Interrupt ':=' ] < variable (VAR) of intnum > ';'
```

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupts*
Enabling an interrupt	*IWatch - Activates an interrupt on page 205*
Disabling all interrupts	*IDisable - Disables interrupts on page 124*
Cancelling an interrupt	*IDelete - Cancels an interrupt on page 123*

1.80. ITimer - Orders a timed interrupt

Usage

`ITimer` (*Interrupt Timer*) is used to order and enable a timed interrupt.

This instruction can be used, for example, to check the status of peripheral equipment once every minute.

Basic examples

Basic examples of the instruction `ITimer` are illustrated below.

See also *More examples on page 201*.

Example 1

```
VAR intnum timeint;
CONNECT timeint WITH iroutine1;
ITimer 60, timeint;
```

Orders an interrupt that is to occur cyclically every `60` seconds. A call is then made to the trap routine `iroutine1`.

Example 2

```
ITimer \Single, 60, timeint;
```

Orders an interrupt that is to occur once, after `60` seconds.

Arguments

```
ITimer [ \Single ] | [ \SingleSafe ] Time Interrupt
```

`[ \Single ]`

Data type: `switch`

Specifies whether the interrupt is to occur once or cyclically.

If the argument `Single` is set, the interrupt occurs only once. If the `Single` and `SingleSafe` arguments is omitted, an interrupt will occur each time at the specified time.

`[ \SingleSafe ]`

Data type: `switch`

Specifies that the interrupt is single and safe. For definition of single, see description of `Single` argument. A safe interrupt can not be put in sleep with instruction `ISleep`. The safe interrupt event will be queued at program stop and stepwise execution, and when starting in continious mode again, the interrupt will be executed.

`Time`

Data type: `num`

The amount of time that must lapse before the interrupt occurs.

The value is specified in seconds. If `Single` or `SingleSafe` is set this time may not be less than 0.01 seconds. The corresponding time for cyclical interrupts is 0.1 seconds.

`Interrupt`

Data type: `intnum`

The variable (interrupt identity) of the interrupt. This should have previously been connected to a trap routine by means of the instruction `CONNECT`.

Continues on next page

Program execution

The corresponding trap routine is automatically called at a given time following the interrupt order. When this has been executed program execution continues from where the interrupt occurred.

If the interrupt occurs cyclically a new computation of time is started from when the interrupt occurs.

More examples

More examples of the instruction `ITimer` are illustrated below.

Example 1

```
VAR intnum timeint;
CONNECT timeint WITH check_serialch;
ITimer 60, timeint;
...
TRAP check_serialch
  WriteBin ch1, buffer, 1;
  IF ReadBin(ch1\Time:=5) < 0 THEN
     TPWrite "The serial communication is broken";
     EXIT;
  ENDIF
ENDTRAP
```

Communication across the `ch1` serial channel is monitored by means of interrupts which are generated every `60` seconds. The trap routine checks whether the communication is working. If it is not program execution is terminated and an error message appears.

Limitations

The same variable for interrupt identity cannot be used more than once without being first deleted. See Instructions - `ISignalDI`.

Syntax

```
ITimer
  [ '\' Single ] | [ '\' SingleSafe ] ','
  [ Time ':=' ] < expression (IN) of num >','
  [ Interrupt' :=' ] < variable (VAR) of intnum > ';'
```

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupts*
More information on interrupt management	*Technical reference manual - RAPID overview*, section *Basic Characteristics-Interrupts*

1.81. IVarValue - orders a variable value interrupt

Usage

`IVarValue` (*Interrupt Variable Value*) is used to order and enable an interrupt when the value of a variable accessed via the serial sensor interface has been changed.

This instruction can be used, for example, to get seam volume or gap values from a seam tracker.

Basic examples

Basic examples of the instruction `IVarValue` are illustrated below.

Example 1

```
LOCAL PERS num
     adptVlt{25}:=[1,1.2,1.4,1.6,1.8,2,2.16667,2.33333,2.5,...];

LOCAL PERS num
     adptWfd{25}:=[2,2.2,2.4,2.6,2.8,3,3.16667,3.33333,3.5,...];
LOCAL PERS num
     adptSpd{25}:=10,12,14,16,18,20,21.6667,23.3333,25[,...];
LOCAL CONST num GAP_VARIABLE_NO:=11;
PERS num gap_value;
VAR intnum IntAdap;

PROC main()
  ! Setup the interrupt. The trap routine AdapTrp will be called
  ! when the gap variable with number ´GAP_VARIABLE_NO’ in the
  !sensor interface has been changed. The new value will be
  ! available in the PERS gp_value variable.
  ! Connect to the sensor device "sen1:" (defined in sio.cfg).
  SenDevice "sen1:";

  CONNECT IntAdap WITH AdapTrp;
  IVarValue "sen1:", GAP_VARIABLE_NO, gap_value, IntAdap;

  ! Start welding
  ArcL\On,*,v100,adaptSm,adaptWd,adaptWv,z10,tool\j\Track:=track;
  ArcL\On,*,v100,adaptSm,adaptWd,adaptWv,z10,tool\j\Track:=track;

ENDPROC
```


Continues on next page

```
TRAP AdapTrap
  VAR num ArrInd;
  !Scale the raw gap value received
  ArrInd:=ArrIndx(gap_value);

  ! Update active welddata PERS variable 'adaptWd' with new data
  ! from the arrays of predefined parameter arrays. The scaled gap
  ! value is used as index in the voltage, wirefeed and
  ! speed arrays.
  adaptWd.weld_voltage:=adptVlt{ArrInd};
  adaptWd.weld_wirefeed:=adptWfd{ArrInd};
  adaptWd.weld_speed:=adptSpd{ArrInd};

  !Request a refresh of AW parameters using the new data i adaptWd
  ArcRefresh;

ENDTRAP
```

Arguments

```
IVarValue device VarNo Value Interrupt [ \Unit ] [ \DeadBand ]
```

`device`

Data type: `string`

The I/O device name configured in sio.cfg for the sensor used.

`VarNo`

Data type: `num`

The number of the variable to be supervised.

`Value`

Data type: `num`

A `PERS` variable which will hold the new value of `VarNo`.

`Interrupt`

Data type: `intnum`

The variable (interrupt identity) of the interrupt. This should have previously been connected to a trap routine by means of the instruction `CONNECT`.

`[ \Unit ]`

Data type: `num`

Scale factor with which the sensor value for `VarNo` is multiplied before check and before it is saved in `Value`.

`[ \DeadBand ]`

Data type: `num`

If the value for `Varno`, returned by the sensor, is within `+/- DeadBand` no interrupt is generated.

Continues on next page

Program execution

The corresponding trap routine is automatically called at a given time following the interrupt order. When this has been executed program execution continues from where the interrupt occurred.

Limitations

The same variable for interrupt identity cannot be used more than five times without first being deleted.

CAUTION!

Too high interrupt frequency will stall the whole RAPID execution.

Syntax

```
IVarValue
  [ device ':=' ] < expression (IN) of string>','
  [ VarNo ':=' ] < expression (IN) of num >','
  [ Value ':=' ] < persistent (PERS) of num >','
  [ Interrupt' :=' ] < variable (VAR) of intnum > ','
  [ '\' Unit' :=' ] < expression (IN) of num >','
  [ '\' DeadBand' :=' ] < expression (IN) of num > ';'
```

Related information

For information about	See
Connect to a sensor device	*SenDevice - connect to a sensor device on page 425*
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupts*
More information on interrupt management	*Technical reference manual - RAPID overview*, section *Basic characteristics - Interrupts*
Optical Tracking	*Application manual - Continuous application platform*
Optical Tracking Art	*Application manual - Arc and Arc Sensor*

1.82. IWatch - Activates an interrupt

Usage

`IWatch` (*Interrupt Watch*) is used to activate an interrupt which was previously ordered but was deactivated with `ISleep`.

Basic examples

Basic examples of the instruction `IWatch` are illustrated below.

See also *More examples on page 205*.

Example 1

```
IWatch sig1int;
```

The interrupt `sig1int` that was previously deactivated is activated.

Arguments

```
IWatch Interrupt
```

`Interrupt`

Data type: `intnum`

Variable (interrupt identity) of the interrupt.

Program execution

Re-activates interrupts of the specified type once again. However, interrupts generated during the time the `ISleep` instruction was in effect are ignored.

More examples

More examples of the instruction `IWatch` are illustrated below.

Example 1

```
VAR intnum sig1int;
CONNECT sig1int WITH iroutine1;
ISignalDI di1,1,sig1int;
...
ISleep sig1int;
weldpart1;
IWatch sig1int;
```

During execution of the `weldpart1` routine no interrupts are permitted from the signal `di1`.

Error handling

Interrupts which have not been ordered are not permitted. If the interrupt number is unknown the system variable `ERRNO` is set to `ERR_UNKINO` (see *errnum - Error number on page 1108*). The error can be handled in the error handler.

Syntax

```
IWatch
  [ Interrupt ':=' ] < variable (VAR) of intnum > ';'
```

Continues on next page

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupts*
Deactivating an interrupt	*ISleep - Deactivates an interrupt on page 198*

1.83. Label - Line name

Usage

`Label` is used to name a line in the program. Using the `GOTO` instruction this name can then be used to move program execution within the same routine.

Basic examples

Basic examples of the instruction `Label` are illustrated below.

Example 1

```
GOTO next;
...
next:
```

Program execution continues with the instruction following `next`.

Arguments

```
Label:
```

`Label`

Identifier

The name you wish to give the line.

Program execution

Nothing happens when you execute this instruction.

Limitations

The label must not be the same as

- any other label within the same routine.
- any data name within the same routine.

A label hides global data and routines with the same name within the routine it is located in.

Syntax

```
(EBNF)
<identifier>':'
```

Related information

For information about	See
Identifiers	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*
Moving program execution to a label	*GOTO - Goes to a new instruction on page 117*

1.84. Load - Load a program module during execution

Usage

`Load` is used to load a program module into the program memory during execution.

The loaded program module will be added to the already existing modules in the program memory.

A program or system module can be loaded in static (default) or dynamic mode.

Both static and dynamic loaded modules can be unloaded by the instruction `UnLoad`.

Static mode

The following table describes how different operations affect static loaded program or system modules.

Type of module	Set PP to main from FlexPendant	Open new RAPID program
Program Module	Not affected	Unloaded
System Module	Not affected	Not affected

Dynamic mode

The following table describes how different operations affect dynamic loaded program or system modules.

Type of module	Set PP to main from FlexPendant	Open new RAPID program
Program Module	Unloaded	Unloaded
System Module	Unloaded	Unloaded

Basic examples

Basic examples of the instruction `Load` are illustrated below.

See also *More examples on page 210*.

Example 1

```
Load \Dynamic, diskhome \File:="PART_A.MOD";
```

Loads the program module `PART_A.MOD` from the `diskhome` into the program memory. `diskhome` is a predefined string constant `"HOME:"`. Load the program module in the dynamic mode.

Example 2

```
Load \Dynamic, diskhome \File:="PART_A.MOD";
Load \Dynamic, diskhome \File:="PART_B.MOD" \CheckRef;
```

Loads the program module `PART_A.MOD` into the program memory, then `PART_B.MOD` is loaded. If `PART_A.MOD` contains references to `PART_B.MOD`, `\CheckRef` can be used to check for unresolved references only when the last module is loaded. IF `\CheckRef` is used on `PART_A.MOD`, a link error would occur and the module would not be loaded.

Continues on next page

Arguments

```
Load [\Dynamic] FilePath [\File] [\CheckRef]
```

`[\Dynamic]`

Data type: `switch`

The switch enables load of a module in dynamic mode. Otherwise the load is in static mode.

`FilePath`

Data type: `string`

The file path and the file name to the file that will be loaded into the program memory. The file name shall be excluded when the argument `\File` is used.

`[\File]`

Data type: `string`

When the file name is excluded in the argument `FilePath` then it must be defined with this argument.

`[\CheckRef]`

Data type: `switch`

Check after loading of the module for unsolved references in the program task. If not used no check for unsolved references are done.

Program execution

Program execution waits for the program module to finish loading before proceeding with the next instruction.

Unresolved references will always be accepted for the loading operation, if parameter `\CheckRef` is not used, but it will be a run time error on execution of an unresolved reference.

After the program module is loaded it will be linked and initialized. The initialization of the loaded module sets all variables at module level to their unit values.

If any error from the loading operation, including unresolved references if use of switch `\CheckRef`, the loaded module will not be available any more in the program memory.

To obtain a good program structure that is easy to understand and maintain, all loading and unloading of program modules should be done from the main module which is always present in the program memory during execution.

For loading of program that contains a main procedure to a main program (with another main procedure), see example in *More examples on page 210* below.

Continues on next page

More examples

More examples of how to use the instruction `Load` are illustrated below.

More general examples

```
Load \Dynamic, "HOME:/DOORDIR/DOOR1.MOD";
```

Loads the program module `DOOR1.MOD` from `HOME:` at the directory `DOORDIR` into the program memory. The program module is loaded in the dynamic mode.

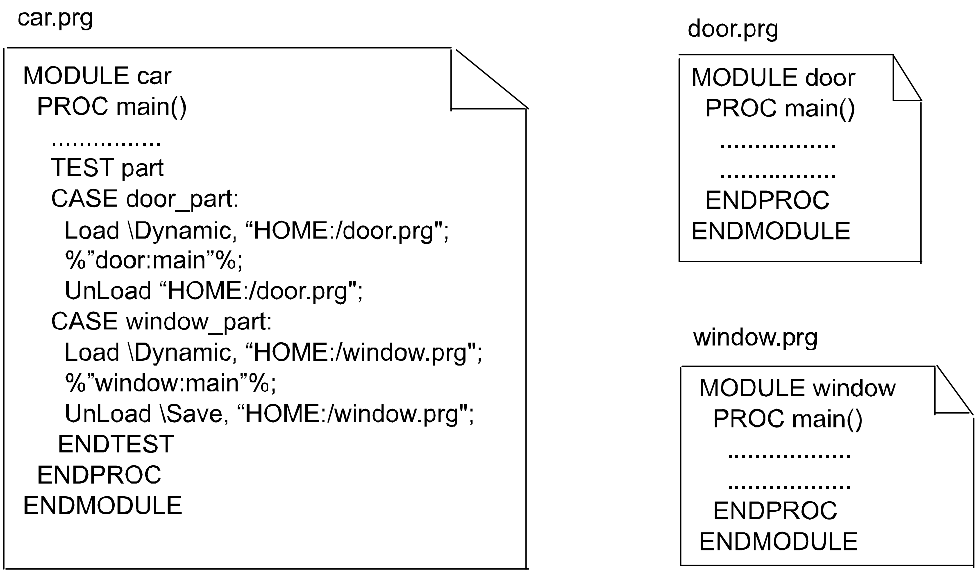
```
Load "HOME:" \File:="DOORDIR/DOOR1.MOD";
```

Same as above but another syntax, and the module is loaded in the static mode.

```
Load\Dynamic, "HOME:/DOORDIR/DOOR1.MOD";
%"routine_x"%;
UnLoad "HOME:/DOORDIR/DOOR1.MOD";
```

Procedure `routine_x`, will be binded during execution (late binding).

Loaded program contains a main procedure



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The above example shows how you can load a program which includes a `main` procedure. This program can have been developed and tested separately and later loaded with `Load` or `StartLoad... WaitLoad` into the system using some type of main program framework. In this example `car.prg`, which loads other programs `door.prg` or `window.prg`.

In the program `car.prg` you load `door.prg` or `window.prg` located at `"HOME:"`. Because the `main` procedures in `door.prg` and `window.prg` after the loading are considered **LOCAL** in the module by the system, the procedure calls are made in the following way: `%"door:main"%` or `%"window: main"%`. This syntax is used when you want to get access to **LOCAL** procedures in other modules in this example procedure `main` in module `door` or module `window`.

Unloading the modules with `\Save` argument will again make the `main` procedures global in the saved program.

If you, when the module `car` or `window` are loaded in the system, set program pointer to `main` from any part of the program, the program pointer will always be set to the global `main` procedure in the main program, `car.prg` in this example.

Continues on next page

Limitations

Avoid ongoing robot movements during the loading.

Error handling

If the file specified in the `Load` instruction cannot be found the system variable `ERRNO` is set to `ERR_FILNOTFND` at execution.

If some other type of problems to read the file to load the system variable `ERRNO` will be set to `ERR_IOERROR`.

If the module cannot be loaded because the program memory is full the system variable `ERRNO` is set to `ERR_PRGMEMFULL`.

If the module is already loaded into the program memory the system variable `ERRNO` is set to `ERR_LOADED`.

If the loaded module contains syntax errors the system variable `ERRNO` is set to `ERR_SYNTAX`.

If the loaded module result in fatal link errors the system variable `ERRNO` is set to `ERR_LINKREF`.

If `Load` is used with the switch `\CheckRef` to check for any reference error and the program memory contains unresolved references the system variable `ERRNO` is set to `ERR_LINKREF`.

These errors can then be handled in the `ERROR` handler. If some of these error occurs the actual module will be unloaded and will not be available in the `ERROR` handler.

Syntax

```
Load
  [´\´Dynamic´,´]
  [FilePath´:=´]<expression (IN) of string>
  [´\´File´:=´ <expression (IN) of string>]
  [´\´CheckRef]´;´
```

Related information

For information about	See
Unload a program module	*UnLoad - UnLoad a program module during execution on page 655*
Load a program module in parallel with another program execution	*StartLoad - Load a program module during execution on page 482* *WaitLoad - Connect the loaded module to the task on page 682*
Check program references	*CheckProgRef - Check program references on page 37*

1.85. LoadId - Load identification of tool or payload

Usage

`LoadId` (*Load Identification*) can be used for load identification of tool (also gripper tool if roomfix TCP) or payload (activates with instruction `GripLoad`) by executing a user defined RAPID program.

NOTE!

An easier way to identify the tool load or payload is to use the interactive dialogue RAPID program `LoadIdentify`. This program can be started from the menu `Program Editor/Debug/Call Service Rout./LoadIdentify`.

Basic examples

Basic examples of the instruction `LoadId` are illustrated below.

See also *More examples on page 216*.

Example 1

```
VAR bool invalid_pos := TRUE;
VAR jointtarget joints;
VAR bool valid_joints{12};
CONST speeddata low_ori_speed := [20, 5, 20, 5];
VAR bool slow_test_flag := TRUE;
PERS tooldata grip3 := [ TRUE, [[97.4, 0, 223.1], [0.924, 0, 0.383
      ,0]], [0, [0, 0, 0], [1, 0, 0, 0], 0, 0, 0]];
! Check if valid robot type
IF ParIdRobValid(TOOL_LOAD_ID) <> ROB_LOAD_VAL THEN
  EXIT;
ENDIF
! Check if valid robot position
WHILE invalid_pos = TRUE DO
  joints := CJointT();
  IF ParIdPosValid (TOOL_LOAD_ID, joints, valid_joints) = TRUE
       THEN
    ! Valid position
    invalid_pos := FALSE;
  ELSE
    ! Invalid position
    ! Adjust the position by program movements (horizontal tilt
        house)
    MoveAbsJ joints, low_ori_speed, fine, tool0;
  ENDIF
ENDWHILE
! Do slow test for check of free working area
IF slow_test_flag = TRUE THEN
  LoadId TOOL_LOAD_ID, MASS_WITH_AX3, grip3 \SlowTest;
ENDIF
! Do measurement and update all load data in grip3
LoadId TOOL_LOAD_ID, MASS_WITH_AX3, grip3;
```

Continues on next page

Load identification of tool `grip3`.

Condition

The following conditions should be fulfilled before load measurements with `LoadId`:

- Make sure that all loads are correctly mounted on the robot
- Check whether valid robot type with `ParIdRobValid`
- Check whether valid position with `ParIdPosValid`:
  - Axes 3, 5, and 6 not close to their corresponding working range
  - Tilt housing almost horizontal, i.e. that axis 4 is in zero position
- The following data should be defined in system parameters and in arguments to `LoadId` before running `LoadId`

The table below illustrates the load identification of tool.

Load identification modes / Defined data before `LoadId`	**Moving TCP Mass Known**	**Moving TCP Mass Unknown**	**Roomfix TCP Mass Known**	**Roomfix TCP Mass Unknown**
Upper arm load (System parameter)		Defined		Defined
Mass in tool	Defined		Defined	

The table below illustrates the load identification of payload.

Load identification modes / Defined data before `LoadId`	**Moving TCP Mass Known**	**Moving TCP Mass Unknown**	**Roomfix TCP Mass Known**	**Roomfix TCP Mass Unknown**
Upper arm load (System parameters)		Defined		Defined
Load data in tool	Defined	Defined	Defined	Defined
Mass in payload	Defined		Defined	
Tool frame in tool	Defined	Defined		
User frame in work object			Defined	Defined
Object frame in work object			Defined	Defined

- Operating mode and speed override:
  - Slow test in manual mode reduced speed
  - Load measurements in automatic mode (or manual mode full speed) with speed override 100%

Continues on next page

Arguments

```
LoadId ParIdType LoadIdType Tool [\PayLoad] [\WObj] [\ConfAngle]
    [\SlowTest] [\Accuracy]
```

`ParIdType`

Data type: `paridnum`

Type of load identification as defined in the table below.

Value	Symbolic constant	Comment
1	TOOL_LOAD_ID	Identify tool load
2	PAY_LOAD_ID	Identify payload (Ref. instruction GripLoad)

`LoadIdType`

Data type: `loadidnum`

Type of load identification as defined in the table below.

Value	Symbolic constant	Comment
1	MASS_KNOWN	Known mass in tool or payload respectively. (Mass in specified Tool or PayLoad must be specified)
2	MASS_WITH_AX3	Unknown mass in tool or payload respectively. Identification of mass in tool or payload will be done with movements of axis 3

`Tool`

Data type: `tooldata`

Persistent variable for the tool to be identified. If argument `\PayLoad` is specified, the persistent variable for the tool in use.

For load identification of tool, the following arguments `\PayLoad` and `\WObj` should not be specified.

`[ \ PayLoad ]`

Data type: `loaddata`

Persistent variable for the payload to be identified.

This option argument must always be specified for load identification of payload.

`[ \ WObj ]`

Data type: `wobjdata`

Persistent variable for the work object in use.

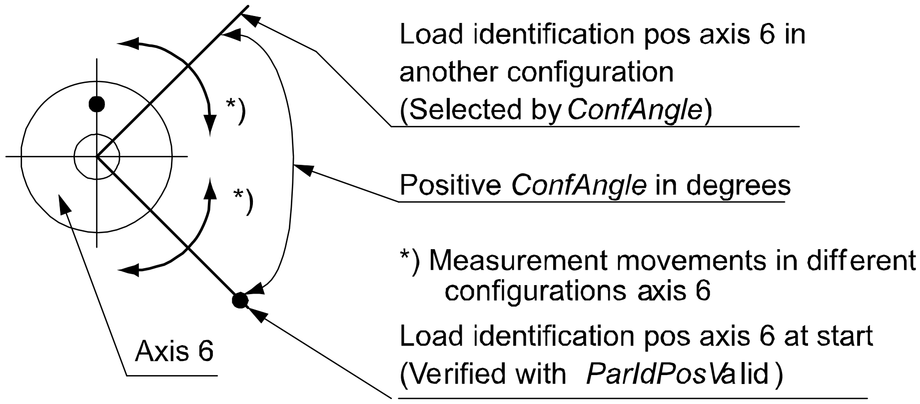
This option argument must always be specified for load identification of payload with roomfix TCP.

Continues on next page

`[ \ ConfAngle ]`

Data type: `num`

Option argument for specification of a specific configuration angle ± degrees to be used for the parameter identification.



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Default + 90 degrees if this argument is not specified. Min. + or - 30 degrees. Optimum + or - 90 degrees.

`[ \ SlowTest ]`

Data type: `switch`

Option argument to specify whether only slow test for checking of free working area should be done. See table below:

`LoadId ... \SlowTest`	Run only slow test
`LoadId ...`	Run only measurement and update tool or payload

`[ \ Accuracy ]`

Data type: `num`

Variable for output of calculated measurement accuracy in % for the whole load identification calculation (100% means maximum accuracy).

Program execution

The robot will carry out a large number of relative small transport and measurement movements on axes 5 and 6. For identification of mass, movements will also be made with axis 3.

After all measurements, movements, and load calculations the load data is returned in argument `Tool` or `PayLoad`. The following load data is calculated:

- Mass in kg (if mass is unknown otherwise not affected)
- Center of gravity x, y, z, and axes of moment
- Inertia ix, iy, iz in kgm

Continues on next page

More examples

More examples of the instruction `LoadId` are illustrated below.

Example 1

```
PERS tooldata grip3 := [ FALSE, [[97.4, 0, 223.1], [0.924, 0, 0.383
     ,0]], [6, [10, 10, 100], [0.5, 0.5, 0.5, 0.5], 1.2, 2.7,
     0.5]];
PERS loaddata piece5 := [ 5, [0, 0, 0], [1, 0, 0, 0], 0, 0, 0];
PERS wobjdata wobj2 := [ TRUE, TRUE, "", [ [34, 0, -45], [0.5, -
     0.5, 0.5 ,-0.5] ], [ [0.56, 10, 68], [0.5, 0.5, 0.5 ,0.5] ] ];
VAR num load_accuracy;
! Do measurement and update all payload data except mass in piece5
LoadId PAY_LOAD_ID, MASS_KNOWN, grip3 \PayLoad:=piece5
     \WObj:=wobj2 \Accuracy:=load_accuracy;
TPWrite " Load accuracy for piece5 (%) = " \Num:=load_accuracy;
```

Load identification of payload `piece5` with known mass in installation with roomfix TCP.

Limitations

Usually load identification of tool or payload for the robot is done with the service routine `LoadIdentify`. It is also possible to do this identification with this RAPID instruction `LoadId`. Before loading or executing the program with `LoadId` following modules must be loaded to the system:

```
Load \Dynamic, "RELEASE:/system/mockit.sys";
Load \Dynamic, "RELEASE:/system/mockit1.sys";
```

It is not possible to restart the load identification movements after any type of stop such as program stop, emergency stop, or power failure. The load identification movements must then be started from the beginning.

Error handling

At any error during execution of the RAPID `NOSTEPIN` routine `LoadId`, the system variable `ERRNO` is set to `ERR_PID_MOVESTOP`, `ERR_PID_RAISE_PP` or `ERR_LOADID_FATAL` and the program pointer is raised to the user call of `LoadId`.

Syntax

```
LoadId
  [ ParIdType ':=' ] <expression (IN) of paridnum>´,'
  [ LoadIdType' :=' ] <expression (IN) of loadidnum> ´,'
  [ Tool ':=' ] <persistent (PERS) of tooldata>
  [ '\' PayLoad' :=' <persistent (PERS) of loaddata> ]
  [ '\' WObj' :=' <persistent (PERS) of wobjdata> ]
  [ '\' ConfAngle' :=' <expression (IN) of num> ]
  [ ´\' SlowTest ]
  [ ´\' Accuracy' :=' <variable (VAR) of num> ] ´;'
```


Continues on next page

Related information

For information about	See
Predefined program Load Identify	*Operating manual - IRC5 with FlexPendant*, section *Programming and testing - Service routines - LoadIdentify, load identification and service routines*
Type of parameter identification	*paridnum - Type of parameter identification on page 1154*
Result of `ParIdRobValid`	*paridvalidnum - Result of ParIdRobValid on page 1156*
Type of load identification	*loadidnum - Type of load identification on page 1137*
Valid robot type	*ParIdRobValid - Valid robot type for parameter identification on page 916*
Valid robot position	*ParIdPosValid - Valid robot position for parameter identification on page 913*

1.86. MakeDir - Create a new directory

Usage

`MakeDir` is used to create a new directory. The user must have write and execute permission for the parent directory under which the new directory is created.

Basic examples

Basic examples of the instruction `MakeDir` are illustrated below.

Example 1

```
MakeDir "HOME:/newdir";
```

This example creates a new directory, called `newdir`, under `HOME`:

Arguments

```
MakeDir Path
```

`Path`

Data type:`string`

The name of the new directory specified with full or relative path.

Error handling

If the directory cannot be created the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

Syntax

```
MakeDir
[ Path':=' ] < expression (IN) of string>';'
```

Related information

For information about	See
Remove a directory	*RemoveDir - Delete a directory on page 355*
Rename a file	*RenameFile - Rename a file on page 357*
Remove a file	*RemoveFile - Delete a file on page 356*
Copy a file	*CopyFile - Copy a file on page 65*
Check file type	*IsFile - Check the type of a file on page 878*
Check file size	*FileSize - Retrieve the size of a file on page 842*
Check file system size	*FSSize - Retrieve the size of a file system on page 848*

1.87. ManLoadIdProc - Load identification of IRBP manipulators

Usage

`ManLoadIdProc` (*Manipulator Load Identification Procedure*) is used for load identification of payload for external manipulators by executing a user defined RAPID program.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

NOTE!

An easier way to identify the payload is to use the interactive dialogue RAPID program `ManLoadIdentify`.This program can be started from the menu `Program Editor/Debug/Call Routine.../ManLoadIdentify`.

Basic examples

Basic examples of the instruction `ManLoadIdProc` are illustrated below.

```
PERS loaddata myload := [6,[0,0,0],[1,0,0,0],0,0,0];
VAR bool defined;
ActUnit STN1;
ManLoadIdProc \ParIdType := IRBP_L
              \MechUnit := STN1
              \PayLoad := myload
              \ConfigAngle := 60
              \AlreadyActive
              \DefinedFlag := defined;
DeactUnit STN1;
```

Load identification of payload `myload` mounted on the mechanical unit `STN1`. The external manipulator is of type `IRBP-L`. The configuration angle is set to 60 degrees. The manipulator is activated before the load identification and deactivated after. After the identification `myload` has been updated and defined it is set to `TRUE`.

Arguments

```
ManLoadIdProc [\ParIdType] [\MechUnit] | [\MechUnitName]
      [\AxisNumber] [\PayLoad] [\ConfigAngle] [\DeactAll] |
      [\AlreadyActive] [DefinedFlag] [DoExit]
```

`[ \ ParIdType ]`

Data type: `paridnum`

Type of parameter identification. Predefined constants are found under the datatype `paridnum`.

`[ \ MechUnit ]`

Data type: `mecunit`

Mechanical unit used for the load identification. Can not be used together with argument `\MechUnitName`.

Continues on next page

`[ \ MechUnitName ]`

Data type: `string`

Mechanical unit used for the load identification given as a string. Can not be used together with argument `\MechUnit`.

`[ \ AxisNumber ]`

Data type: `num`

Axis number within the mechanical unit, which holds the load to be identified.

`[ \ PayLoad ]`

Data type: `loaddata`

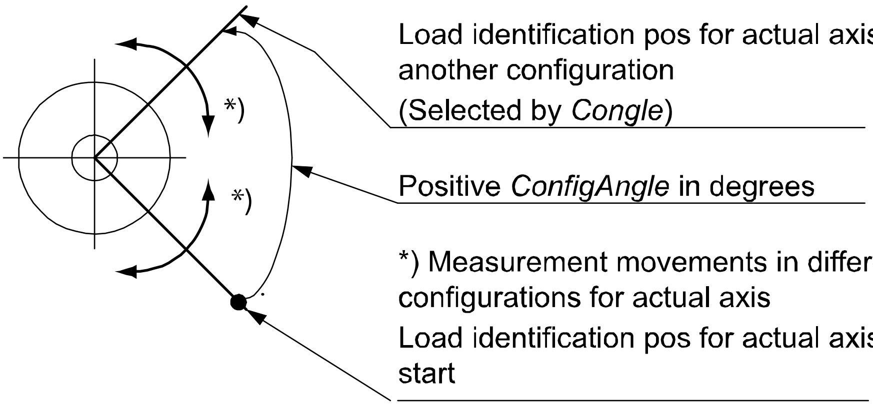
Variable for the payload to be identified. The component mass must be specified.

This variable will be updated after the identification is done.

`[ \ ConfigAngle ]`

Data type: `num`

Specification of a specific configuration angle ± degrees to be used for the parameter identification.



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Min. + or - 30 degrees. Optimum + or - 90 degrees.

`[ \ DeactAll ]`

Data type: `switch`

If this switch is used all mechanical units in the system will be deactivated before identification is done. The mechanical unit to identify will then be activated. It cannot be used together with argument `\AlreadyActive`.

`[ \ AlreadyActive ]`

Data type: `switch`

This switch is used if the mechanical unit to identify is active. It cannot be used together with argument `\DeactAll`.

`[ \ DefinedFlag ]`

Data type: `bool`

This argument will be set to `TRUE` if the identification has been made, `FALSE` otherwise.

Continues on next page

`[ \ DoExit]`

Data type: `bool`

If set to `TRUE` the load identification will end up with an `EXIT` command to force the user to set PP to main before continuing the execution. If not present or set to `FALSE` no `EXIT` will be done. Note that `ManLoadIdProc` always clears the current path.

Program Execution

All arguments are optional. If an argument is not given the user will be asked for the value from the FlexPendant (except for `\DoExit`).

The user will always be asked to give the mass and if the manipulator is of type IRBP R, z in mm.

The mechanical unit will carry out a large number of relative small transport and measurement movements.

After all measurements, movements, and load calculations the load data is returned in argument `Payload` if used. The following load data is calculated.

Manipulator type/ Calculated load data	**IRBP-K**	**IRBP-L IRBP-C IRBP_T**	**IRBP-R**	**IRBP-A IRBP-B IRBP-D**
Parameter `PayLoad` - cog.x, cog.y, cog.z in loaddata in mm	cog.x cog.y	cog.x cog.y	cog.x cog.y	cog.x cog.y cog.z
Parameter `PayLoad` - ix, iy, iz in loaddata in kgm2	iz	iz	ix iy iz	ix iy iz

The calculated data will be displayed on the FlexPendant.

Limitations

Usually load identification of load for the external manipulator is done with the service routine `ManLoadIdentify`. It is also possible to do this identification with this RAPID instruction `ManLoadIdProc`.

Any path in progress will be cleared before the load identification. The program pointer will be lost after the load identification if argument `\DoExit:=TRUE` is used.

It is not possible to restart the load identification movements after any type of stop, such as program stop, emergency stop, or power failure. The load identification movements must be again restarted from the beginning.

Error handling

At any error during execution of the RAPID `NOSTEPIN` routine `ManLoadIdProc` the system variable `ERRNO` is set to `ERR_PID_MOVESTOP`, `ERR_PID_RAISE_PP`, or `ERR_LOADID_FATAL` and the program pointer is raised to the user call of `ManLoadIdProc`.

Continues on next page

Syntax

```
ManLoadIdProc
  [ ´\'ParIdType ':=' <expression (IN) of paridnum>]
  [ ´\'MechUnit ':=' <variable (VAR) of mecunit> ]
  |[´\'MechUnitName ':=' <expression (IN) of string>]
  [´\' AxisNumber ':=' <expression (IN) of num> ]
  [´\' PayLoad ':=' <var or pers (INOUT) of loaddata>
  [ ´\' ConfigAngle ':=' <expression (IN) of num>]
  [ ´\' DeactAll] | [´\'AlreadyActive]
  [ ´\' DefinedFlag ':=' <variable (VAR) of bool> ]
  [ ´\' DoExit ':=' <expression (IN) of bool> ] ´;'
```

Related information

For information about	See
Type of parameter identification	*paridnum - Type of parameter identification on page 1154*
Mechanical unit	*mecunit - Mechanical unit on page 1139*
PayLoad	*loaddata - Load data on page 1132*

1.88. MechUnitLoad - Defines a payload for a mechanical unit

Usage

`MechUnitLoad` is used to define a payload for an external mechanical unit. (The payload for the robot is defined with instruction `GripLoad`.)

This instruction should be used for all mechanical units with dynamic model in servo to achieve the best motion performance.

The `MechUnitLoad` instruction should always be executed after execution of the instruction `ActUnit`.

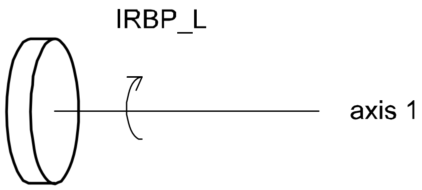
This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `MechUnitLoad` are illustrated below.

Illustration

The following figure shows a mechanical unit named `IRBP_L` of type `IRBP L`.



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Example 1

```
ActUnit IRBP_L;
MechUnitLoad IRBP_L, 1, load0;
```

Activate mechanical unit `IRBP_L` and define the payload `load0` corresponding to no load (at all) mounted on axis `1`.

Example 2

```
ActUnit IRBP_L;
MechUnitLoad IRBP_L, 1, fixture1;
```

Activate mechanical unit `IRBP_L` and define the payload `fixture1` corresponding to fixture `fixture1` mounted on axis `1`.

Example 3

```
ActUnit IRBP_L;
MechUnitLoad IRBP_L, 1, workpiece1;
```

Activate mechanical unit `IRBP_L` and define the payload `workpiece1` corresponding to fixture and work piece named `workpiece1` mounted on axis `1`.

Continues on next page

Arguments

```
MechUnitLoad MechUnit AxisNo Load
```

`MechUnit`

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit.

`AxisNo`

Axis Number

Data type: `num`

The axis number within the mechanical unit that holds the load.

`Load`

Data type: `loaddata`

The load data that describes the current payload to be defined.

Program execution

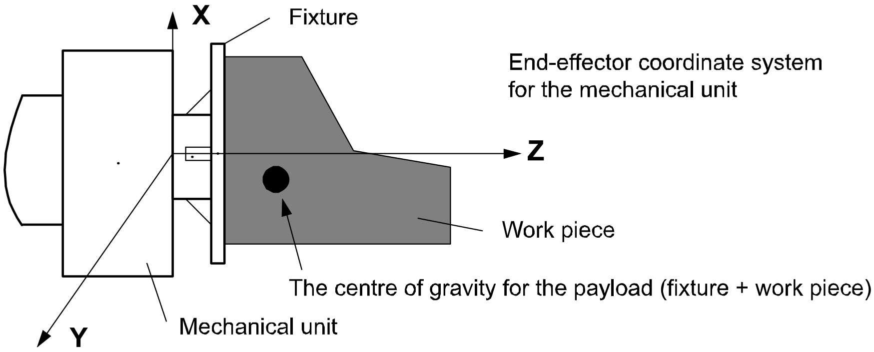
After execution of `MechUnitLoad`, when the robot and external axes have come to a standstill, the specified load is defined for the specified mechanical unit and axis. This means that the payload is controlled and monitored by the control system.

The default payload at cold start-up, for a certain mechanical unit type, is the predefined maximal payload for this mechanical unit type.

When some other payload is used the actual payload for the mechanical unit and axis should be redefined with this instruction. This should always be done after activation of the mechanical unit.

The defined payload will survive a power failure restart. The defined payload will also survive a restart of the program after manual activation of some other mechanical units from the jogging window.

The following figure shows a payload mounted on the end-effector of a mechanical unit.



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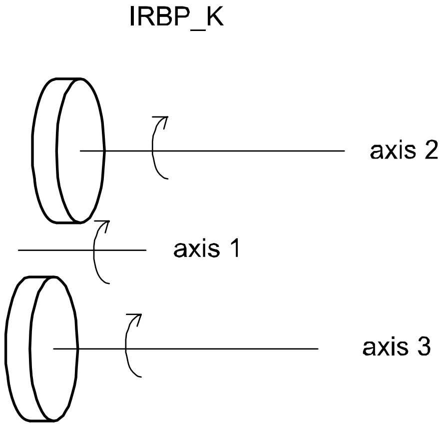
Continues on next page

More examples

More examples of how to use the instruction `MechUnitLoad` are illustrated below.

Illustration

The following figure shows a mechanical unit named `IRBP_K` of type `IRBP K` with three axes.



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Example 1

```
MoveL homeside1, v1000, fine, gun1;
...
ActUnit IRBP_K;
```

The whole mechanical unit `IRBP_K` is activated.

Example 2

```
MechUnitLoad IRBP_K, 2, workpiece1;
```

Defines payload `workpiece1` on the mechanical unit `IRBP_K` axis `2`.

Example 3

```
MechUnitLoad IRBP_K, 3, workpiece2;
```

Defines payload `workpiece2` on the mechanical unit `IRBP_K` axis `3`.

Example 4

```
MoveL homeside2, v1000, fine, gun1;
```

The axes of the mechanical unit `IRBP_K` move to the switch position `homeside2` with mounted payload on both axes `2` and `3`.

Limitations

If this instruction is preceded by a move instruction, that move instruction must be programmed with a stop point (zonedata `fine`), not a fly-by point. Otherwise restart after power failure will not be possible.

`MechUnitLoad` cannot be executed in a RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart or Step.

Continues on next page

Syntax

```
MechUnitLoad
  [MechUnit ':=' ] <variable (VAR) of mecunit>' ,'
  [AxisNo ´:=' ] <expression (IN) of num> ´,'
  [Load ':=' ] <persistent (PERS) of loaddata>';'
```

Related information

For information about	See
Identification of payload for external mechanical units	*Application manual - Additional axes and stand alone controller*
Mechanical units	*mecunit - Mechanical unit on page 1139*
Definition of load data	*loaddata - Load data on page 1132*
Definition of payload for the robot	*GripLoad - Defines the payload for the robot on page 119*

1.89. MotionSup - Deactivates/Activates motion supervision

Usage

`MotionSup` (*Motion Supervision*) is used to deactivate or activate the motion supervision function for robot movements during program execution.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Description

Motion supervision is the name of a collection of functions for high sensitivity, model-based supervision of the robot. Currently it contains functionality for load supervision, jam supervision, and collision detection. Because the supervision is designed to be very sensitive it may trip if there are large process forces acting on the robot.

If the load is not correctly defined use the load identification function to specify it. If large external process forces are present in most parts of the application, such as during deburring, then use the system parameters to raise the supervision level of the motion supervision until it no longer triggers. If, however, the external forces are only temporary, such as during the closing of a large spotweld gun, then the `MotionSup` instruction should be used to raise the supervision level (or turn the function off) for those parts of the application where the disturbance acts.

Basic examples

Basic examples of the instruction `MotionSup` are illustrated below.

Example 1

```
! If the motion supervision is active in the system parameters,
! then it is active by default during program execution
...
! If the motion supervision is deactivated through the system
! parameters,
! then it cannot be activated through the MotionSup instruction
...
! Deactivate motion supervision during program execution
MotionSup \Off;
...
! Activate motion supervision again during program execution
MotionSup \On;
...
! Tune the supervision level to 200% (makes the function less
! sensitive) of the level in
! the system parameters
MotionSup \On \TuneValue:= 200;
...
```


Continues on next page

Arguments

```
MotionSup[\On] | [\Off] [\TuneValue]
```

[`\On`]

Data type: `switch`

Activate the motion supervision function during program execution (if it has already been activated in system parameters).

[`\Off`]

Data type: `switch`

Deactivate the motion supervision function during program execution.

One of the arguments `\On` or `\Off` must be specified.

[`\TuneValue`]

Data type: `num`

Tuning the motion supervision sensitivity level in percent (1 - 300%) of system parameter level. A higher level gives more robust sensitivity. This argument can only be combined with argument `\On`.

Program execution

If the function motion supervision is active both in the system parameters and in the RAPID program and the motion supervision is triggered because of a collision etc., then

- the robot will stop as quickly as possible
- the robot will back up to remove any residual forces
- the program execution will stop with an error message

If motion supervision is active in system parameters it is then active by default during program execution (`TuneValue` 100%). These values are set automatically

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

Limitations

Motion supervision is never active for external axes or when one or more joints are run in independent joint mode. When using the robot in the soft servo mode it may be necessary to turn the motion supervision off to avoid accidental tripping.

Syntax

```
MotionSup
[ '\' On] | [ '\' Off ]
['\' Tunevalue':='< expression (IN) of num> ] ';'
```


Continues on next page

Related information

For information about	See
General description of the function	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Motion supervision/collision detection*
Tuning using system parameters	*Technical reference manual - System parameters*, section *Motion - Motion Planner - Use Motion Supervision*

1.90. MoveAbsJ - Moves the robot to an absolute joint position

Usage

`MoveAbsJ` (*Move Absolute Joint*) is used to move the robot and external axes to an absolute position defined in axes positions.

Examples of use:

- the end point is a singular point
- for ambiguous positions on the IRB 6400C, e.g. for movements with the tool over the robot

The final position of the robot during a movement with `MoveAbsJ` is neither affected by the given tool and work object nor by active program displacement. However, the robot uses this data to calculate the load, TCP velocity, and the corner path. The same tools can be used in adjacent movement instructions.

The robot and external axes move to the destination position along a non-linear path. All axes reach the destination position at the same time.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `MoveAbsJ` are illustrated below.

See also *More examples on page 233*.

Example 1

```
MoveAbsJ p50, v1000, z50, tool2;
```

The robot with the tool `tool2` is moved along a non-linear path to the absolute axis position, `p50`, with velocity data `v1000` and zone data `z50`.

Example 2

```
MoveAbsJ *, v1000\T:=5, fine, grip3;
```

The robot with the tool `grip3` is moved along a non-linear path to a stop point which is stored as an absolute axis position in the instruction (marked with an *). The entire movement takes `5` seconds.

Continues on next page

Arguments

```
MoveAbsJ [\Conc] ToJointPos [\ID] [\NoEOffs] Speed [\V] | [\T]
     Zone [\Z] [\Inpos] Tool [\WObj]
```

`[\Conc]`

Concurrent

Data type: `switch`

Subsequent instructions are executed while the robot is moving. The argument is usually not used but is used to shorten the cycle time when, for example, communicating with external equipment if synchronization is not required.

Using the argument `\Conc`, the number of movement instructions in succession is limited to 5. In a program section that includes `StorePath-RestoPath` movement instructions with the argument `\Conc` are not permitted.

If this argument is omitted and the `ToJointPos` is not a stop point, the subsequent instruction is executed some time before the robot has reached the programmed zone.

This argument can not be used in coordinated synchronized movement in a MultiMove System.

`ToJointPos`

To Joint Position

Data type: `jointtarget`

The destination absolute joint position of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove System, if it is a coordinated synchronized movement, and is not allowed in any other cases.

The specified id number must be the same in all cooperating program tasks. The id number gives a guarantee that the movements are not mixed up at runtime.

`[ \NoEOffs ]`

No External Offsets

Data type: `switch`

If the argument `\NoEOffs` is set then the movement with `MoveAbsJ` is not affected by active offsets for external axes.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the tool center point, the tool reorientation, and external axes.

Continues on next page

`[ \V ]`

Velocity

Data type: `num`

This argument is used to specify the velocity of the TCP in mm/s directly in the instruction. It is then substituted for the corresponding velocity specified in the speed data.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`[ \Z ]`

`Zone`

Data type: `num`

This argument is used to specify the position accuracy of the robot TCP directly in the instruction. The length of the corner path is given in mm, which is substituted for the corresponding zone that is specified in the zone data.

`[ \Inpos ]`

In position

Data type: `stoppointdata`

This argument is used to specify the convergence criteria for the position of the robots TCP in the stop point. The stop point data substitutes the zone specified in the `Zone` parameter.

`Tool`

Data type: `tooldata`

The tool in use during the movement.

The position of the TCP and the load on the tool are defined in the tool data. The TCP position is used to calculate the velocity and the corner path for the movement.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object used during the movement.

This argument can be omitted if the tool is held by the robot. However, if the robot holds the work object, i.e. the tool is stationary, or with coordinated external axes, then the argument must be specified.

In the case of a stationary tool or coordinated external axes, the data used by the system to calculate the velocity and the corner path for the movement is defined in the work object.

Continues on next page

Program execution

A movement with `MoveAbsJ` is not affected by active program displacement and if executed with switch `\NoEOffs` there will be no offset for external axes. Without switch `\NoEOffs` the external axes in the destination target are affected by active offset for external axes.

The tool is moved to the destination absolute joint position with interpolation of the axis angles. This means that each axis is moved with constant axis velocity and that all axes reach the destination joint position at the same time, which results in a non-linear path.

Generally speaking, the TCP is moved at approximate programmed velocity. The tool is reoriented and the external axes are moved at the same time as the TCP moves. If the programmed velocity for reorientation or for the external axes cannot be attained, the velocity of the TCP will be reduced.

A corner path is usually generated when movement is transferred to the next section of the path. If a stop point is specified in the zone data program execution only continues when the robot and external axes have reached the appropriate joint position.

More examples

More examples of how to use the instruction `MoveAbsJ` are illustrated below.

Example 1

```
MoveAbsJ *, v2000\V:=2200, z40 \Z:=45, grip3;
```

The tool, `grip3`, is moved along a non-linear path to an absolute joint position stored in the instruction. The movement is carried out with data set to `v2000` and `z40`. The velocity and zone size of the TCP are `2200` mm/s and `45` mm respectively.

Example 2

```
MoveAbsJ p5, v2000, fine \Inpos := inpos50, grip3;
```

The tool, `grip3`, is moved along a non-linear path to an absolute joint position `p5`. The robot considers it to be in the point when 50% of the position condition and 50% of the speed condition for a stop point `fine` are satisfied. It waits at most for 2 seconds for the conditions to be satisfied. See predefined data `inpos50` of data type `stoppointdata`.

Example 3

```
MoveAbsJ \Conc, *, v2000, z40, grip3;
```

The tool, `grip3`, is moved along a non-linear path to an absolute joint position stored in the instruction. Subsequent logical instructions are executed while the robot moves.

Example 4

```
MoveAbsJ \Conc, * \NoEOffs, v2000, z40, grip3;
```

Same movement as above but the movement is not affected by active offsets for external axes.

Example 5

```
GripLoad obj_mass;
MoveAbsJ start, v2000, z40, grip3 \WObj:= obj;
```

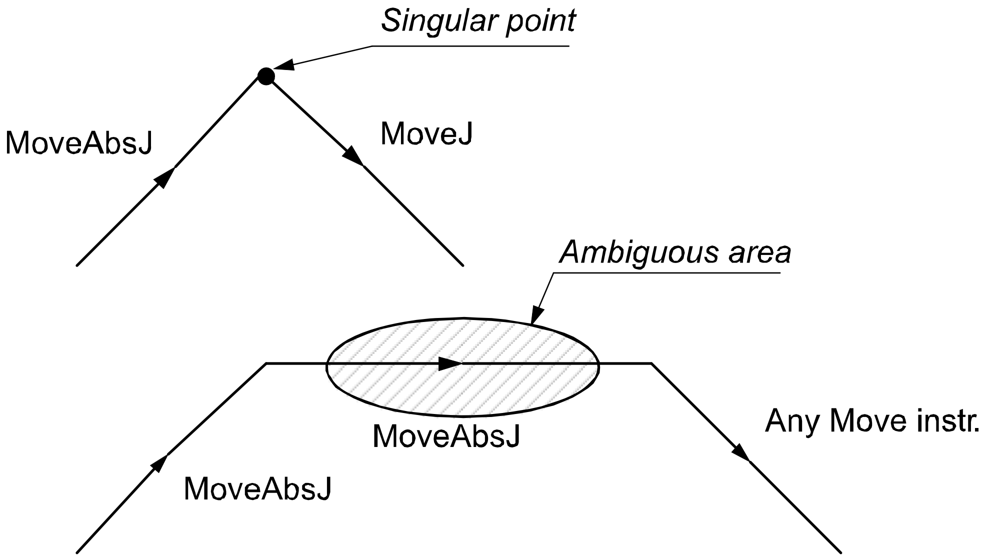
The robot moves the work object `obj` in relation to the fixed tool `grip3` along a non-linear path to an absolute axis position `start`.

Continues on next page

Limitations

In order to be able to run backwards with the instruction `MoveAbsJ` involved and avoiding problems with singular points or ambiguous areas, it is essential that the subsequent instructions fulfil certain requirements as follows (see figure below).

The figure shows limitation for backward execution with `MoveAbsJ`.



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Syntax

```
MoveAbsJ
  [ ’\’ Conc ’,’ ]
  [ ToJointPos’ :=’ ] < expression (IN) of jointtarget >
  [ ’\’ ID ’:=’ < expression (IN) of identno >]
  [ ’\’ NoEoffs ] ’,’
  [ Speed ’:=’ ] < expression (IN) of speeddata >
  [ ’\’ V ’:=’ < expression (IN) of num > ]
  | [ ’\’ T’ :=’ < expression (IN) of num > ] ’,’
  [Zone ’:=’ ] < expression (IN) of zonedata>
  [’\’ Z ´:=’ ] < expression (IN) of num >
  [ ’\’ Inpos’ :=’ < expression (IN) of stoppointdata > ] ´,’
  [ Tool ’:=’ ] < persistent (PERS) of tooldata >
  [ ’\’ WObj’ :=’ < persistent (PERS) of wobjdata > ] ’;’
```


Continues on next page

Related information

For information about	See
Other positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Definition of jointtarget	*jointtarget - Joint position data on page 1129*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*
Definition of stop point data	*stoppointdata - Stop point data on page 1189*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*
Concurrent program execution	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Synchronization with logical instructions*

1.91. MoveC - Moves the robot circularly

Usage

`MoveC` is used to move the tool center point (TCP) circularly to a given destination. During the movement the orientation normally remains unchanged relative to the circle.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `MoveC` are illustrated below.

See also *More examples on page 239*.

Example 1

```
MoveC p1, p2, v500, z30, tool2;
```

The TCP of the tool, `tool2`, is moved circularly to the position `p2` with speed data `v500` and zone data `z30`. The circle is defined from the start position, the circle point `p1`, and the destination point `p2`.

Example 2

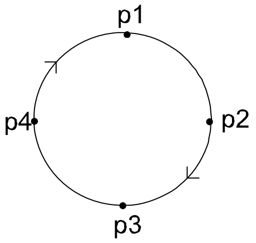
```
MoveC *, *, v500 \T:=5, fine, grip3;
```

The TCP of the tool, `grip3`, is moved circularly to a fine point stored in the instruction (marked by the second *). The circle point is also stored in the instruction (marked by the first *). The complete movement takes `5` seconds.

Example 3

```
MoveL p1, v500, fine, tool1;
MoveC p2, p3, v500, z20, tool1;
MoveC p4, p1, v500, fine, tool1;
```

The figure shows how a complete circle is performed by two `MoveC` instructions.



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Arguments

```
MoveC [\Conc] CirPoint ToPoint [\ID] Speed [\V] | [\T] Zone [\Z]
     [\Inpos] Tool [\WObj] [\Corr]
```

`[ \Conc ]`

Concurrent

Data type: `switch`

Subsequent instructions are executed while the robot is moving. The argument is usually not used but can be used to avoid unwanted stops caused by overloaded CPU when using fly-by points. This is useful when the programmed points are very close together at high speeds. The argument is also useful when, for example, communicating with external equipment and synchronization between the external equipment and robot movement is not required.

Using the argument `\Conc`, the number of movement instructions in succession is limited to 5. In a program section that includes `StorePath-RestoPath`, movement instructions with the argument `\Conc` are not permitted.

If this argument is omitted and the `ToPoint` is not a stop point then the subsequent instruction is executed some time before the robot has reached the programmed zone.

This argument can not be used in coordinated synchronized movement in a MultiMove System.

`CirPoint`

Data type: `robtarget`

The circle point of the robot. The circle point is a position on the circle between the start point and the destination point. To obtain the best accuracy it should be placed about halfway between the start and destination points. If it is placed too close to the start or destination point, the robot may give a warning. The circle point is defined as a named position or stored directly in the instruction (marked with an * in the instruction). The position of the external axes are not used.

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove System, if it is a coordinated synchronized movement, and is not allowed in any other cases.

The specified id number must be the same in all cooperating program tasks. The id number gives a guarantee that the movements are not mixed up at runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the TCP, the tool reorientation, and external axes.

Continues on next page

`[ \V ]`

Velocity

Data type: `num`

This argument is used to specify the velocity of the TCP in mm/s directly in the instruction. It is then substituted for the corresponding velocity specified in the speed data.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot and external axes move. It is then substituted for the corresponding speed data.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`[ \Z ]`

Zone

Data type: `num`

This argument is used to specify the position accuracy of the robot TCP directly in the instruction. The length of the corner path is given in mm, which is substituted for the corresponding zone specified in the zone data.

`[ \Inpos ]`

In position

Data type: `stoppointdata`

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the `Zone` parameter.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point that is moved to the specified destination point.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (object coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if it is then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used this argument must be specified in order for a circle relative to the work object to be executed.

`[ \Corr ]`

Correction

Data type: `switch`

Correction data written to a corrections entry by the instruction `CorrWrite` will be added to the path and destination position if this argument is present.

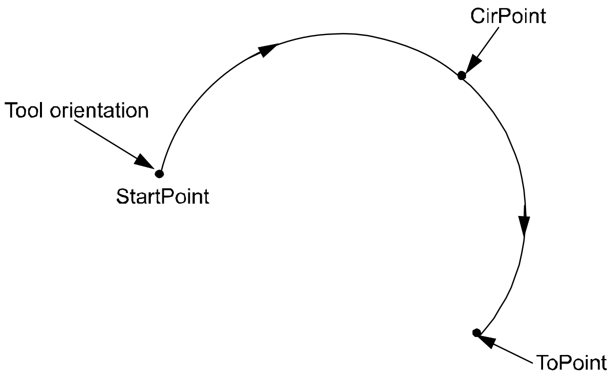
Continues on next page

Program execution

The robot and external units are moved to the destination point as follows:

- The TCP of the tool is moved circularly at a constant programmed velocity.
- The tool is reoriented at a constant velocity from the orientation at the start position to the orientation at the destination point.
- The reorientation is performed relative to the circular path. Thus, if the orientation relative to the path is the same at the start and the destination points, the relative orientation remains unchanged during the movement (see figure below).

The figure shows tool orientation during circular movement.



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The orientation in the circle point is not reached. It is only used to distinguish between two possible directions of reorientation. The accuracy of the reorientation along the path depends only on the orientation at the start and destination points.

Different modes for tool orientation during circle path are described in instruction `CirPathMode`.

Uncoordinated external axes are executed at constant velocity in order for them to arrive at the destination point at the same time as the robot axes. The position in the circle position is not used.

If it is not possible to attain the programmed velocity for the reorientation or for the external axes, the velocity of the TCP will be reduced.

A corner path is usually generated when movement is transferred to the next section of a path. If a stop point is specified in the zone data, program execution only continues when the robot and external axes have reached the appropriate position.

More examples

More examples of how to use the instruction `MoveC` are illustrated below.

Example 1

```
MoveC *, *, v500 \V:=550, z40 \Z:=45, grip3;
```

The TCP of the tool, `grip3`, is moved circularly to a position stored in the instruction. The movement is carried out with data set to `v500` and `z40`; the velocity and zone size of the TCP are `550` mm/s and `45` mm respectively.

Continues on next page

Example 2

```
MoveC p5, p6, v2000, fine \Inpos := inpos50, grip3;
```

The TCP of the tool, `grip3`, is moved circularly to a stop point `p6`. The robot considers it to be in the point when 50% of the position condition and 50% of the speed condition for a stop point `fine` are satisfied. It waits at most for 2 seconds for the conditions to be satisfied. See predefined data `inpos50` of data type `stoppointdata`.

Example 3

```
MoveC \Conc, *, *, v500, z40, grip3;
```

The TCP of the tool, `grip3`, is moved circularly to a position stored in the instruction. The circle point is also stored in the instruction. Subsequent logical instructions are executed while the robot moves.

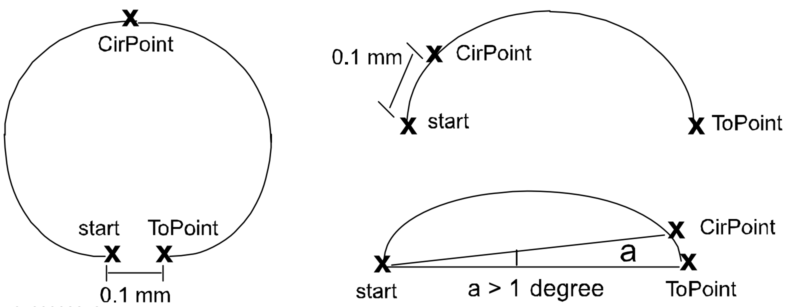
Example 4

```
MoveC cir1, p15, v500, z40, grip3 \WObj:=fixture;
```

The TCP of the tool, `grip3`, is moved circularly to a position, `p15` via the circle point `cir1`. These positions are specified in the object coordinate system for `fixture`.

Limitations

There are some limitations in how the `CirPoint` and the `ToPoint` can be placed, as shown in the figure below.



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- Minimum distance between start and `ToPoint` is 0.1 mm
- Minimum distance between start and `CirPoint` is 0.1 mm
- Minimum angle between `CirPoint` and `ToPoint` from the start point is 1 degree

The accuracy can be poor near the limits, e.g. if the start point and the `ToPoint` on the circle are close to each other then the fault caused by the leaning of the circle can be much greater than the accuracy with which the points have been programmed.

Make sure that the robot can reach the circle point during program execution and divide the circle segment if necessary.

A change of execution mode from forward to backward or vice versa while the robot is stopped on a circular path is not permitted and will result in an error message.

Continues on next page

WARNING!

The instruction `MoveC` (or any other instruction including circular movement) should never be started from the beginning with TCP between the circle point and the end point. Otherwise the robot will not take the programmed path (positioning around the circular path in another direction compared with that which is programmed).

To minimize the risk set the system parameter *Restrict placing of circlepoints* to TRUE (type *Motion Planner*, topic *Motion*). The parameter adds a supervision that the circle path not turns around more than 240 degrees and that the circle point is placed in the middle part of the circle path.

Syntax

```
MoveC
  [ ’\’ Conc ’,’ ]
  [ CirPoint’ :=’ ] < expression (IN) of robtarget> ’,’
  [ ToPoint’ :=’ ] < expression (IN) of robtarget> ’,’
  [ ’\’ ID ’:=’ < expression (IN) of identno>]’,’
  [ Speed ’:=’ ] < expression (IN) of speeddata>
  [ ’\’ V ’:=’ < expression (IN) of num> ]
  [ ’\’ T ’:=’ < expression (IN) of num> ] ’,’
  [Zone ’:=’ ] < expression (IN) of zonedata>
  [ ’\’ Z ’:=’ < expression (IN) of num> ]
  [ ’\’ Inpos’ :=’ < expression (IN) of stoppointdata> ] ´,’
  [ Tool ’:=’ ] < persistent (PERS) of tooldata>
  [ ’\’ WObj’ :=’ < persistent (PERS) of wobjdata> ]
  [ ’\’ Corr ]’;’
```

Related information

For information about	See
Other positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*
Definition of stop point data	*stoppointdata - Stop point data on page 1189*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Writes to a corrections entry	*CorrWrite - Writes to a correction generator on page 77*
Tool reorientation during circle path	*CirPathMode - Tool reorientation during circle path on page 38*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
Concurrent program execution	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Synchronization with logical instructions*
System parameters	*Technical reference manual - System parameters*

1.92. MoveCDO - Moves the robot circularly and sets digital output in the corner

Usage

`MoveCDO` (*Move Circular Digital Output*) is used to move the tool center point (TCP) circularly to a given destination. The specified digital output is set/reset in the middle of the corner path at the destination point. During the movement the orientation normally remains unchanged relative to the circle.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `MoveCDO` are illustrated below.

Example 1

```
MoveCDO p1, p2, v500, z30, tool2, do1,1;
```

The TCP of the tool, `tool2`, is moved circularly to the position `p2` with speed data `v500` and zone data `z30`. The circle is defined from the start position, the circle point `p1`, and the destination point `p2`. Output `do1` is set in the middle of the corner path at `p2`.

Arguments

```
MoveCDO CirPoint ToPoint [\ID] Speed [\T] Zone Tool [\WObj] Signal
     Value
```

`CirPoint`

Data type: `robtarget`

The circle point of the robot. The circle point is a position on the circle between the start point and the destination point. To obtain the best accuracy it should be placed about halfway between the start and destination points. If it is placed too close to the start or destination point the robot may give a warning. The circle point is defined as a named position or stored directly in the instruction (marked with an * in the instruction). The position of the external axes are not used.

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove System, if coordinated synchronized movement, and is not allowed in any other cases.

The specified ID number must be the same in all cooperating program tasks. The ID number gives a guarantee that the movements are not mixed up at runtime.

Continues on next page

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the TCP, the tool reorientation, and external axes.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot and external axes move. It is then substituted for the corresponding speed data.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point that is moved to the specified destination point.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (object coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used then this argument must be specified in order for a circle relative to the work object to be executed.

`Signal`

Data type: `signaldo`

The name of the digital output signal to be changed.

`Value`

Data type: `dionum`

The desired value of signal (0 or 1).

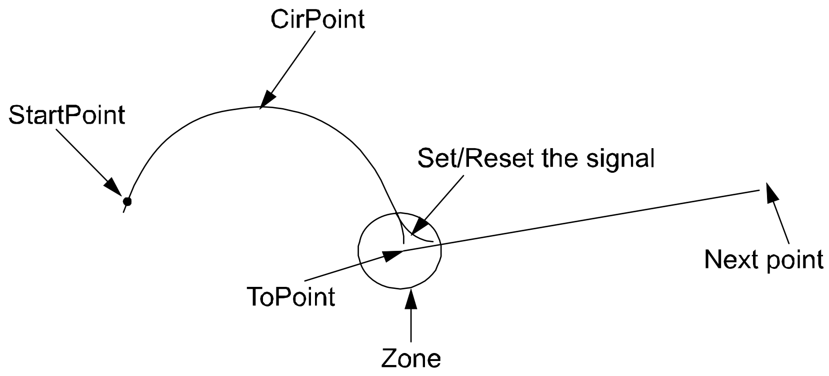
Continues on next page

Program execution

See the instruction `MoveC` for more information about circular movement.

The digital output signal is set/reset in the middle of the corner path for flying points, as shown in figure below.

The figure shows set/reset of digital output signal in the corner path with `MoveCDO`.



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For stop points we recommend the use of“ normal” programming sequence with `MoveC` + `SetDO`. But when using stop point in instruction `MoveCDO` the digital output signal is set/reset when the robot reaches the stop point.

The specified I/O signal is set/reset in execution mode continuously and stepwise forward, but not in stepwise backward.

Limitations

General limitations according to instruction `MoveC`.

Syntax

```
MoveCDO
  [ CirPoint ':=' ] < expression (IN) of robtarget > ','
  [ ToPoint' :=' ] < expression (IN) of robtarget > ','
  [ '\' ID ':=' < expression (IN) of identno >]','
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' T ':=' < expression (IN) of num > ] ','
  [ Zone ':=' ] < expression (IN) of zonedata > ','
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\' WObj' :=' < persistent (PERS) of wobjdata > ] ','
  [ Signal ':=' ] < variable (VAR) of signaldo > ] ´,'
  [ Value ´:=' ] < expression (IN) of dionum > ] ';'
```


Continues on next page

Related information

For information about	See
Other positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Move the robot circularly	*MoveC - Moves the robot circularly on page 236*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
Movements with I/O settings	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Synchronization with logical instructions*

1.93. MoveCSync - Moves the robot circularly and executes a RAPID procedure

Usage

`MoveCSync` (*Move Circular Synchronously*) is used to move the tool center point (TCP) circularly to a given destination. The specified RAPID procedure is ordered to execute at the middle of the corner path in the destination point. During the movement the orientation normally remains unchanged relative to the circle.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `MoveCSync` are illustrated below.

Example 1

```
MoveCSync p1, p2, v500, z30, tool2, "proc1";
```

The TCP of the tool, `tool2`, is moved circularly to the position `p2` with speed data `v500` and zone data `z30`. The circle is defined from the start position, the circle point `p1`, and the destination point `p2`. Procedure `proc1` is executed in the middle of the corner path at `p2`.

Example 2

```
MoveCSync p1, p2, v500, z30, tool2, "MyModule:proc1";
```

The same as in example 1 above, but here the locally declared procedure `proc1` in module `MyModule` will be called in the middle of the corner path.

Arguments

```
MoveCSync CirPoint ToPoint [\ID] Speed [\T] Zone Tool [\WObj]
     ProcName
```

`CirPoint`

Data type: `robtarget`

The circle point of the robot. The circle point is a position on the circle between the start point and the destination point. To obtain the best accuracy it should be placed about halfway between the start and destination points. If it is placed too close to the start or destination point the robot may give a warning. The circle point is defined as a named position or stored directly in the instruction (marked with an * in the instruction). The position of the external axes are not used.

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

Continues on next page

[\ID]

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove system, if it is a coordinated synchronized movement, and is not allowed in any other cases.

The specified id number must be the same in all cooperating program tasks. The id number gives a guarantee that the movements are not mixed up at runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the TCP, the tool reorientation and external axes.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot and external axes move. It is then substituted for the corresponding speed data.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point that is moved to the specified destination point.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (object coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used, this argument must be specified.

`ProcName`

Procedure Name

Data type: `string`

Name of the RAPID procedure to be executed at the middle of the corner path in the destination point.

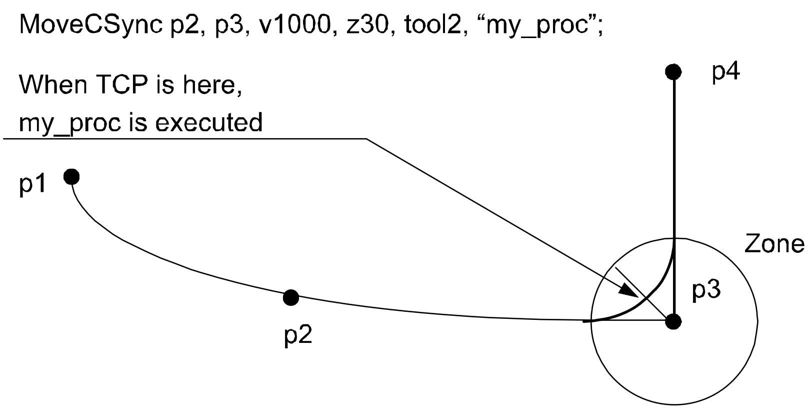
Continues on next page

Program execution

See the instruction `MoveC` for more information about circular movements.

The specified RAPID procedure is ordered to execute when the TCP reaches the middle of the corner path in the destination point of the `MoveCSync` instruction, as shown in the figure below.

The figure shows that the order to execute the user defined RAPID procedure is done at the middle of the corner path.



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For stop points we recommend the use of“ normal” programming sequence with `MoveC` + and other RAPID instructions in sequence.

The table describes execution of the specified RAPID procedure in different execution modes:

Execution mode	Execution of RAPID procedure
Continuously or Cycle	According to this description
Forward step	In the stop point
Backward step	Not at all

Limitation

General limitations according to instruction `MoveC`.

When the robot reaches the middle of the corner path there is normally a delay of 2-30 ms until the specified RAPID routine is executed depending on what type of movement is being performed at the time.

Switching execution mode after program stop from continuously or cycle to stepwise forward or backward results in an error. This error tells the user that the mode switch can result in missed execution of the RAPID procedure in the queue for execution on the path.

Instruction `MoveCSync` cannot be used on TRAP level. The specified RAPID procedure cannot be tested with stepwise execution.

Continues on next page

Syntax

```
MoveCSync
  [ CirPoint ':=' ] < expression (IN) of robtarget > ','
  [ ToPoint' :=' ] < expression (IN) of robtarget > ','
  ['\' ID ':=' < expression (IN) of identno >]','
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' T ':=' < expression (IN) of num > ] ','
  [ Zone ':=' ] < expression (IN) of zonedata > ','
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\' WObj' :=' < persistent (PERS) of wobjdata > ] ','
  [ ProcName ´:=' ] < expression (IN) of string > ] ';'
```

Related information

For information about	See
Other positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Moves the robot circularly	*MoveC - Moves the robot circularly on page 236*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
Defines a position related interrupt	*TriggInt - Defines a position related interrupt on page 588*

1.94. MoveExtJ - Move one or several mechanical units without TCP

Usage

`MoveExtJ` (*Move External Joints*) is used to move linear or rotating external axes. The external axes can belong to one or several mechanical units without TCP.

This instruction can only be used with an actual program task defined as a Motion Task and if the task controls one or several mechanical units without TCP.

Basic examples

Basic examples of the instruction `MoveExtJ` are illustrated below.

See also *More examples on page 252*.

Example 1

```
MoveExtJ jpos10, vrot10, z50;
```

Move rotational external axes to joint position `jpos10` with speed `10` degrees/s with zone data `z50`.

Example 2

```
MoveExtJ \Conc, jpos20, vrot10 \T:=5, fine \InPos:=inpos20;
```

Move external axes to joint position `jpos20` in 5. The program execution goes forward at once but the external axes stops in the position `jpos20` until the convergence criteria in `inpos20` are fulfilled.

Arguments

```
MoveExtJ [\Conc] ToJointPos [\ID] [\UseEOffs] Speed [\T] Zone
    [\Inpos]
```

`[ \Conc ]`

Concurrent

Data type: `switch`

Subsequent instructions are executed while the external axis is moving. The argument is usually not used but can be used to avoid unwanted stops caused by overloaded CPU when using fly-by points. This is useful when the programmed points are very close together at high speeds. The argument is also useful when, for example, communicating with external equipment and synchronization between the external equipment and robot movement is not required.

Using the argument `\Conc`, the number of movement instructions in succession is limited to 5. In a program section that includes `StorePath-RestoPath` movement instructions with the argument `\Conc` are not permitted.

If this argument is omitted and the `ToJointPos` is not a stop point then the subsequent instruction is executed some time before the external axes has reached the programmed zone.

This argument can not be used in coordinated synchronized movement in a MultiMove System.

Continues on next page

`ToJointPos`

To Joint Position

Data type: `jointtarget`

The destination absolute joint position of the external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`[ \ID ]`

Synchronization ID

Data type: `identno`

This argument must be used in a MultiMove System, if it is a coordinated synchronized movement, and is not allowed in any other cases.

The specified ID number must be the same in all cooperating program tasks. The id number gives a guarantee that the movements are not mixed up at runtime.

`[ \UseEOffs ]`

Use External Offset

Data type: `switch`

The offset for external axes, setup by instruction `EOffsSet`, is activated for `MoveExtJ` instruction when the argument `UseEOffs` is used. See instruction `EOffsSet` for more information about external offset.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the linear or rotating external axis.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the external axes move. It is then substituted for the corresponding speed data.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data defines stop point or fly-by point. If it is a fly-by point then the zone size describes the deceleration and acceleration for the linear or rotational external axes.

`[ \Inpos ]`

In position

Data type: `stoppointdata`

This argument is used to specify the convergence criteria for the position of the external axis in the stop point. The stop point data substitutes the zone specified in the `Zone` parameter.

Program execution

The linear or rotating external axes are moved to the programmed point with the programmed velocity.

Continues on next page

More examples

```
CONST jointtarget j1 :=
      [[9E9,9E9,9E9,9E9,9E9,9E9],[0,9E9,9E9,9E9,9E9,9E9]];
CONST jointtarget j2 :=
      [[9E9,9E9,9E9,9E9,9E9,9E9],[30,9E9,9E9,9E9,9E9,9E9]];
CONST jointtarget j3 :=
      [[9E9,9E9,9E9,9E9,9E9,9E9],[60,9E9,9E9,9E9,9E9,9E9]];
CONST jointtarget j4 :=
      [[9E9,9E9,9E9,9E9,9E9,9E9],[90,9E9,9E9,9E9,9E9,9E9]];
CONST speeddata rot_ax_speed := [0, 0, 0, 45];

MoveExtJ j1, rot_ax_speed, fine;
MoveExtJ j2, rot_ax_speed, z20;
MoveExtJ j3, rot_ax_speed, z20;
MoveExtJ j4, rot_ax_speed, fine;
```

In this example the rotating single axis is moved to joint position `0`, `30`, `60`, and `90` degrees with the speed of `45` degrees/s.

Syntax

```
MoveExtJ
  [ '\' Conc ',' ]
  [ ToJointPos' :=' ] < expression (IN) of jointtarget >
  ['\' ID ':=' < expression (IN) of identno >]','
  [ '\' UseEOffs' ,' ]
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' T ':=' < expression (IN) of num > ] ','
  [Zone ':=' ] < expression (IN) of zonedata >
  [ '\' Inpos' :=' < expression (IN) of stoppointdata >]';'
```

Related information

For information about	See
Other positioning instructions	*Technical reference manual - RAPID overview*, section *Motion*
Definition of jointtarget	*jointtarget - Joint position data on page 1129*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*
Concurrent program execution	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Synchronization with logical instructions*

1.95. MoveJ - Moves the robot by joint movement

Usage

`MoveJ` is used to move the robot quickly from one point to another when that movement does not have to be in a straight line.

The robot and external axes move to the destination position along a non-linear path. All axes reach the destination position at the same time.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `MoveJ` are illustrated below.

See also *More examples on page 255*.

Example 1

```
MoveJ p1, vmax, z30, tool2;
```

The tool center point (TCP) of the tool, `tool2`, is moved along a non-linear path to the position, `p1`, with speed data `vmax` and zone data `z30`.

Example 2

```
MoveJ *, vmax \T:=5, fine, grip3;
```

The TCP of the tool, `grip3`, is moved along a non-linear path to a stop point stored in the instruction (marked with an *). The entire movement takes `5` seconds.

Arguments

```
MoveJ [\Conc] ToPoint [\ID] Speed [\V] | [\T] Zone [\Z] [\Inpos]
    Tool [\WObj]
```

`[ \Conc ]`

Concurrent

Data type: `switch`

Subsequent instructions are executed while the robot is moving. The argument is usually not used but can be used to avoid unwanted stops caused by overloaded CPU when using fly-by points. This is useful when the programmed points are very close together at high speeds. The argument is also useful when, for example, communicating with external equipment and synchronization between the external equipment and robot movement is not required.

Using the argument `\Conc`, the number of movement instructions in succession is limited to 5. In a program section that includes `StorePath-RestoPath` movement instructions with the argument `\Conc` are not permitted.

If this argument is omitted and the `ToPoint` is not a stop point, the subsequent instruction is executed some time before the robot has reached the programmed zone.

This argument can not be used in coordinated synchronized movement in a MultiMove system.

Continues on next page

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`[ \ID]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove system, if coordinated synchronized movement, and is not allowed in any other cases.

The specified id number must be the same in all cooperating program tasks. The id number gives a guarantee that the movements are not mixed up at runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the tool center point, the tool reorientation, and external axes.

`[ \V ]`

Velocity

Data type: `num`

This argument is used to specify the velocity of the TCP in mm/s directly in the instruction. It is then substituted for the corresponding velocity specified in the speed data.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`[ \Z ]`

Zone

Data type: `num`

This argument is used to specify the position accuracy of the robot TCP directly in the instruction. The length of the corner path is given in mm, which is substituted for the corresponding zone specified in the zone data.

`[ \Inpos ]`

In position

Data type: `stoppointdata`

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the `Zone` parameter.

Continues on next page

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point moved to the specified destination point.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used then this argument must be specified.

Program execution

The tool center point is moved to the destination point with interpolation of the axis angles. This means that each axis is moved with constant axis velocity and that all axes reach the destination point at the same time, which results in a non-linear path.

Generally speaking, the TCP is moved at the approximate programmed velocity (regardless of whether or not the external axes are coordinated). The tool is reoriented and the external axes are moved at the same time that the TCP moves. If the programmed velocity for reorientation or for the external axes cannot be attained then the velocity of the TCP will be reduced.

A corner path is usually generated when movement is transferred to the next section of the path. If a stop point is specified in the zone data the program execution only continues when the robot and external axes have reached the appropriate position.

More examples

More examples of how to use the instruction `MoveJ` are illustrated below.

Example 1

```
MoveJ *, v2000\V:=2200, z40 \Z:=45, grip3;
```

The TCP of the tool, `grip3`, is moved along a non-linear path to a position stored in the instruction. The movement is carried out with data set to `v2000` and `z40`; the velocity and zone size of the TCP are `2200` mm/s and `45` mm respectively.

Example 2

```
MoveJ p5, v2000, fine \Inpos := inpos50, grip3;
```

The TCP of the tool, `grip3`, is moved in a non-linear path to a stop point `p5`. The robot considers it to be in the point when 50% of the position condition and 50% of the speed condition for a stop point `fine` are satisfied. It waits at most for 2 seconds for the conditions to be satisfied. See predefined data `inpos50` of data type `stoppointdata`.

Example 3

```
MoveJ \Conc, *, v2000, z40, grip3;
```

The TCP of the tool, `grip3`, is moved along a non-linear path to a position stored in the instruction. Subsequent logical instructions are executed while the robot moves.

Continues on next page

Example 4

```
MoveJ start, v2000, z40, grip3 \WObj:=fixture;
```

The TCP of the tool, `grip3`, is moved along a non-linear path to a position, `start`. This position is specified in the object coordinate system for `fixture`.

Syntax

```
MoveJ
  [ '\' Conc ',' ]
  [ ToPoint' :=' ] < expression (IN) of robtarget >
  [ '\' ID ':=' < expression (IN) of identno >]','
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' V ':=' < expression (IN) of num > ]
  | [ '\' ':=' < expression (IN) of num > ] ','
  [Zone ':=' ] < expression (IN) of zonedata >
  [ '\' Z ':=' < expression (IN) of num > ]
  [ '\' Inpos' :=' < expression (IN) of stoppointdata > ] ´,'
  [ Tool' :=' ] < persistent (PERS) of tooldata >
  [ '\' WObj' :=' < persistent (PERS) of wobjdata > ] ';'
```

Related information

For information about	See
Other positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*
Definition of stop point data	*stoppointdata - Stop point data on page 1189*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
Concurrent program execution	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Synchronization with logical instructions*

1.96. MoveJDO - Moves the robot by joint movement and sets digital output in the corner

Usage

`MoveJDO` (*Move Joint Digital Output*) is used to move the robot quickly from one point to another when that movement does not have to be in a straight line. The specified digital output signal is set/reset at the middle of the corner path.

The robot and external axes move to the destination position along a non-linear path. All axes reach the destination position at the same time.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `MoveJDO` are illustrated below.

Example 1

```
MoveJDO p1, vmax, z30, tool2, do1, 1;
```

The tool center point (TCP) of the tool, `tool2` , is moved along a non-linear path to the position, `p1`, with speed data `vmax` and zone data `z30`. Output `do1` is set in the middle of the corner path at `p1`.

Arguments

```
MoveJDO ToPoint [\ID] Speed [\T] Zone Tool [\WObj] Signal Value
```

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove system, if it is a coordinated synchronized movement, and is not allowed in any other cases.

The specified id number must be the same in all cooperating program tasks. The ID number gives a guarantee that the movements are not mixed up at runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the tool center point, the tool reorientation, and external axes.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

Continues on next page

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point moved to the specified destination point.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used then this argument must be specified.

`Signal`

Data type: `signaldo`

The name of the digital output signal to be changed.

`Value`

Data type: `dionum`

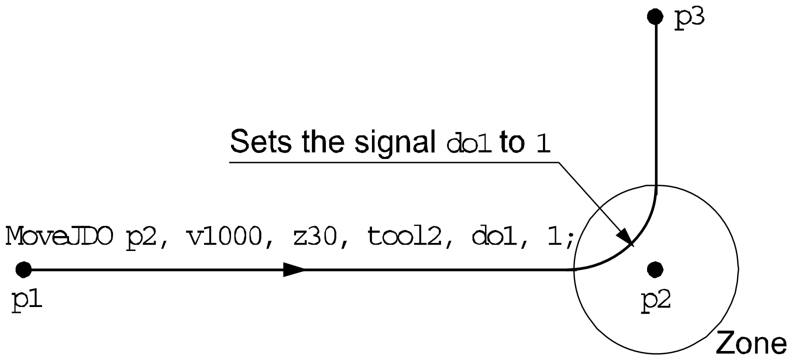
The desired value of signal (0 or 1).

Program execution

See the instruction `MoveJ` for more information about joint movement.

The digital output signal is set/reset in the middle of the corner path for flying points, as shown in figure below.

The figure shows set/reset of digital output signal in the corner path with `MoveJDO`.



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For stop points we recommend the use of“ normal” programming sequence with `MoveJ` + `SetDO`. But when using stop point in instruction `MoveJDO`, the digital output signal is set/reset when the robot reaches the stop point.

The specified I/O signal is set/reset in execution mode continuously and stepwise forward, but not in stepwise backward.

Continues on next page

Syntax

```
MoveJDO
  [ ToPoint ':=' ] < expression (IN) of robtarget >
  [ '\' ID ':=' < expression (IN) of identno >]','
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' T ':=' < expression (IN) of num > ] ','
  [ Zone ':=' ] < expression (IN) of zonedata > ','
  [ Tool ':=' ] < persistent (PERS) of tooldata>
  [ '\' WObj' :=' < persistent (PERS) of wobjdata > ] ','
  [ Signal ':=' ] < variable (VAR) of signaldo>] ´,'
  [ Value ´:=' ] < expression (IN) of dionum > ] ';'
```

Related information

For information about	See
Other positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Moves the robot by joint movement	*MoveJ - Moves the robot by joint movement on page 253*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
Movements with I/O settings	*Technical reference manual - RAPID overview*, section *Synchronization with logical instructions*

1.97. MoveJSync - Moves the robot by joint movement and executes a RAPID procedure

Usage

`MoveJSync` (*Move Joint Synchronously*) is used to move the robot quickly from one point to another when that movement does not have to be in a straight line. The specified RAPID procedure is ordered to execute at the middle of the corner path in the destination point.

The robot and external axes move to the destination position along a non-linear path. All axes reach the destination position at the same time.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `MoveJSync` are illustrated below.

Example 1

```
MoveJSync p1, vmax, z30, tool2, "proc1";
```

The tool center point (TCP) of the tool, `tool2`, is moved along a non-linear path to the position, `p1`, with speed data `vmax` and zone data `z30`. Procedure `proc1` is executed in the middle of the corner path at `p1`.

Example 2

```
MoveJSync p1, vmax, z30, tool2, "MyModule:proc1";
```

The same as in example 1 above, but here the locally declared procedure `proc1` in module `MyModule` will be called in the middle of the corner path.

Arguments

```
MoveJSync ToPoint [\ID] Speed [\T] Zone Tool [\WObj] ProcName
```

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove system, if it is a coordinated synchronized movement, and is not allowed in any other cases.

The specified id number must be the same in all cooperating program tasks. The id number gives a guarantee that the movements are not mixed up at runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the tool center point, the tool reorientation, and external axes.

Continues on next page

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point moved to the specified destination point.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used then this argument must be specified.

`ProcName`

Procedure Name

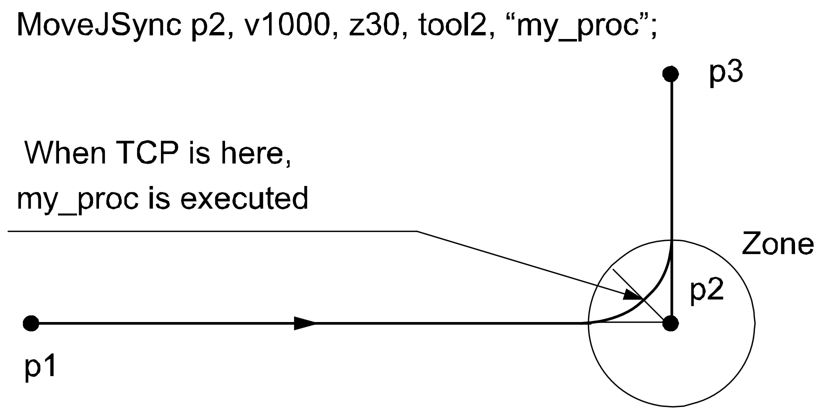
Data type: `string`

Name of the RAPID procedure to be executed at the middle of the corner path in the destination point. The procedure call is a late binding call, and therefore inherits its properties.

Program execution

See the instruction `MoveJ` for more information about joint movements.

The specified RAPID procedure is ordered to execute when the TCP reaches the middle of the corner path in the destination point of the `MoveJSync` instruction, as shown in the figure below.



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Continues on next page

For stop points we recommend the use of “normal” programming sequence with `MoveJ` + other RAPID instructions in sequence.

The table describes execution of the specified RAPID procedure in different execution modes:

Execution mode	Execution of RAPID procedure
Continuously or Cycle	According to this description
Forward step	In the stop point
Backward step	Not at all

Limitation

When the robot reaches the middle of the corner path there is normally a delay of 2-30 ms until the specified `RAPID` routine is executed, depending on what type of movement is being performed at the time.

Switching execution mode after program stop from continuously or cycle to stepwise forward or backward results in an error. This error tells the user that the mode switch can result in missed execution of the RAPID procedure in the queue for execution on the path.

Instruction `MoveJSync` cannot be used on TRAP level. The specified RAPID procedure cannot be tested with stepwise execution.

Syntax

```
MoveJSync
  [ ToPoint ':=' ] < expression (IN) of robtarget >
  [ '\' ID ':=' < expression (IN) of identno >] ','
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' T ':=' < expression (IN) of num >] ','
  [ Zone ':=' ] < expression (IN) of zonedata >´,´
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\' WObj ´:=' < persistent (PERS) of wobjdata > ] ','
  [ ProcName ´:=' ] < expression (IN) of string > ] ';'
```


Continues on next page

Related information

For information about	See
Other positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Moves the robot by joint movement	*MoveJ - Moves the robot by joint movement on page 253*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
Defines a position related interrupt	*TriggInt - Defines a position related interrupt on page 588*

1.98. MoveL - Moves the robot linearly

Usage

`MoveL` is used to move the tool center point (TCP) linearly to a given destination. When the TCP is to remain stationary then this instruction can also be used to reorientate the tool.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove System, in Motion tasks.

Basic examples

Basic examples of the instruction `MoveL` are illustrated below.

See also *More examples on page 266*.

Example 1

```
MoveL p1, v1000, z30, tool2;
```

The TCP of the tool, `tool2`, is moved linearly to the position `p1,` with speed data `v1000` and zone data `z30`.

Example 2

```
MoveL *, v1000\T:=5, fine, grip3;
```

The TCP of the tool, `grip3`, is moved linearly to a stop point stored in the instruction (marked with an *). The complete movement takes `5` seconds.

Arguments

```
MoveL [\Conc] ToPoint [\ID] Speed [\V] | [ \T] Zone [\Z] [\Inpos]
      Tool [\WObj] [\Corr]
```

`[ \Conc ]`

Concurrent

Data type: `switch`

Subsequent instructions are executed while the robot is moving. The argument is usually not used but can be used to avoid unwanted stops caused by overloaded CPU when using fly-by points. This is useful when the programmed points are very close together at high speeds. The argument is also useful when, for example, communicating with external equipment and synchronization between the external equipment and robot movement is not required.

Using the argument `\Conc`, the number of movement instructions in succession is limited to 5. In a program section that includes `StorePath-RestoPath`, movement instructions with the argument `\Conc` are not permitted.

If this argument is omitted and the `ToPoint` is not a stop point then the subsequent instruction is executed some time before the robot has reached the programmed zone.

This argument can not be used in coordinated synchronized movement in a MultiMove System.

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

Continues on next page

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove System, if it is a coordinated synchronized movement, and is not allowed in any other cases.

The specified id number must be the same in all cooperating program tasks. The ID number gives a guarantee that the movements are not mixed up at runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity for the tool center point, the tool reorientation, and external axes.

`[ \V ]`

Velocity

Data type: `num`

This argument is used to specify the velocity of the TCP in mm/s directly in the instruction. It is then substituted for the corresponding velocity specified in the speed data.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`[ \Z ]`

Zone

Data type: `num`

This argument is used to specify the position accuracy of the robot TCP directly in the instruction. The length of the corner path is given in mm, which is substituted for the corresponding zone specified in the zone data.

`[ \Inpos ]`

In position

Data type: `stoppointdata`

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the `Zone` parameter.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point moved to the specified destination position.

Continues on next page

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary tool or coordinated external axes are used then this argument must be specified in order to perform a linear movement relative to the work object.

`[ \Corr ]`

Correction

Data type: `switch`

Correction data written to a corrections entry by the instruction `CorrWrite` will be added to the path and destination position if this argument is present.

Program execution

The robot and external units are moved to the destination position as follows:

- The TCP of the tool is moved linearly at constant programmed velocity.
- The tool is reoriented at equal intervals along the path.
- Uncoordinated external axes are executed at a constant velocity in order for them to arrive at the destination point at the same time as the robot axes.

If it is not possible to attain the programmed velocity for the reorientation or for the external axes then the velocity of the TCP will be reduced.

A corner path is usually generated when movement is transferred to the next section of a path. If a stop point is specified in the zone data then program execution only continues when the robot and external axes have reached the appropriate position.

More examples

More examples of how to use the instruction `MoveL` are illustrated below.

Example 1

```
MoveL *, v2000 \V:=2200, z40 \Z:=45, grip3;
```

The TCP of the tool, `grip3`, is moved linearly to a position stored in the instruction. The movement is carried out with data set to `v2000` and `z40`. The velocity and zone size of the TCP are `2200` mm/s and `45` mm respectively.

Example 2

```
MoveL p5, v2000, fine \Inpos := inpos50, grip3;
```

The TCP of the tool, `grip3`, is moved linearly to a stop point `p5`. The robot considers it to be in the point when 50% of the position condition and 50% of the speed condition for a stop point `fine` are satisfied. It waits at most for 2 seconds for the conditions to be satisfied. See predefined data `inpos50` of data type `stoppointdata`.

Example 3

```
MoveL \Conc, *, v2000, z40, grip3;
```

The TCP of the tool, `grip3`, is moved linearly to a position stored in the instruction. Subsequent logical instructions are executed while the robot moves.

Continues on next page

Example 4

```
MoveL start, v2000, z40, grip3 \WObj:=fixture;
```

The TCP of the tool, `grip3`, is moved linearly to a position, `start`. This position is specified in the object coordinate system for `fixture`.

Syntax

```
MoveL
  [ '\' Conc ',' ]
  [ ToPoint' :=' ] < expression (IN) of robtarget >
  [ '\' ID ':=' < expression (IN) of identno >] ','
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' V ':=' < expression (IN) of num > ]
  | [ '\' T' :=' < expression (IN) of num > ] ','
  [Zone ':=' ] < expression (IN) of zonedata >
  [ '\' Z ':='< expression (IN) of num > ]
  [ '\' Inpos' :=' < expression (IN) of stoppointdata > ] ´,'
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\' WObj' :=' < persistent (PERS) of wobjdata > ]
  [ '\' Corr ] ';'
```

Related information

For information about	See
Other positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*
Definition of stop point data	*stoppointdata - Stop point data on page 1189*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Writes to a corrections entry	*CorrWrite - Writes to a correction generator on page 77*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
Concurrent program execution	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Synchronization with logical instructions*

1.99. MoveLDO - Moves the robot linearly and sets digital output in the corner

Usage

`MoveLDO` (*Move Linearly Digital Output*) is used to move the tool center point (TCP) linearly to a given destination. The specified digital output signal is set/reset at the middle of the corner path.

When the TCP is to remain stationary then this instruction can also be used to reorient the tool.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `MoveLDO` are illustrated below.

Example 1

```
MoveLDO p1, v1000, z30, tool2, do1,1;
```

The TCP of the tool, `tool2`, is moved linearly to the position `p1` with speed data `v1000` and zone data `z30`. Output do1 is set in the middle of the corner path at `p1`.

Arguments

```
MoveLDO ToPoint [\ID] Speed [\T] Zone Tool [\WObj] Signal Value
```

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove system, if coordinated synchronized movement, and is not allowed in any other cases.

The specified ID number must be the same in all cooperating program tasks. The ID number gives a guarantee that the movements are not mixed up at runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity for the tool center point, the tool reorientation, and external axes.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

Continues on next page

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point moved to the specified destination position.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used then this argument must be specified.

`Signal`

Data type: `signaldo`

The name of the digital output signal to be changed.

`Value`

Data type: `dionum`

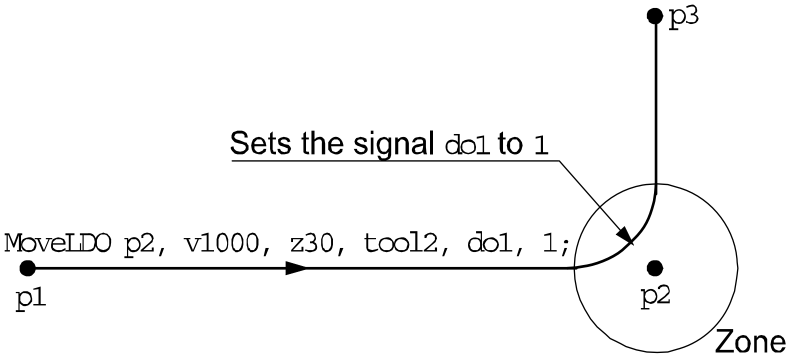
The desired value of signal (0 or 1).

Program execution

See the instruction `MoveL` for more information about linear movements.

The digital output signal is set/reset in the middle of the corner path for flying points, as shown in the figure below.

The figure shows set/reset of digital output signal in the corner path with `MoveLDO`.



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For stop points we recommend the use of“ normal” programming sequence with `MoveL` + `SetDO`. But when using stop point in instruction `MoveLDO`, the digital output signal is set/reset when the robot reaches the stop point.

The specified I/O signal is set/reset in execution mode continuously and stepwise forward, but not in stepwise backward.

Continues on next page

Syntax

```
MoveLDO
  [ ToPoint ':=' ] < expression (IN) of robtarget >
  [ '\' ID ':=' < expression (IN) of identno >]','
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' T ':=' < expression (IN) of num > ] ','
  [ Zone ':=' ] < expression (IN) of zonedata > ','
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\' WObj' :=' ] < persistent (PERS) of wobjdata > ','
  [ Signal ':=' ] < variable (VAR) of signaldo >] ´,'
  [ Value ´:=' ] < expression (IN) of dionum > ] ';'
```

Related information

For information about	See
Other positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Moves the robot linearly	*MoveL - Moves the robot linearly on page 264*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
Movements with I/O settings	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Synchronization with logical instructions*

1.100. MoveLSync - Moves the robot linearly and executes a RAPID procedure

Usage

`MoveLSync` (*Move Linearly Synchronously*) is used to move the tool center point (TCP) linearly to a given destination. The specified RAPID procedure is ordered to execute at the middle of the corner path in the destination point.

When the TCP is to remain stationary then this instruction can also be used to reorient the tool.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `MoveLSync` are illustrated below.

Example 1

```
MoveLSync p1, v1000, z30, tool2, "proc1";
```

The TCP of the tool, `tool2`, is moved linearly to the position `p1` with speed data `v1000` and zone data `z30`. Procedure `proc1` is executed in the middle of the corner path at `p1`.

Example 2

```
MoveLSync p1, v1000, z30, tool2, "proc1";
```

The same as in example 1 above, but here the locally declared procedure `proc1` in module `MyModule` will be called in the middle of the corner path.

Arguments

```
MoveLSync ToPoint [\ID] Speed [\T] Zone Tool [\WObj] ProcName
```

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove system, if it is a coordinated synchronized movement, and is not allowed in any other cases.

The specified ID number must be the same in all cooperating program tasks. The ID number gives a guarantee that the movements are not mixed up at runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity for the tool center point, the tool reorientation, and external axes.

Continues on next page

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point moved to the specified destination position.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used then this argument must be specified.

`ProcName`

Procedure Name

Data type: `string`

Name of the RAPID procedure to be executed at the middle of the corner path in the destination point. The procedure call is a late binding call, and therefore inherits its properties.

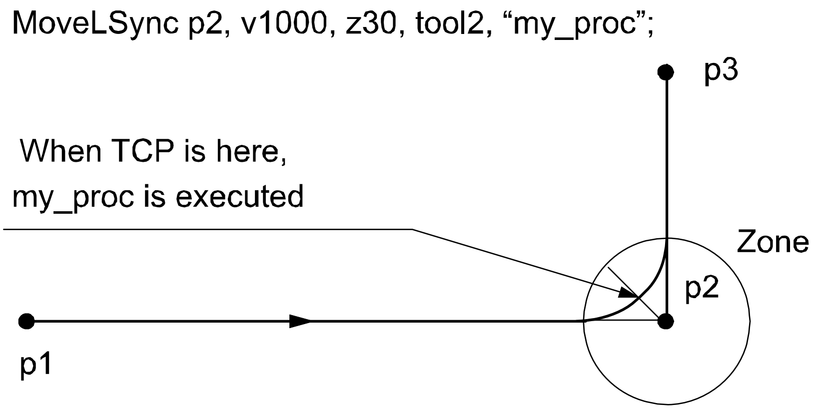
Continues on next page

Program execution

See the instruction `MoveL` for more information about linear movements.

The specified RAPID procedure is ordered to execute when the TCP reaches the middle of the corner path in the destination point of the `MoveLSync` instruction, as shown in the figure below.

The figure shows that the order to execute the user defined RAPID procedure is done in the middle of the corner path.



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For stop points we recommend the use of“ normal” programming sequence with `MoveL` + other RAPID instructions in sequence.

The table describes execution of the specified RAPID procedure in different execution modes:

Execution mode:	Execution of RAPID procedure:
Continuously or Cycle	According to this description
Forward step	In the stop point
Backward step	Not at all

Limitation

When the robot reaches the middle of the corner path there is normally a delay of 2-30 ms until the specified RAPID routine is executed, depending on what type of movement is being performed at the time.

Switching execution mode after program stop from continuously or cycle to stepwise forward or backward results in an error. This error tells the user that the mode switch can result in missed execution of the RAPID procedure in the queue for execution on the path.

Instruction `MoveLSync` cannot be used on TRAP level. The specified RAPID procedure cannot be tested with stepwise execution.

Continues on next page

Syntax

```
MoveLSync
  [ ToPoint ':=' ] < expression (IN) of robtarget >
  [ '\' ID ':=' < expression (IN) of identno >]','
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' T ':=' < expression (IN) of num > ] ','
  [ Zone ':=' ] < expression (IN) of zonedata > ','
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\' WObj ´:=' < persistent (PERS) of wobjdata > ] ','
  [ ProcName ´:=' ] < expression (IN) of string > ] ´;'
```

Related information

For information about	See
Other positioning instructions	*Technical reference manual - RAPID overview*, section *Motion*
Moves the robot linearly	*MoveL - Moves the robot linearly on page 264*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
Defines a position related interrupt	*TriggInt - Defines a position related interrupt on page 588*

1.101. MToolRotCalib - Calibration of rotation for moving tool

Usage

`MToolRotCalib` *(Moving Tool Rotation Calibration)* is used to calibrate the rotation of a moving tool.

The position of the robot and its movements are always related to its tool coordinate system, i.e. the TCP and tool orientation. To get the best accuracy it is important to define the tool coordinate system as correctly as possible.

The calibration can also be done with a manual method using the FlexPendant (described in *Operating manual - IRC5 with FlexPendan*nt, section *Programming and testing*).

Description

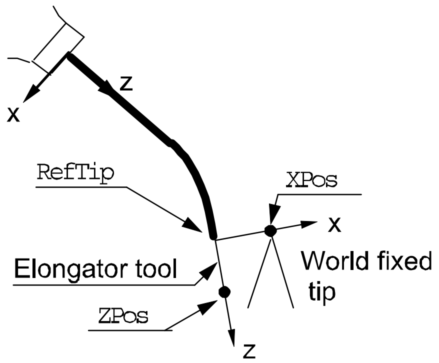
To define the tool orientation, you need a world fixed tip within the robot's working space.

Before using the instruction `MToolRotCalib` some preconditions must be fulfilled:

- The tool that is to be calibrated must be mounted on the robot and defined with correct component `robhold (TRUE)`.
- If using the robot with absolute accuracy then the load and center of gravity for the tool should already be defined. `LoadIdentify` can be used for the load definition.
- The TCP value of the tool must already be defined. The calibration can be done with the instruction `MToolTCPCalib`.
- `tool0`, `wobj0`, and `PDispOff` must be activated before jogging the robot.
- Jog the TCP of the actual tool as close as possible to the world fixed tip (origin of the tool coordinate system) and define a `jointtarget` for the reference point `RefTip`.
- Jog the robot without changing the tool orientation so the world fixed tip is pointing at some point on the positive z-axis of the tool coordinate system, and define a `jointtarget` for point `ZPos`.
- Optionally jog the robot without changing the tool orientation so the world fixed tip is pointing at some point on the positive x-axis of the tool coordinate system, and define a `jointtarget` for point `XPos`.

As a help for pointing out the positive z-axis and x-axis, some type of elongator tool can be used.

See the figure below for a definition of jointtarget for `RefTip`, `ZPos`, and optional `XPos`.



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NOTE!

It is not recommended to modify the positions `RefTip`, `ZPos`, and `XPos` in the instruction `MToolRotCalib`.

Basic examples

Basic examples of the instruction `MToolRotCalib` are illustrated below.

Example 1

```
! Created with the world fixed tip pointing at origin, positive
! z-axis, and positive x-axis of the wanted tool coordinate
! system.
CONST jointtarget pos_tip := [...];
CONST jointtarget pos_z := [...];
CONST jointtarget pos_x := [...];

PERS tooldata tool1:= [ TRUE, [[20, 30, 100], [1, 0, 0 ,0]],
     [0.001, [0, 0, 0.001], [1, 0, 0, 0], 0, 0, 0]];

! Instructions for creating or ModPos of pos_tip, pos_z, and pos_x
MoveAbsJ pos_tip, v10, fine, tool0;
MoveAbsJ pos_z, v10, fine, tool0;
MoveAbsJ pos_x, v10, fine, tool0;

! Only tool calibration in the z direction
MToolRotCalib pos_tip, pos_z, tool1;
```

The tool orientation (`tframe.rot`) in the z direction of `tool1` is calculated. The x and y directions of the tool orientation are calculated to coincide with the wrist coordinate system.

Example 2

```
! Calibration with complete tool orientation
MToolRotCalib pos_tip, pos_z \XPos:=pos_x, tool1;
```

The complete tool orientation (`tframe.rot`) of `tool1` is calculated.

Arguments

```
MToolRotCalib RefTip ZPos [\XPos]Tool
```

`RefTip`

Data type: `jointtarget`

The point where the TCP of the tool is pointing at the world fixed tip.

`ZPos`

Data type: `jointtarget`

The elongator point that defines the positive z direction.

Continues on next page

`[\XPos]`

Data type: `jointtarget`

The elongator point that defines the x positive direction. If this point is omitted then the x and y directions of the tool will coincide with the corresponding axes in the wrist coordinate system.

`Tool`

Data type: `tooldata`

The persistent variable of the tool that is to be calibrated.

Program execution

The system calculates and updates the tool orientation (`tfame.rot`) in the specified tooldata. The calculation is based on the specified 2 or 3 `jointtarget`. The remaining data in tooldata such as TCP (`tframe.trans`) is not changed.

Syntax

```
MToolRotCalib
  [ RefTip ':=' ] < expression (IN) of jointtarget > ','
  [ ZPos ':=' ] < expression (IN) of jointtarget >
  [ '\'XPos ':=' < expression (IN) of jointtarget > ] ','
  [ Tool ':=' ] < persistent (PERS) of tooldata > ';'
```

Related information

For information about	See
Calibration of TCP for a moving tool	*MToolTCPCalib - Calibration of TCP for moving tool on page 278*
Calibration of TCP for a stationary tool	*SToolTCPCalib - Calibration of TCP for stationary tool on page 507*
Calibration of TCP and rotation for a stationary tool	*SToolRotCalib - Calibration of TCP and rotation for stationary tool on page 504*

1.102. MToolTCPCalib - Calibration of TCP for moving tool

Usage

`MToolTCPCalib` (*Moving Tool TCP Calibration*) is used to calibrate Tool Center Point - TCP for a moving tool.

The position of the robot and its movements are always related to its tool coordinate system, i.e. the TCP and tool orientation. To get the best accuracy it is important to define the tool coordinate system as correctly as possible.

The calibration can also be done with a manual method using the FlexPendant (described in *Operating manual - IRC5 with FlexPendant*, section *Programming and testing*).

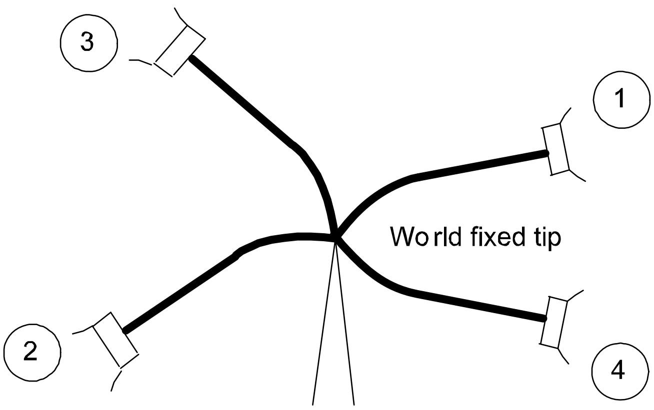
Description

To define the TCP of a tool you need a world fixed tip within the robot's working space.

Before using the instruction `MToolTCPCalib` some preconditions must be fulfilled:

- The tool that is to be calibrated must be mounted on the robot and defined with correct component `robhold` (`TRUE`).
- If using the robot with absolute accuracy then the load and center of gravity for the tool should already be defined. `LoadIdentify` can be used for the load definition.
- `tool0`, `wobj0`, and `PDispOff` must be activated before jogging the robot.
- Jog the TCP of the actual tool as close as possible to the world fixed tip and define a `jointtarget` for the first point `p1`.
- Define the further three positions (`p2`, `p3`, and `p4`) all with different orientations.

Definition of 4 jointtargets p1....p4, see figure below.



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NOTE!

It is not recommended to modify the positions `Pos1` to `Pos4` in the instruction `MToolTCPCalib`.

The reorientation between the 4 positions should be as big as possible, putting the robot in different configurations.Its also good practice to check the quality of the TCP after a calibration. Which can be performed by reorientation of the tool to check if the TCP is standing still.

Continues on next page

Basic examples

Basic examples of the instruction `MToolTCPCalib` are illustrated below.

Example 1

```
! Created with actual TCP pointing at the world fixed tip
CONST jointtarget p1 := [...];
CONST jointtarget p2 := [...];
CONST jointtarget p3 := [...];
CONST jointtarget p4 := [...];

PERS tooldata tool1:= [TRUE, [[0, 0, 0], [1, 0, 0 ,0]], [0.001,
     [0, 0, 0.001], [1, 0, 0, 0], 0, 0, 0]];
VAR num max_err;
VAR num mean_err;
...
! Instructions for createing or ModPos of p1 - p4
MoveAbsJ p1, v10, fine, tool0;
MoveAbsJ p2, v10, fine, tool0;
MoveAbsJ p3, v10, fine, tool0;
MoveAbsJ p4, v10, fine, tool0;
...
MToolTCPCalib p1, p2, p3, p4, tool1, max_err, mean_err;
```

The TCP value (`tframe.trans`) of `tool1` will be calibrated and updated. `max_err` and `mean_err` will hold the max. error in mm from the calculated TCP and the mean error in mm from the calculated TCP, respectively.

Arguments

```
MToolTCPCalib Pos1 Pos2 Pos3 Pos4 Tool MaxErr MeanErr
```

`Pos1`

Data type: `jointtarget`

The first approach point.

`Pos2`

Data type: `jointtarget`

The second approach point.

`Pos3`

Data type: `jointtarget`

The third approach point.

`Pos4`

Data type: `jointtarget`

The fourth approach point.

`Tool`

Data type: `tooldata`

The persistent variable of the tool that is to be calibrated.

Continues on next page

`MaxErr`

Data type: `num`

The maximum error in mm for one approach point.

`MeanErr`

Data type: `num`

The average distance that the approach points are from the calculated TCP, i.e. how accurately the robot was positioned relative to the tip.

Program execution

The system calculates and updates the TCP value in the wrist coordinate system (`tfame.trans`) in the specified `tooldata`. The calculation is based on the specified `4 jointtarget`. The remaining data in tooldata, such as tool orientation (`tframe.rot`), is not changed.

Syntax

```
MToolTCPCalib
  [ Pos1 ':=' ] < expression (IN) of jointtarget > ','
  [ Pos2 ':=' ] < expression (IN) of jointtarget > ','
  [ Pos3 ':=' ] < expression (IN) of jointtarget > ','
  [ Pos4 ':=' ] < expression (IN) of jointtarget > ','
  [ Tool ':=' ] < persistent (PERS) of tooldata > ','
  [ MaxErr ':=' ] < variable (VAR) of num > ','
  [ MeanErr' :=' ] < variable (VAR) of num > ';'
```

Related information

For information about	See
Calibration of rotation for a moving tool	*MToolRotCalib - Calibration of rotation for moving tool on page 275*
Calibration of TCP for a stationary tool	*SToolTCPCalib - Calibration of TCP for stationary tool on page 507*
Calibration of TCP and rotation for a stationary tool	*SToolRotCalib - Calibration of TCP and rotation for stationary tool on page 504*

1.103. Open - Opens a file or serial channel

Usage

`Open` is used to open a file or serial channel for reading or writing.

Basic examples

Basic examples of the instruction `Open` are illustrated below.

See also *More examples on page 283*.

Example 1

```
VAR iodev logfile;
...
Open "HOME:" \File:= "LOGFILE1.DOC", logfile \Write;
```

The file `LOGFILE1.DOC` in unit `HOME:` is opened for writing. The reference name `logfile` is used later in the program when writing to the file.

Example 2

```
VAR iodev logfile;
...
Open "LOGFILE1.DOC", logfile \Write;
```

Same result as example 1.The default directory is `HOME:`.

Arguments

```
Open Object [\File] IODevice [\Read] | [\Write] | [\Append] [\Bin]
```

`Object`

Data type: `string`

The I/O object (I/O device) that is to be opened, e.g. `"HOME:"`, `"TEMP:"`, `"com1:"` or `"pc:"`(option).

The table describes different I/O devices on the robot controller.

I/O device name	Full file path	Type of I/O device
`"HOME:"` or `diskhome`[1]	`"/hd0a/xxxx/HOME/"`[2]	Flashdisk or Hard Drive
`"TEMP:"` or `disktemp`[1]	`"/hd0a/temp/"`	Flashdisk or Hard Drive

`"RemovableDisk1:"` or `usbdisk1`[1]
`"RemovableDisk2:"` or `usbdisk2`[1]
`"RemovableDisk3:"` or `usbdisk3`[1]
`"RemovableDisk4:"` or `usbdisk4`[1]
`"RemovableDisk5:"` or `usbdisk5`[1]
`"RemovableDisk6:"` or `usbdisk6`[1]
`"RemovableDisk7:"` or `usbdisk7`[1]
`"RemovableDisk8:"` or `usbdisk8`[1]
`"RemovableDisk9:"` or `usbdisk9`[1]
`"RemovableDisk10:"` or `usbdisk10`[1]
	`"/bd0/"`
	`"/bd1/"`
	`"/bd2/"`
	`"/bd3/"`
	`"/bd4/"`
	`"/bd5/"`
	`"/bd6/"`
	`"/bd7/"`
	`"/bd8/"`
	`"/bd9/"`
		e.g. USB memory stick[3]

`"com1:"`[4] `"com2:"`[4] `"com3:"`[4]	-	Serial channel

Continues on next page

I/O device name	Full file path	Type of I/O device
`"pc:"`[5]	`"/c:/temp/"`[6]	Mounted disk

1. RAPID string defining device name
2. `"xxxx"` means the system name defined when booting the system
3. **Note!** RemovableDisk1 could be e.g. USB memory on one system but USB floppy on another.
4. User defined serial channel name defined in system parameters
5. Application protocol, server path defined in system parameters
6. Application protocol, server path defined in system parameters

The following table describes different I/O devices on the virtual controller.

I/O device name	Full file path	Type of I/O device
`"HOME:"` or `diskhome`[1]	`"/xxxx/HOME/"`[2]	
"TEMP:" or disktemp	`"/c:/temp/yyyy/"`[3]	Hard Drive

`"RemovableDisk1:"` or `usbdisk1`
`"RemovableDisk2:"` or `usbdisk2`
`"RemovableDisk3:"` or `usbdisk3`
`"RemovableDisk4:"` or `usbdisk4`
	`"/xxxx/HOME/RemovableDisk1/"`
	`"/xxxx/HOME/RemovableDisk2/"`
	`"/xxxx/HOME/RemovableDisk3/"`
	`"/xxxx/HOME/RemovableDisk4/"`
		e.g. USB memory stick[4]

1. RAPID string defining the device name
2. `"xxxx"` means the path to the system directory defined when creating the system
3. `"yyyy"` means a directory named as System ID
4. **Note!** RemovableDisk1 could be e.g. USB memory on one system but USB floppy on another.

`[\File]`

Data type: `string`

The name of the file to be opened, e.g. `"LOGFILE1.DOC"` or `"LOGDIR/LOGFILE1.DOC"`

The complete path can also be specified in the argument `Object`, `"HOME:/LOGDIR/LOGFILE.DOC"`.

`IODevice`

Data type: `iodev`

A reference to the file or serial channel to open. This reference is then used for reading from and writing to the file or serial channel.

`[\Read]`

Data type: `switch`

Opens a file or serial channel for reading. When reading from a file the reading is started from the beginning of the file.

Continues on next page

[\Write]

Data type: switch

Opens a file or serial channel for writing. If the selected file already exists then its contents are deleted. Anything subsequently written is written at the start of the file.

[\Append]

Data type: switch

Opens a file or serial channel for writing. If the selected file already exists then anything subsequently written is written at the end of the file.

Open a file or serial channel with \Append and without the \Bin arguments. The instruction opens a character-based file or serial channel for writing.

Open a file or serial channel with \Append and \Bin arguments. The instruction opens a binary file or serial channel for both reading and writing. The arguments \Read, \Write, \Append are mutually exclusive. If none of these are specified then the instruction acts in the same way as the \Write argument for character-based files or a serial channel (instruction without \Bin argument) and in the same way as the \Append argument for binary files or a serial channel (instruction with \Bin argument).

[\Bin]

Data type: switch

The file or serial channel is opened in a binary mode. If none of the arguments \Read, \Write or \Append are specified then the instruction opens a binary file or serial channel for both reading and writing, with the file pointer at the end of the file.

The Rewind instruction can be used to set the file pointer to the beginning of the file if desirable.

The set of instructions to access a binary file or serial channel is different from the set of instructions to access a character-based file.

More examples

More examples of how to use the instruction Open are illustrated below.

Example 1

```
VAR iodev printer;
...
Open "com2:", printer \Bin;
WriteStrBin printer, "This is a message to the printer\0D";
Close printer;
```

The serial channel com2: is opened for binary reading and writing. The reference name printer is used later when writing to and closing the serial channel.

Continues on next page

Program execution

The specified file or serial channel is opened so that it is possible to read from or write to it.

It is possible to open the same physical file several times at the same time but each invocation of the `Open` instruction will return a different reference to the file (data type `iodev`). E.g. it is possible to have one write pointer and one different read pointer to the same file at the same time.

The iodev variable used when opening a file or serial channel must be free from use. If it has been used previously to open a file then this file must be closed prior to issuing a new `Open` instruction with the same iodev variable.

At Program Stop and moved PP to Main, any open file or serial channel in the program task will be closed and the I/O descriptor in the variable of type `iodev` will be reset. An exception to the rule is variables that are installed shared in the system of type global VAR or LOCAL VAR. Such file or serial channel belonging to the whole system will still be open.

At power fail restart, any open file or serial channel in the system will be closed and the I/O descriptor in the variable of type `iodev` will be reset.

Error handling

If a file cannot be opened then the system variable `ERRNO` is set to `ERR_FILEOPEN`. This error can then be handled in the error handler.

Syntax

```
Open  [Object' :='] <expression (IN) of string>
  ['\'File':=' <expression (IN) of string>] ','
  [IODevice ':='] <variable (VAR) of iodev>
  ['\'Read] |
  ['\'Write] |
  ['\'Append]
  ['\'Bin] ';'
```

Related information

For information about	See
Writing to, reading from and closing files or serial channels	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*

1.104. OpenDir - Open a directory

Usage

`OpenDir` is used to open a directory for further investigation.

Basic examples

Basic examples of the instruction `OpenDir` are illustrated below.

Example 1

```
PROC lsdir(string dirname)
  VAR dir directory;
  VAR string filename;
  OpenDir directory, dirname;
  WHILE ReadDir(directory, filename) DO
     TPWrite filename;
  ENDWHILE
  CloseDir directory;
ENDPROC
```

This example prints out the names of all files or subdirectories under the specified directory.

Arguments

```
OpenDir Dev Path
```

`Dev`

Data type: `dir`

A variable with reference to the directory, fetched by `OpenDir`. This variable is then used for reading from the directory.

`Path`

Data type: `string`

Path to the directory.

Limitations

Open directories should always be closed by the user after reading (instruction `CloseDir`).

Error handling

If the path points to a non-existing directory or if there are too many directories open at the same time then the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

Syntax

```
OpenDir
  [ Dev':=' ] < variable (VAR) of dir>','
  [ Path':=' ] < expression (IN) of string>';'
```


Continues on next page

Related information

For information about	See
Directory	*dir - File directory structure on page 1103*
Make a directory	*MakeDir - Create a new directory on page 218*
Remove a directory	*RemoveDir - Delete a directory on page 355*
Read a directory	*ReadDir - Read next entry in a directory on page 944*
Close a directory	*CloseDir - Close a directory on page 56*
Remove a file	*RemoveFile - Delete a file on page 356*
Rename a file	*RenameFile - Rename a file on page 357*

1.105. PackDNHeader - Pack DeviceNet Header into rawbytes data

Usage

`PackDNHeader` is used to pack the header of a DeviceNet explicit message into a container of type `rawbytes`.

The data part of the DeviceNet message can afterwards be set with the instruction `PackRawBytes`.

Basic examples

Basic examples of the instruction `PackDNHeader` are illustrated below.

Example 1

```
VAR rawbytes raw_data;

PackDNHeader "0E", "6,20 01 24 01 30 06,9,4", raw_data;
```

Pack the header for DeviceNet explicit message with service code `"0E"` and path string `"6,20 01 24 01 30 06,9,4"` into `raw_data` corresponding to get the serial number from some I/O unit.

This message is ready to send without filling the message with additional data.

Example 2

```
VAR rawbytes raw_data;

PackDNHeader "10", "20 1D 24 01 30 64", raw_data;
```

Pack the header for DeviceNet explicit message with service code `"10"` and path string `"20 1D 24 01 30 64"` into `raw_data` corresponding to set the filter time for the rising edge on insignal 1 for some I/O unit.

This message must be increased with data for the filter time. This can be done with instruction `PackRawBytes` starting at index `RawBytesLen(raw_data)+1` (done after `PackDNHeader`).

Arguments

```
PackDNHeader Service Path RawData
```

`Service`

Data type: `string`

The service to be done such as get or set attribute. To be specified with a hexadecimal code in a string e.g. `"IF"`.

String length	2 characters
Format	’0’ -’ 9’, ’a’ -’f’, ’A’ - ’F’
Range	"00" - "FF

The values for the `Service` is found in the EDS file. For a more detailed description see the Open DeviceNet Vendor Association *ODVA DeviceNet Specification revision 2.0*.

Continues on next page

`Path`

Data type: `string`

The values for the `Path` is found in the EDS file. For a more detailed description see the Open DeviceNet Vendor Association *ODVA DeviceNet Specification revision 2.0*.

Support for both long string format (e.g. "`6,20 1D 24 01 30 64,8,1`") and short string format (e.g. "`20 1D 24 01 30 64`").

`RawData`

Data type: `rawbytes`

Variable container to be packed with message header data starting at index 1 in `RawData`.

Program execution

During program execution the DeviceNet message `RawData` container is:

- first completely cleared
- and then the header part is packed with data

Format DeviceNet Header

The instruction `PackDNHeader` will create a DeviceNet message header with following format:

RawData Header Format	No of bytes	Note
Format	1	Internal IRC5 code for DeviceNet
Service	1	Hex code for service
Size of Path	1	In bytes
Path	x	ASCII chars

The data part of the DeviceNet message can afterwards be set with the instruction `PackRawBytes` starting at index fetched with (`RawBytesLen(my_rawdata)+1)`.

Syntax

```
PackDNHeader
  [Service ´:=´ ] < expression (IN) of string> ´,´
  [Path ´:=´ ] < expression (IN) of string> ´,´
  [RawData ´:=´ ] < variable (VAR) of rawbytes> ´;´
```


Continues on next page

Related information

For information about	See
`rawbytes` data	*rawbytes - Raw data on page 1165*
Get the length of `rawbytes` data	*RawBytesLen - Get the length of rawbytes data on page 940*
Clear the contents of `rawbytes` data	*ClearRawBytes - Clear the contents of rawbytes data on page 49*
Copy the contents of `rawbytes` data	*CopyRawBytes - Copy the contents of rawbytes data on page 67*
Pack data to `rawbytes` data	*PackRawBytes - Pack data into rawbytes data on page 290*
Write `rawbytes` data	*WriteRawBytes - Write rawbytes data on page 725*
Read `rawbytes` data	*ReadRawBytes - Read rawbytes data on page 352*
Unpack data from `rawbytes` data	*UnpackRawBytes - Unpack data from rawbytes data on page 658*
Bit/Byte Functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics - Bit Functions*
String functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - String Functions*

1.106. PackRawBytes - Pack data into rawbytes data

Usage

`PackRawBytes` is used to pack the contents of variables of type `num`, `dnum`, `byte`, or `string` into a container of type `rawbytes`.

Basic examples

Basic examples of the instruction `PackRawBytes` are illustrated below.

```
VAR rawbytes raw_data;
VAR num integer := 8;
VAR dnum bigInt := 4294967295;
VAR num float := 13.4;
VAR byte data1 := 122;
VAR byte byte1;
VAR string string1:="abcdefg";
PackDNHeader "10", "20 1D 24 01 30 64", raw_data;
```

Pack the header for DeviceNet into `raw_data`.

Then pack requested field bus data in `raw_data` with `PackRawBytes`. The example below shows how different data can be added.

Example 1

```
PackRawBytes integer, raw_data, (RawBytesLen(raw_data)+1) \IntX :=
    DINT;
```

The contents of the next 4 bytes after the header in `raw_data` will be `8` decimal.

Example 2

```
PackRawBytes bigInt, raw_data, (RawBytesLen(raw_data)+1) \IntX :=
    UDINT;
```

The contents of the next 4 bytes after the header in `raw_data` will be `4294967295` decimal.

Example 3

```
PackRawBytes bigInt, raw_data, (RawBytesLen(raw_data)+1) \IntX :=
    LINT;
```

The contents of the next 8 bytes after the header in `raw_data` will be `4294967295` decimal.

Example 4

```
PackRawBytes float, raw_data, RawBytesLen(raw_data)+1) \Float4;
```

The contents of the next 4 bytes in `raw_data` will be `13.4` decimal.

Example 5

```
PackRawBytes data1, raw_data, (RawBytesLen(raw_data)+1) \ASCII;
```

The contents of the next byte in `raw_data` will be `122`, the ASCII code for "z".

Example 6

```
PackRawBytes string1, raw_data, (RawBytesLen(raw_data)+1) \ASCII;
```

The contents of next 7 bytes in `raw_data` will be `"abcdefg"`, coded in ASCII.

Continues on next page

Example 7

```
byte1 := StrToByte("1F" \Hex);
PackRawBytes byte1, raw_data, (RawBytesLen(raw_data)+1) \Hex1;
```

The contents of the next byte in `raw_data` will be `"1F"`, hexadecimal.

Arguments

```
PackRawBytes Value RawData [ \Network ] StartIndex
     [ \Hex1 ] | [ \IntX ] | [ \Float4 ] | [ \ASCII ]
```

`Value`

Data type: `anytype`

Data to be packed into `RawData`.

Allowed data types are: `num`, `dnum`, `byte`, or `string`. Array can not be used.

`RawData`

Data type: `rawbytes`

Variable container to be packed with data.

`[ \Network ]`

Data type: `switch`

Indicates that `integer` and `float` shall be packed in big-endian (network order) representation in `RawData`. ProfiBus and InterBus use big-endian.

Without this switch, `integer` and `float` will be packed in little-endian (not network order) representation in `RawData`. DeviceNet uses little-endian.

Only relevant together with option parameter `\IntX - UINT`, `UDINT`, `INT`, `DINT` and `\Float4`.

`StartIndex`

Data type: `num`

`StartIndex` between 1 and 1024 indicates where the first byte contained in `Value` shall be placed in `RawData`.

`[ \Hex1 ]`

Data type: `switch`

The `Value` to be packed has `byte` format and shall be converted to hexadecimal format and stored in 1 byte in `RawData`.

`[ \IntX ]`

Data type: `inttypes`

The `Value` to be packed has `num` or `dnum` format. It is an integer and shall be stored in `RawData` according to this specified constant of data type `inttypes` .

See *Predefined data on page 293*.

`[ \Float4 ]`

Data type: `switch`

The `Value` to be packed has `num` format and shall be stored as float, 4 bytes, in `RawData`.

Continues on next page

`[ \ASCII ]`

Data type: `switch`

The `Value` to be packed has `byte` or `string` format.

If the `Value` to be packed has `byte` format then it will be stored in `RawData` as 1 byte interpreting `Value` as ASCII code for a character.

If the `Value` to be packed has string format (1-80 characters) then it will be stored in `RawData` as ASCII characters with the same number of characters as contained in `Value`. String data is not `NULL` terminated by the system in data of type `rawbytes`. It is up to the programmer to add string header if necessary (required for DeviceNet).

One of the arguments `\Hex1`, `\IntX`, `\Float4`, or `\ASCII` must be programmed.

The following combinations are allowed:

Data type of Value:	Allowed option parameters:
`num` *)	`\IntX`
`dnum` **)	`\IntX`
`num`	`\Float4`
`string`	`\ASCII` (1-80 characters)
`byte`	`\Hex1 \ASCII`ob

*) Must be an integer within the value range of selected symbolic constant `USINT`, `UINT`, `UDINT`, `SINT`, `INT` or `DINT`.

**) Must be an integer within the value range of selected symbolic constant `USINT`, `UINT`, `UDINT`, `ULINT`, `SINT`, `INT`, `DINT` or `LINT`.

Program execution

During program execution the data is packed from the variable of type `anytype` into a container of type `rawbytes`.

The current length of valid bytes in the `RawData` variable is set to:

- (`StartIndex` + packed_number_of_bytes - 1)
- The current length of valid bytes in the `RawData` variable is not changed if the complete pack operation is done inside the old current length of valid bytes in the `RawData` variable.

Continues on next page

Predefined data

The following symbolic constants of the data type `inttypes` are predefined and can be used to specify the integer in parameter `\IntX`.

Symbolic constant	Constant value	Integer format	Integer value range
`USINT`	1	Unsigned 1 byte integer	0 ... 255
`UINT`	2	Unsigned 2 byte integer	0 ... 65 535
`UDINT`	4	Unsigned 4 byte integer	0 ... 8 388 608 *) 0 ... 4 294 967 295 ****)
`ULINT`	8	Unsigned 8 byte integer	0 ... 4 503 599 627 370 496**)
`SINT`	- 1	Signed 1 byte integer	- 128... 127
`INT`	- 2	Signed 2 byte integer	- 32 768 ... 32 767
`DINT`	- 4	Signed 4 byte integer	- 8 388 607 ... 8 388 608 *) -2 147 483 648 ... 2 147 483 647 ***)
`LINT`	- 8	Signed 8 byte integer	- 4 503 599 627 370 496... 4 503 599 627 370 496 **)

*) RAPID limitation for storage of integer in data type `num`.

**) RAPID limitation for storage of integer in data type `dnum`.

***) Range when using a dnum variable and inttype `DINT`.

****) Range when using a dnum variable and inttype `UDINT`.

Syntax

```
PackRawBytes
  [Value ´:=´ ] < expression (IN) of anytype> ´,´
  [RawData ´:=´ ] < variable (VAR) of rawbytes>
  [ ’\’ Network ] ´,´
  [StartIndex ´:=´ ] < expression (IN) of num>
  [ ’\’ Hex1 ]
  | [ ’\’ IntX’ :=’ < expression (IN) of inttypes>]
  |[ ’\’ Float4 ]
  | [ ’\’ ASCII]’ ;’
```


Continues on next page

Related information

For information about	See
`rawbytes` data	*rawbytes - Raw data on page 1165*
Get the length of `rawbytes` data	*RawBytesLen - Get the length of rawbytes data on page 940*
Clear the contents of `rawbytes` data	*ClearRawBytes - Clear the contents of rawbytes data on page 49*
Copy the contents of `rawbytes` data	*CopyRawBytes - Copy the contents of rawbytes data on page 67*
Pack DeviceNet header into `rawbytes` data	*PackDNHeader - Pack DeviceNet Header into rawbytes data on page 287*
Write `rawbytes` data	*WriteRawBytes - Write rawbytes data on page 725*
Read `rawbytes` data	*ReadRawBytes - Read rawbytes data on page 352*
Unpack data from `rawbytes` data	*UnpackRawBytes - Unpack data from rawbytes data on page 658*
Bit/Byte Functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Mathematics - Bit Functions*
String functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - String Functions*

1.107. PathAccLim - Reduce TCP acceleration along the path

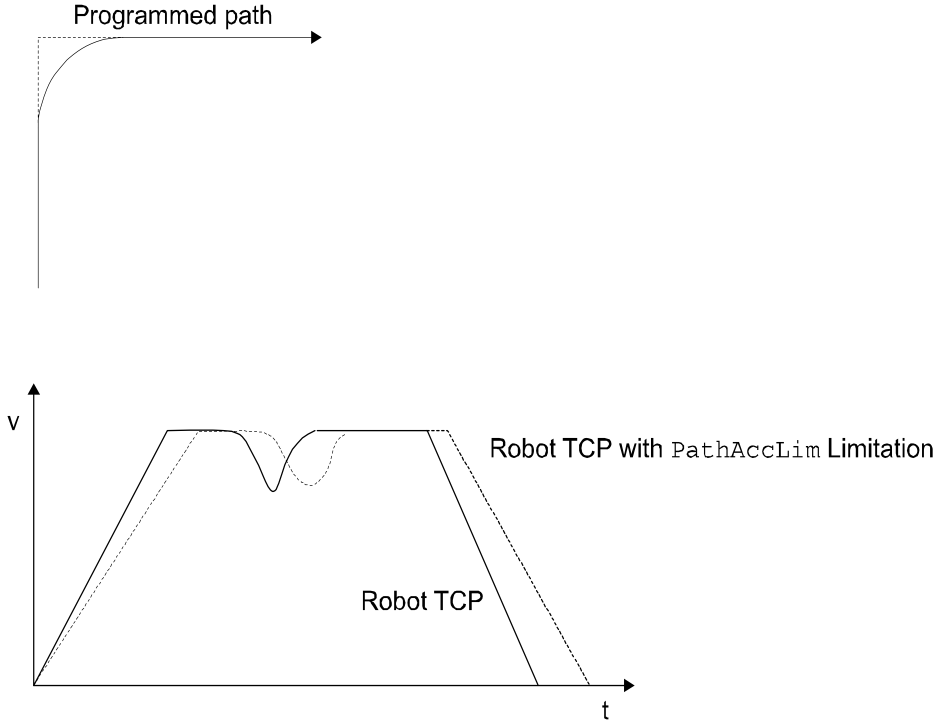
Usage

`PathAccLim` (*Path Acceleration Limitation*) is used to set or reset limitations on TCP acceleration and/or TCP deceleration along the movement path.

The limitation will be performed along the movement path, i.e. the acceleration in the path frame. It is the tangential acceleration/deceleration in the path direction that will be limited.

The instruction does not limit the total acceleration of the equipment, i.e. the acceleration in world frame, so it can not be directly used to protect the equipment from large accelerations.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.



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Basic examples

Basic examples of the instruction `PathAccLim` are illustrated below.

See also *More examples on page 296*.

Example 1

```
PathAccLim TRUE \AccMax := 4, TRUE \DecelMax := 4;
```

TCP acceleration and TCP deceleration are limited to 4 m/s^2.

Example 2

```
PathAccLim FALSE, FALSE;
```

The TCP acceleration and deceleration is reset to maximum (default).

Continues on next page

Arguments

```
PathAccLim AccLim [\AccMax] DecelLim [\DecelMax]
```

`AccLim`

Data type: `bool`

TRUE if there is to be a limitation of the acceleration, FALSE otherwise.

`[ \AccMax ]`

Data type: `num`

The absolute value of the acceleration limitation in m/s^2. Only to be used when `AccLim` is TRUE.

`DecelLim`

Data type: `bool`

TRUE if there is to be a limitation of the deceleration, FALSE otherwise.

`[ \DecelMax ]`

Data type: `num`

The absolute value of the deceleration limitation in m/s^2. Only to be used when `DecelLim` is TRUE.

Program execution

The acceleration/deceleration limitations applies for the next executed robot segment and is valid until a new `PathAccLim` instruction is executed.

The maximum acceleration/deceleration (`PathAccLim FALSE, FALSE`) are automatically set

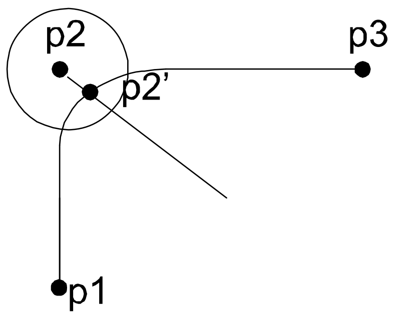
- at a cold start-up
- when a new program is loaded
- when starting program execution from the beginning.

If there is a combination of instructions `AccSet` and `PathAccLim` the system reduces the acceleration/deceleration in the following order:

- according `AccSet`
- according `PathAccLim`

More examples

More examples of how to use the instruction `PathAccLim` are illustrated below.



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Example 1

```
MoveL p1, v1000, fine, tool0;
PathAccLim TRUE\AccMax := 4, FALSE;
MoveL p2, v1000, z30, tool0;
MoveL p3, v1000, fine, tool0;
PathAccLim FALSE, FALSE;
```

TCP acceleration is limited to `4` m/s^2 between `p1` and `p3`.

Example 2

```
MoveL p1, v1000, fine, tool0;
MoveL p2, v1000, z30, tool0;
PathAccLim TRUE\AccMax :=3, TRUE\DecelMax := 4;
MoveL p3, v1000, fine, tool0;
PathAccLim FALSE, FALSE;
```

TCP acceleration is limited to `3` m/s^2 between `p2'` and `p3`.

TCP deceleration is limited to `4` m/s^2 between `p2'` and `p3`.

Error handling

If the parameters `\AccMax` or `\DecelMax` is set to a value too low, the system variable ERRNO is set to ERR_ACC_TOO_LOW. This error can then be handled in the error handler.

Limitations

The minimum acceleration/deceleration allowed is `0.5` m/s^2.

Syntax

```
PathAccLim
  [ AccLim ':=' ] < expression (IN) of bool >
  ['\'AccMax' :=' <expression (IN) of num >]','
  [DecelLim ':=' ] < expression (IN) of bool>
  ['\'DecelMax ':=' <expression (IN) of num >]';'
```

Related information

For information about	See
Positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Motion settings data	*motsetdata - Motion settings data on page 1141*
Reduction of acceleration	*AccSet - Reduces the acceleration on page 15*

1.108. PathRecMoveBwd - Move path recorder backwards

Usage

`PathRecMoveBwd` is used to move the robot backwards along a recorded path.

Basic examples

Basic examples of the instruction `PathRecMoveBwd` are illustrated below.

See also *More examples on page 300*.

Example 1

```
VAR pathrecid fixture_id;
PathRecMoveBwd \ID:=fixture_id \ToolOffs:=[0, 0, 10] \Speed:=v500;
```

The robot is moved backwards to the position in the program where the instruction `PathRecStart` planted the `fixture_id` identifier. The TCP offset is 10 mm in Z direction and the speed is set to 500 mm/s.

Arguments

```
PathRecMoveBwd [\ID] [\ToolOffs] [\Speed]
```

`[\ID]`

Identifier

Data type: `pathrecid`

Variable that specifies the ID position to move backward to. Data type `pathrecid` is a non-value type, only used as an identifier for naming the recording position.

If no ID position is specified then the backward movement is in a single system done to the closest recorded ID position. But in a MultiMove Synchronized Mode, the backward movements is done to the closest of the following positions:

- Back to the position where the synchronized movement started
- Back to the closest recorded ID position

`[\ToolOffs]`

Tool Offset

Data type: `pos`

Provides clearance offset for TCP during motion. A cartesian offset coordinate is applied to the TCP coordinates. Positive Z offset value indicates clearance. This is useful when the robot runs a process adding material. If running synchronized motion then all or none of the mechanical units needs to use the argument. If no offset is desired for some of the mechanical units then a zero offset can be applied. Even non TCP mechanical units need to use the argument if a TCP robot in a different task is used.

`[\Speed]`

Data type: `speeddata`

Speed replaces the speed original used during forward motion. Speeddata defines the velocity for the tool center point, the tool reorientation, and the external axis. If present, this speed will be used throughout the backward movement. If omitted, the backward motion will execute with the speed in the original motion instructions.

Continues on next page

Program execution

The path recorder is activated with the `PathRecStart` instruction. After the recorder has been started then all move instructions will be recorded and the robot can be moved backwards along its recorded path at any point by executing `PathRecMoveBwd`.

Synchronized motion

Running the path recorder in synchronization motion adds a few considerations.

- All tasks involved in the synchronization recorded motion must order `PathRecMoveBwd` before any of the robots start to move.
- All synchronization handling is recorded and executed in reverse. For example, if `PathRecMoveBwd` is ordered from within a synchronization block to an independent position then the path recorder will automatically change state to independent at the `SyncMoveOn` instruction.
- `SyncMoveOn` is considered as a breakpoint without path identifier. That is, if the path recorder has been started by means of `PathRecStart` and `PathRecMoveBwd` without the optional argument `\ID` is executed within a synchronized motion block, then the robot will move backwards to the position the robot was at when `SyncMoveOn` was executed. Since the backward movement stops before `SyncMoveOn`, the state will be changed to independent.
- `WaitSyncTask` is considered as a breakpoint without path identifier. That is, if the path recorder has been started by the means of `PathRecStart` and `PathRecMoveBwd` is executed then the robot will move back no longer than to the position the robot was at when `WaitSyncTask` was executed.

Continues on next page

More examples

More examples of how to use the instruction `PathRecMoveBwd` are illustrated below.

Example 1 - Independent motion

```
VAR pathrecid safe_id;
CONST robtarget p0 := [...];
...
CONST robtarget p4 := [...];
VAR num choice;

MoveJ p0, vmax, z50, tool1;
PathRecStart safe_id;
MoveJ p1, vmax, z50, tool1;
MoveL p2, vmax, z50, tool1;
MoveL p3, vmax, z50, tool1;
MoveL p4, vmax, z50, tool1;

ERROR:
TPReadFK choice,"Go to
     safe?",stEmpty,stEmpty,stEmpty,stEmpty,"Yes";
  IF choice=5 THEN
     IF PathRecValidBwd(\ID:=safe_id) THEN
        StorePath;
        PathRecMoveBwd \ID:=safe_id \ToolOffs:=[0, 0 , 10];
        Stop;
        !Fix problem
        PathRecMoveFwd;
        RestoPath;
        StartMove;
        RETRY;
     ENDIF
  ENDIF
```


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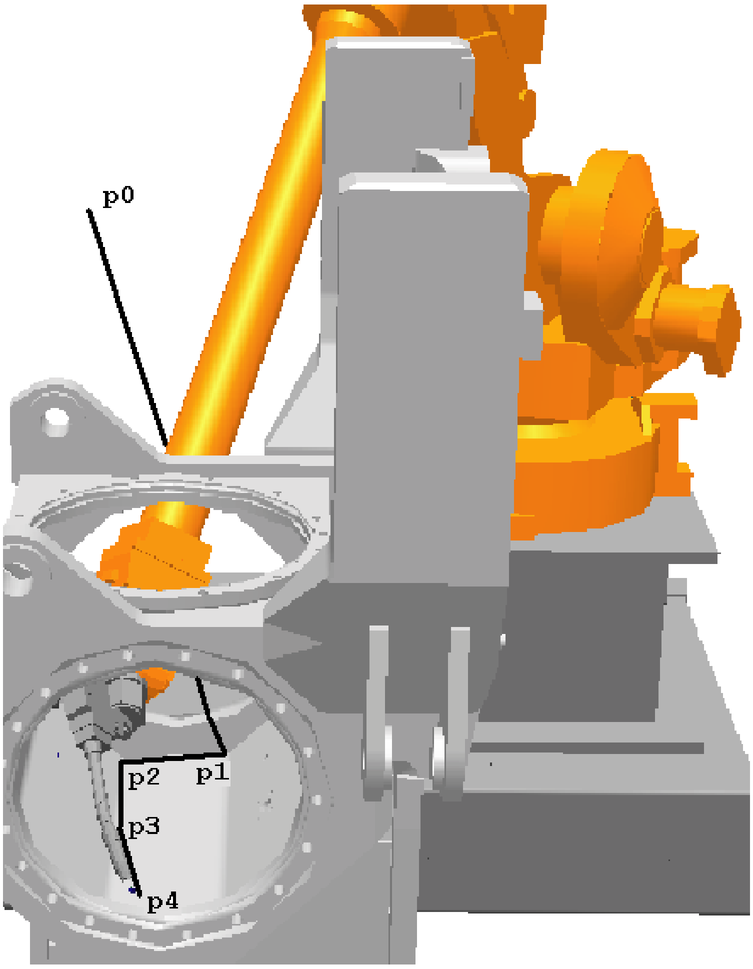

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This example shows how the path recorder can be utilized to extract the robot from narrow spaces upon error without programming a designated path.

A part is being manufactured. At the approach point, `p0`, the path recorder is started and given the path recorder identifier `safe_id`. Assume that when the robot moves from `p3` to `p4` that a recoverable error arises. At that point the path is stored by executing `StorePath`. By storing the path the error handler can start a new movement and later on restart the original movement. When the path has been stored the path recorder is used to move the robot out to the safe position, `p0`, by executing `PathRecMoveBwd`.

Note that a tool offset is applied to provide clearance from, for example, a newly added weld. When the robot has been moved out the operator can do what is necessary to fix the error (for example clean the torch of welding). Then the robot is moved back to the error location by the means of `PathRecMoveFwd`. At the error location the path level is switched back to base level by `RestoPath` and a retry attempt is made.

Continues on next page

Example 2 - Synchronized motion

T_ROB1

```
VAR pathrecid HomeROB1;
CONST robtarget pR1_10:=[...];
...
CONST robtarget pR1_60:=[...];

PathRecStart HomeROB1;
MoveJ pR1_10, v1000, z50, tGun;
MoveJ pR1_20, v1000, z50, tGun;
MoveJ pR1_30, v1000, z50, tGun;
SyncMoveOn sync1, tasklist;
MoveL pR1_40 \ID:=1, v1000, z50, tGun\wobj:=pos1;
MoveL pR1_50 \ID:=2, v1000, z50, tGun\wobj:=pos1;
MoveL pR1_60 \ID:=3, v1000, z50, tGun\wobj:=pos1;
SyncMoveOff sync2;

ERROR
  StorePath \KeepSync;
  TEST ERRNO
  CASE ERR_PATH_STOP:
     PathRecMoveBwd \ID:= HomeROB1\ToolOffs:=[0,0,10];
  ENDTEST
  !Perform service action
  PathRecMoveFwd \ToolOffs:=[0,0,10];
  RestoPath;
  StartMove;
```

T_ROB2

```
VAR pathrecid HomeROB2;
CONST robtarget pR2_10:=[...];
...
CONST robtarget pR2_50:=[...];

PathRecStart HomeROB2;
MoveJ pR2_10, v1000, z50, tGun;
MoveJ pR2_20, v1000, z50, tGun;
SyncMoveOn sync1, tasklist;
MoveL pR2_30 \ID:=1, v1000, z50, tGun\wobj:=pos1;
MoveL pR2_40 \ID:=2, v1000, z50, tGun\wobj:=pos1;
MoveL pR2_50 \ID:=3, v1000, z50, tGun\wobj:=pos1;
SyncMoveOff sync2;

ERROR
  StorePath \KeepSync;
  TEST ERRNO
  CASE ERR_PATH_STOP:
     PathRecMoveBwd \ToolOffs:=[0,0,10];
```


Continues on next page

```
  ENDTEST
  !Perform service action
  PathRecMoveFwd \ToolOffs:=[0,0,10];
  RestoPath;
  StartMove;
```

T_ROB3

```
VAR pathrecid HomePOS1;
CONST jointtarget jP1_10:=[...];
...
CONST jointtarget jP1_40:=[...];

PathRecStart HomePOS1;
MoveExtJ jP1_10, v1000, z50;
SyncMoveOn sync1, tasklist;
MoveExtJ jP1_20 \ID:=1, v1000, z50;
MoveExtJ jP1_30 \ID:=2, v1000, z50;
MoveExtJ jP1_40 \ID:=3, v1000, z50;
SyncMoveOff sync2;

ERROR
  StorePath \KeepSync;
  TEST ERRNO
  CASE ERR_PATH_STOP:
     PathRecMoveBwd \ToolOffs:=[0,0,0];
  DEFAULT:
  PathRecMoveBwd \ID:=HomePOS1\ToolOffs:=[0,0,0];
  ENDTEST
  !Perform service action
  PathRecMoveFwd \ToolOffs:=[0,0,0];
  RestoPath;
  StartMove;
```

A system is consisting of three manipulators that all run in separate tasks. Assume that `T_ROB1` experiences an error `ERR_PATH_STOP` within the synchronized block, `sync1`. Upon error it is desired to move back to the home position marked with the path recorder identifier `HomeROB1` to perform service of the robot's external equipment. This is done by using `PathRecMoveBwd` and suppling the `pathrecid` identifier.

Since the error occurred during synchronized motion it is necessary that the second TCP robot`T_ROB2` and the external axis `T_POS1` also orders `PathRecMoveBwd`. These manipulators do not have to move back further than before the synchronized motion started. By not suppling `PathRecMoveBwd` at `ERR_PATH_STOP` with a path recorder identifier the path recorder ability to stop after `SyncMoveOn` is utilized. Note that the external axis that does not have a TCP still adds a zero tool offset to enable the possibility for the TCP robots to do so.

The `DEFAULT` behavior in the `ERROR` handler in this example is that all manipulators first do the synchronized movements backwards and then the independent movements backwards to the start point of the recorded path. This is obtained by specifying `\ID` in `PathRecMoveBwd` for all manipulators.

Continues on next page

Limitations

Movements using the path recorder cannot be performed on base level, i.e. `StorePath` has to be executed prior to `PathRecMoveBwd`.

It is never possible to move backwards through a `SynchMoveOff` statement.

It is never possible to move backwards through a `WaitSyncTask` statement.

`SyncMoveOn` must be preceded by at least one independent movement if it is desired to move back to the position where the synchronized movement started.

If it is not desired to return to the point where `PathRecMoveBwd` was executed (by executing `PathRecMoveFwd`) then the PathRecorder has to be stopped by the means of `PathRecStop`. `PathRecStop\Clear` also clears the recorded path.

`PathRecMoveBwd` cannot be executed in a RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart, Reset or Step.

Syntax

```
PathRecMoveBwd
  [ ´\' ID ´:=' < variable (VAR) of pathrecid > ]
  [ ´\' ToolOffs´:=' <expression (IN) of pos> ]
  [ ´\' Speed`:=' <expression (IN) of speeddata> ]';'
```

Related information

For information about	See
Path Recorder Identifier	*pathrecid - Path recorder identifier on page 1158*
Start - stop the path recorder	*PathRecStart - Start the path recorder on page 308* *PathRecStop - Stop the path recorder on page 311*
Check for valid recorded path	*PathRecValidBwd - Is there a valid backward path recorded on page 921* *PathRecValidFwd - Is there a valid forward path recorded on page 924*
Move path recorder forward	*PathRecMoveFwd - Move path recorder forward on page 305*
Store - restore paths	*StorePath - Stores the path when an interrupt occurs on page 521* *RestoPath - Restores the path after an interrupt on page 362*
Other positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Error Recovery	*Technical reference manual - RAPID overview*, section *Basic characteristics - Error recovery*

1.109. PathRecMoveFwd - Move path recorder forward

Usage

`PathRecMoveFwd` is used to move the robot back to the position where `PathRecMoveBwd` was executed. It is also possible to move the robot partly forward by supplying an identifier that has been passed during the backward movement.

Basic examples

Basic examples of how to use the instruction `PathRecMoveFwd` are illustrated below.

See also *More examples on page 306*.

Example 1

```
PathRecMoveFwd;
```

The robot is moved back to the position where the path recorder started the backward movement.

Arguments

```
PathRecMoveFwd [\ID] [\ToolOffs] [\Speed]
```

[\ID]

Identifier

Data type: `pathrecid`

Variable that specifies the ID position to move forward to. Data type `pathrecid` is a non-value type only used as an identifier for naming the recording position.

If no ID position is specified then the forward movement will always be done to interrupt position on the original path.

[\ToolOffs]

Tool Offset

Data type: `pos`

Provides clearance offset for TCP during motion. A cartesian coordinate is applied to the TCP coordinates. This is useful when the robot runs a process adding material.

`[\Speed]`

Data type: `speeddata`

Speed overrides the original speed used during forward motion. Speeddata defines the velocity for the tool center point, the tool reorientation, and the external axis. If present, this speed will be used throughout the forward movement. If omitted, the forward motion will execute with the speed in the original motion instructions.

Program execution

The path recorder is activated with the `PathRecStart` instruction. After the recorder has been started the robot can be moved backwards along its executed path by executing `PathRecMoveBwd`. The robot can thereafter be ordered back to the position where the backward execution started by calling `PathRecMoveFwd`. It is also possible to move the robot partly forward by supplying an identifier that has been passed during the backward movement.

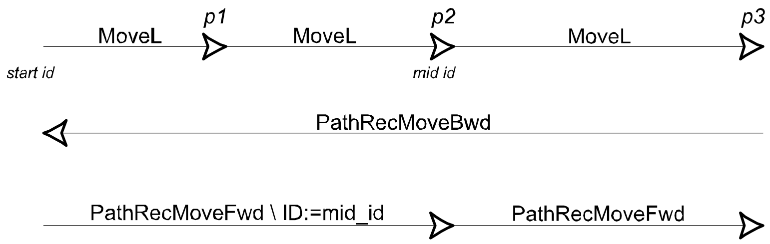
Continues on next page

More examples

More examples of how to use the instruction `PathRecMoveFwd` are illustrated below.

```
VAR pathrecid start_id;
VAR pathrecid mid_id;
CONST robtarget p1 := [...];
CONST robtarget p2 := [...];
CONST robtarget p3 := [...];

  PathRecStart start_id;
  MoveL p1, vmax, z50, tool1;
  MoveL p2, vmax, z50, tool1;
  PathRecStart mid_id;
  MoveL p3, vmax, z50, tool1;
  StorePath;
  PathRecMoveBwd \ID:=start_id;
  PathRecMoveFwd \ID:=mid_id;
  PathRecMoveFwd;
  RestoPath;
```



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The example above will start the path recorder and the starting point will be tagged with the path identifier `start_id`. Thereafter the robot will move forward with traditional move instructions and then move back to the path recorder identifier `start_id` using the recorded path. Finally it will move forward again in two steps by the means of `PathRecMoveFwd`.

Limitations

Movements using the path recorder have to be performed on trap-level, i.e. `StorePath` must execute prior to `PathRecMoveFwd`.

To be able to execute `PathRecMoveFwd` a `PathRecMoveBwd` must have been executed before.

If it is not desired to return to the point where `PathRecMoveBwd` was executed (by executing `PathRecMoveFwd`) then the PathRecorder has to be stopped by the means of `PathRecStop`. `PathRecStop\Clear` also clears recorded path.

`PathRecMoveFwd` cannot be executed in a RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart, Reset or Step.

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Syntax

```
PathRecMoveFwd’ (’
  [ ‘\’ ID‘ :=’ < variable (VAR) of pathid > ]
  [ ‘\’ ToolOffs‘ :=’ <expression (IN) of pos> ]
  [ ‘\’ Speed‘ :=’ <expression (IN) of speeddata> ]’;’
```

Related information

For information about	See
Path Recorder Identifiers	*pathrecid - Path recorder identifier on page 1158*
Start - stop the path recorder	*PathRecStart - Start the path recorder on page 308* *PathRecStop - Stop the path recorder on page 311*
Check for valid recorded path	*PathRecValidBwd - Is there a valid backward path recorded on page 921* *PathRecValidFwd - Is there a valid forward path recorded on page 924*
Move path recorder backward	*PathRecMoveBwd - Move path recorder backwards on page 298*
Store - restore paths	*StorePath - Stores the path when an interrupt occurs on page 521* *RestoPath - Restores the path after an interrupt on page 362*
Other positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Error Recovery	*Technical reference manual - RAPID overview*, section *RAPID summary - Error recovery* *Technical reference manual - RAPID overview*, section *Basic characteristics - Error recovery*

1.110. PathRecStart - Start the path recorder

Usage

`PathRecStart` is used to start recording the robot's path. The path recorder will store path information during execution of the RAPID program.

Basic examples

Basic examples of the instruction `PathRecStart` are illustrated below.

Example 1

```
VAR pathrecid fixture_id;

PathRecStart fixture_id;
```

The path recorder is started and the starting point (the instruction's position in the RAPID program) is tagged with the identifier `fixture_id`.

Arguments

```
PathRecStart ID
```

`ID`

Identifier

Data type: `pathrecid`

Variable that specifies the name of the recording start position. Data type `pathrecid` is a non-value type only used as an identifier for naming the recording position.

Program execution

When the path recorder is ordered to start the robot path will be recorded internally in the robot controller. The recorded sequence of program positions can be traversed backwards by means of `PathRecMoveBwd` causing the robot to move backwards along its executed path.

Continues on next page

More examples

More examples of how to use the instruction `PathRecStart` are illustrated below.

Example 1

```
VAR pathrecid origin_id;
VAR pathrecid corner_id;
VAR num choice;
MoveJ p1, vmax, z50, tool1;
PathRecStart origin_id;
MoveJ p2, vmax, z50, tool1;
PathRecStart corner_id;
MoveL p3, vmax, z50, tool1;
MoveAbsJ jt4, vmax, fine, tool1;
ERROR
  TPReadFK choice,"Extract
       to:",stEmpty,stEmpty,stEmpty,"Origin","Corner";
  IF choice=4 OR choice=5 THEN
    StorePath;
    IF choice=4 THEN
      PathRecMoveBwd \ID:=origin_id;
    ELSE
      PathRecMoveBwd \ID:=corner_id;
    ENDIF
    Stop;
    !Fix problem
    PathRecMoveFwd;
    RestoPath;
    StartMove;
    RETRY;
  ENDIF
```

In the example above the path recorder is used for moving the robot to a service position if an error during normal execution occurs.

The robot is executing along a path. After the position `p1` the path recorder is started. After the point `p2` another path identifier is inserted. Assume that a recoverable error occurs while moving from position `p3` to position `jt4`. The error handler will now be invoked, and the user can choose between extracting the robot to position `Origin` (point `p1`) or `Corner` (point `p2`). Then the path level is switched with `StorePath` to be able to restart at the error location later on. When the robot has backed out from the error location it's up to the user solving the error (usually fixing the robots surrounding equipment).

Then the robot is ordered back to the error location. The path level is switched back to normal, and a retry attempt is made.

Limitations

The path recorder can only be started and will only record the path in the base path level, i.e. movements at `StorePath` level are not recorded.

Continues on next page

Syntax

```
PathRecStart
  [ ID ':='] < variable (VAR) of pathrecid> ´;´
```

Related information

For information about	See
Path Recorder Identifiers	*pathrecid - Path recorder identifier on page 1158*
Stop the path recorder	*PathRecStop - Stop the path recorder on page 311*
Check for valid recorded path	*PathRecValidBwd - Is there a valid backward path recorded on page 921* *PathRecValidFwd - Is there a valid forward path recorded on page 924*
Play the path recorder backward	*PathRecMoveBwd - Move path recorder backwards on page 298*
Play the path recorder forward	*PathRecMoveFwd - Move path recorder forward on page 305*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*

1.111. PathRecStop - Stop the path recorder

Usage

`PathRecStop` is used to stop recording the robot's path.

Basic examples

Basic examples of the instruction `PathRecStop` are illustrated below.

See also *More examples* below.

Example 1

```
PathRecStop \Clear;
```

The path recorder is stopped and the buffer of stored path information is cleared.

Arguments

```
PathRecStop [\Clear]
```

`[\Clear]`

Data type: `switch`

Clear the recorded path.

Program execution

When the path recorder is ordered to stop the recording of the path will stop. The optional argument `\Clear` will clear the buffer of stored path information preventing the recorded path to be executed by mistake.

After the recorder has been stopped with `PathRecStop`, earlier recorded paths cannot be used for back-up movements (`PathRecMoveBwd`). However, it is possible to use earlier recorded paths if `PathRecStart` is ordered again from the same position that the path recorder was stopped in. See the example below.

More examples

More examples of how to use the instruction `PathRecStop` are illustrated below.

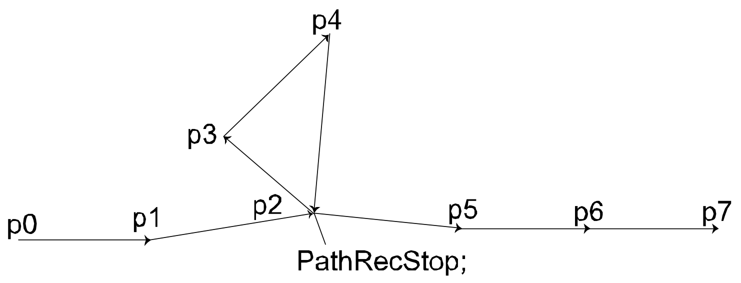
```
LOCAL VAR pathrecid id1;
LOCAL VAR pathrecid id2;
LOCAL CONST robtarget p0:= [...];
......
LOCAL CONST robtarget p6 := [...];

PROC example1()
  MoveL p0, vmax, z50, tool1;
  PathRecStart id1;
  MoveL p1, vmax, z50, tool1;
  MoveL p2, vmax, z50, tool1;
  PathRecStop;
  MoveL p3, vmax, z50, tool1;
  MoveL p4, vmax, z50, tool1;
  MoveL p2, vmax, z50, tool1;
  PathRecStart id2;
```

Continues on next page

```
    MoveL p5, vmax, z50, tool1;
    MoveL p6, vmax, z50, tool1;
    StorePath;
    PathRecMoveBwd \ID:=id1;
    PathRecMoveFwd;
    RestoPath;
    StartMove;
    MoveL p7, vmax, z50, tool1;
  ENDPROC

  PROC example2()
    MoveL p0, vmax, z50, tool1;
    PathRecStart id1;
    MoveL p1, vmax, z50, tool1;
    MoveL p2, vmax, z50, tool1;
    PathRecStop;
    MoveL p3, vmax, z50, tool1;
    MoveL p4, vmax, z50, tool1;
    PathRecStart id2;
    MoveL p2, vmax, z50, tool1;
    MoveL p5, vmax, z50, tool1;
    MoveL p6, vmax, z50, tool1;
    StorePath;
    PathRecMoveBwd \ID:=id1;
    PathRecMoveFwd;
    RestoPath;
    StartMove;
    MoveL p7, vmax, z50, tool1;
  ENDPROC
```



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The above examples describe recording of the robot path when the recording is stopped in the middle of the sequence. In `example1` the `PathRecMoveBwd \ID:=id1;` order is valid and the robot will execute the following path: `p6 -> p5 -> p2 -> p1 -> p0`

The reason that the order is valid is due to the recorder being stopped and started in the exact same robot position. If this behavior isn't desirable the stop order should include the optional argument `\Clear`. In that way the recorded path will be cleared and it will never be possible to back-up to previous path recorder identifiers.

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The only difference in `example2` is where the recorder was started the second time. In this case `PathRecMoveBwd \ID:=id1` will cause an error. This is because no recorded path exists between `p4`, `p3` and `p2`. However, it is possible to execute `PathRecMoveBwd \ID:=id2`.

Syntax

```
PathRecStop
  [ ´\'switch Clear ] ´;'
```

Related information

For information about	See
Path Recorder Identifiers	*pathrecid - Path recorder identifier on page 1158*
Start the path recorder	*PathRecStart - Start the path recorder on page 308*
Check for valid recorded path	*PathRecValidBwd - Is there a valid backward path recorded on page 921* *PathRecValidFwd - Is there a valid forward path recorded on page 924*
Play the recorder backward	*PathRecMoveBwd - Move path recorder backwards on page 298*
Play the recorder forwards	*PathRecMoveFwd - Move path recorder forward on page 305*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*

1.112. PathResol - Override path resolution

Usage

`PathResol` (*Path Resolution*) is used to override the configured geometric path sample time defined in the system parameters for the mechanical units that are controlled from current program task.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in any motion tasks.

Description

The path resolution affects the accuracy of the interpolated path and the program cycle time. The path accuracy is improved and the cycle time is often reduced when the parameter `PathSampleTime` is decreased. A value for parameter `PathSampleTime`, which is too low, may cause CPU load problems in some demanding applications. However, use of the standard configured path resolution (`PathSampleTime` 100%) will avoid CPU load problems and provide sufficient path accuracy in most situations.

Example of `PathResol` usage:

Dynamically critical movements (max payload, high speed, combined joint motions close to the border of the work area) may cause CPU load problems. Increase the parameter `PathSampleTime`.

Low performance external axes may cause CPU load problems during coordination. Increase the parameter `PathSampleTime`.

Arc-welding with high frequency weaving may require high resolution of the interpolated path. Decrease the parameter `PathSampleTime`.

Small circles or combined small movements with direction changes can decrease the path performance quality and increase the cycle time. Decrease the parameter `PathSampleTime`.

Gluing with large reorientations and small corner zones can cause speed variations. Decrease the parameter `PathSampleTime`.

Basic examples

Basic examples of the instruction `PathResol` are illustrated below.

```
MoveJ p1,v1000,fine,tool1;
PathResol 150;
```

With the robot at a stop point the path sample time is increased to `150` % of the configured.

Arguments

```
PathResol PathSampleTime
```

`PathSampleTime`

Data type: `num`

Override as a percent of the configured path sample time. 100% corresponds to the configured path sample time. Within the range 25-400%.

A lower value of the parameter `PathSampleTime` improves the path resolution (path accuracy).

Continues on next page

Program execution

The path resolutions of all subsequent positioning instructions are affected until a new `PathResol` instruction is executed. This will affect the path resolution during all program execution of movements (default path level and path level after `StorePath`) and also during jogging.

In a MultiMove system at synchronized coordinated mode the following points are valid:

- All mechanical units involved in synchronized coordinated mode will run with the current path resolution for actual (used) motion planner.
- New path resolution order against actual motion planner affects the synchronized coordinated movement and future independent movement in that motion planner.
- New path resolution order against another motion planner only affects future independent movement in that motion planner.

About connection between program task and motion planner see *Application manual - MultiMove*.

The default value for override of path sample time is 100%. This value is automatically set

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

The current override of path sample time can be read from the variable `C_MOTSET` (data type `motsetdata`) in the component `pathresol`.

Limitation

If this instruction is preceded by a move instruction then that move instruction must be programmed with a stop point (zonedata `fine`), not a fly-by point. Otherwise restart after power failure will not be possible.

`PathResol` cannot be executed in a RAPID routine connected to any of following special system events: PowerOn, Stop, QStop, Restart, or Step.

Syntax

```
PathResol
  [PathSampleTime ':=' ] < expression (IN) of num> ';'
```

Related information

For information about	See
Positioning instructions	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*
Motion settings	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion settings*
Configuration of path resolution	*Technical reference manual - System parameters*, section *Motion Planner - CPU Load Equalization*

1.113. PDispOff - Deactivates program displacement

Usage

`PDispOff` (*Program Displacement Off*) is used to deactivate a program displacement.

Program displacement is activated by the instruction `PDispSet` or `PDispOn` and applies to all movements until some other program displacement is activated or until program displacement is deactivated.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `PDispOff` are illustrated below.

Example 1

```
PDispOff;
```

Deactivation of a program displacement.

Example 2

```
MoveL p10, v500, z10, tool1;
PDispOn \ExeP:=p10, p11, tool1;
MoveL p20, v500, z10, tool1;
MoveL p30, v500, z10, tool1;
PDispOff;
MoveL p40, v500, z10, tool1;
```

A program displacement is defined as the difference between the positions `p10` and `p11`. This displacement affects the movement to `p20` and `p30` but not to `p40`.

Program execution

Active program displacement is reset. This means that the program displacement coordinate system is the same as the object coordinate system, and thus all programmed positions will be related to the latter.

Syntax

```
PDispOff ´;'
```

Related information

For information about	See
Definition of program displacement using two positions	*PDispOn - Activates program displacement on page 317*
Definition of program displacement using known frame	*PDispSet - Activates program displacement using known frame on page 321*

1.114. PDispOn - Activates program displacement

Usage

`PDispOn` (*Program Displacement On*) is used to define and activate a program displacement using two robot positions.

Program displacement is used, for example, after a search has been carried out or when similar motion patterns are repeated at several different places in the program.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `PDispOn` are illustrated below.

See also *More examples on page 319*.

Example 1

```
MoveL p10, v500, z10, tool1;
PDispOn \ExeP:=p10, p20, tool1;
```

Activation of a program displacement (parallel displacement). This is calculated based on the difference between positions `p10` and `p20`.

Example 2

```
MoveL p10, v500, fine \Inpos := inpos50, tool1;
PDispOn *, tool1;
```

Activation of a program displacement (parallel displacement). Since a stop point that is accurately defined has been used in the previous instruction the argument `\ExeP` does not have to be used. The displacement is calculated on the basis of the difference between the robot's actual position and the programmed point (*) stored in the instruction.

Example 3

```
PDispOn \Rot \ExeP:=p10, p20, tool1;
```

Activation of a program displacement including a rotation. This is calculated based on the difference between positions `p10` and `p20`.

Arguments

```
PDispOn [\Rot] [\ExeP] ProgPoint Tool [\WObj]
```

`[ \Rot ]`

Rotation

Data type: `switch`

The difference in the tool orientation is taken into consideration and this involves a rotation of the program.

`[ \ExeP ]`

Executed Point

Data type: `robtarget`

The new robot position used for calculation of the displacement. If this argument is omitted then the robot's current position at the time of the program execution is used.

Continues on next page

`ProgPoint`

Programmed Point

Data type: `robtarget`

The robot's original position at the time of programming.

`Tool`

Data type: `tooldata`

The tool used during programming, i.e. the TCP to which the `ProgPoint` position is related.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

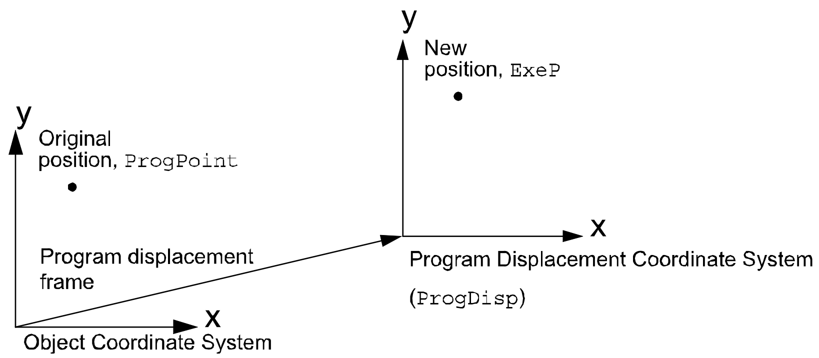
The work object (coordinate system) to which the `ProgPoint` position is related.

This argument can be omitted and if so then the position is related to the world coordinate system. However, if a stationary TCP or coordinated external axes are used then this argument must be specified.

The arguments **Tool** and **\WObj** are used both to calculate the `ProgPoint` during programming and to calculate the current position during program execution if no `\ExeP` argument is programmed.

Program execution

Program displacement means that the `ProgDisp` coordinate system is translated in relation to the object coordinate system. Since all positions are related to the `ProgDisp` coordinate system, all programmed positions will also be displaced. See figure below, which shows parallel displacement of a programmed position using program displacement.



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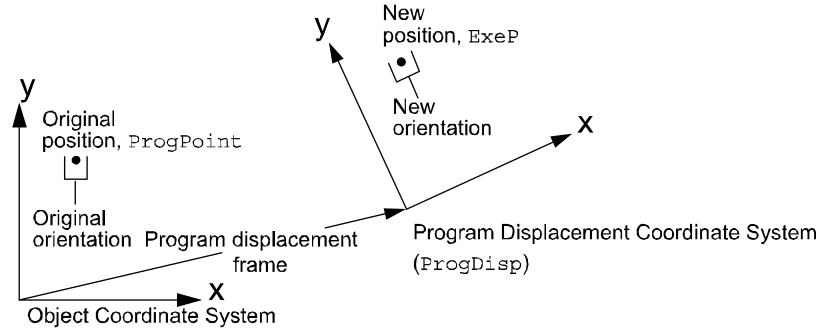
Program displacement is activated when the instruction `PDispOn` is executed and remains active until some other program displacement is activated (the instruction `PDispSet` or `PDispOn`) or until program displacement is deactivated (the instruction `PDispOff`).

Only one program displacement can be active at the same time. Several `PDispOn` instructions, on the other hand, can be programmed one after the other and in this case the different program displacements will be added.

Program displacement is calculated as the difference between `ExeP` and `ProgPoint`. If `ExeP` has not been specified then the current position of the robot at the time of the program execution is used instead. Since it is the actual position of the robot that is used, the robot should not move when `PDispOn` is executed.

Continues on next page

If the argument `\Rot` is used then the rotation is also calculated based on the tool orientation at the two positions. The displacement will be calculated in such a way that the new position (`ExeP`) will have the same position and orientation in relation to the displaced coordinate system, `ProgDisp`, as the old position (`ProgPoint`) had in relation to the original object coordinate system. See the figure below, which shows translation and rotation of a programmed position.



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The program displacement is automatically reset

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

More examples

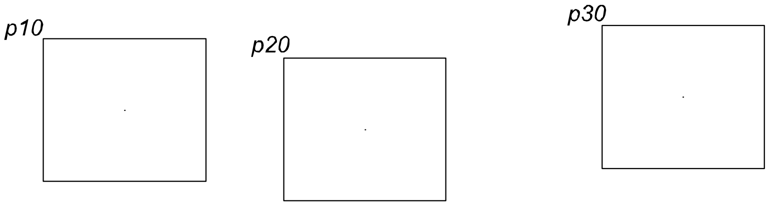
More examples of how to use the instruction `PDispOn` are illustrated below.

Example 1

```
PROC draw_square()
  PDispOn *, tool1;
  MoveL *, v500, z10, tool1;
  MoveL *, v500, z10, tool1;
  MoveL *, v500, z10, tool1;
  MoveL *, v500, z10, tool1;
  PDispOff;
ENDPROC
...
MoveL p10, v500, fine \Inpos := inpos50, tool1;
draw_square;
MoveL p20, v500, fine \Inpos := inpos50, tool1;
draw_square;
MoveL p30, v500, fine \Inpos := inpos50, tool1;
draw_square;
```


Continues on next page

The routine `draw_square` is used to execute the same motion pattern at three different positions based on the positions `p10, p20`, and `p30`. See the figure below, which shows that when using program displacement the motion patterns can be reused.



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Example 2

```
SearchL sen1, psearch, p10, v100, tool1\WObj:=fixture1;
PDispOn \ExeP:=psearch, *, tool1 \WObj:=fixture1;
```

A search is carried out in which the robot's searched position is stored in the position `psearch`. Any movement carried out after this starts from this position using a program displacement (parallel displacement). The latter is calculated based on the difference between the searched position and the programmed point (`*`) stored in the instruction. All positions are based on the `fixture1` object coordinate system.

Syntax

```
PDispOn
  [ [ '\' Rot ]
     ['\' ExeP ':=' < expression (IN) of robtarget>]',']
  [ ProgPoint' :=' ] < expression (IN) of robtarget> ','
  [ Tool ':=' ] < persistent (PERS) of tooldata>
  [ ´\'WObj' :=' < persistent (PERS) of wobjdata> ] ´;'
```

Related information

For information about	See
Deactivation of program displacement	*PDispOff - Deactivates program displacement on page 316*
Definition of program displacement using known frame	*PDispSet - Activates program displacement using known frame on page 321*
Coordinate systems	*Technical reference manual - System parameters*, section *Motion and I/O principles - Coordinate systems*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*

1.115. PDispSet - Activates program displacement using known frame

Usage

`PDispSet` (*Program Displacement Set*) is used to define and activate a program displacement using known frame.

Program displacement is used, for example, when similar motion patterns are repeated at several different places in the program.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `PDispSet` are illustrated below.

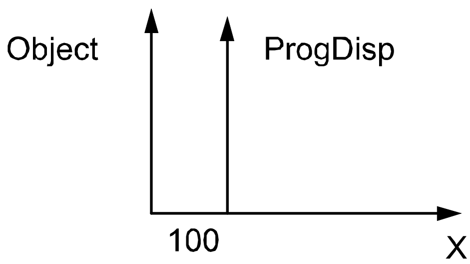
Example 1

```
VAR pose xp100 := [ [100, 0, 0], [1, 0, 0, 0] ];
...
PDispSet xp100;
```

Activation of the `xp100` program displacement meaning that:

- The `ProgDisp` coordinate system is displaced 100 mm from the object coordinate system in the direction of the positive x-axis (see figure below).
- As long as this program displacement is active all positions will be displaced 100 mm in the direction of the x-axis.

The figure shows a 100 mm program displacement along the x-axis.



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Arguments

```
PDispSet DispFrame
```

`DispFrame`

Displacement Frame

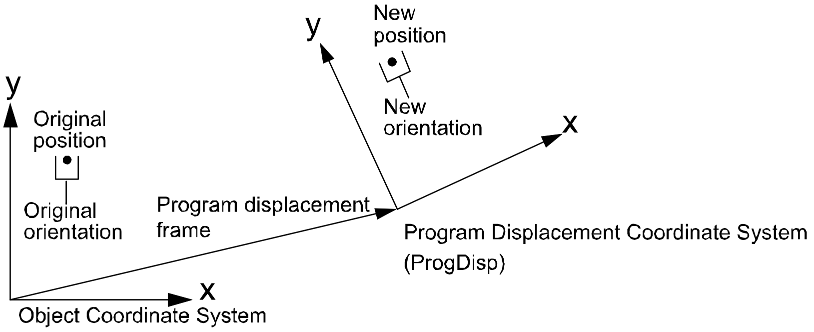
Datatype: `pose`

The program displacement is defined as data of the type `pose`.

Continues on next page

Program execution

Program displacement involves translating and/or rotating the `ProgDisp` coordinate system relative to the object coordinate system. Since all positions are related to the `ProgDisp` coordinate system, all programmed positions will also be displaced. See the figure below, which shows translation and rotation of a programmed position.



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Program displacement is activated when the instruction `PDispSet` is executed and remains active until some other program displacement is activated (the instruction `PDispSet` or `PDispOn`) or until program displacement is deactivated (the instruction `PDispOff`).

Only one program displacement can be active at the same time. Program displacements cannot be added to one another using `PDispSet`.

The program displacement is automatically reset

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

Syntax

```
PDispSet
  [ DispFrame ':=' ] < expression (IN) of pose> ';'
```

Related information

For information about	See
Deactivation of program displacement	*PDispOff - Deactivates program displacement on page 316*
Definition of program displacement using two positions	*PDispOn - Activates program displacement on page 317*
Definition of data of the type pose	*pose - Coordinate transformations on page 1162*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
Examples of how program displacement can be used	*PDispOn - Activates program displacement on page 317*

1.116. ProcCall - Calls a new procedure

Usage

A procedure call is used to transfer program execution to another procedure. When the procedure has been fully executed the program execution continues with the instruction following the procedure call.

It is usually possible to send a number of arguments to the new procedure. These control the behavior of the procedure and make it possible for the same procedure to be used for different things.

Basic examples

Basic examples of the instruction `ProcCall` are illustrated below.

Example 1

```
weldpipe1;
```

Calls the `weldpipe1` procedure.

Example 2

```
errormessage;
Set do1;
...
PROC errormessage()
  TPWrite "ERROR";
ENDPROC
```

The `errormessage` procedure is called. When this procedure is ready the program execution returns to the instruction following the procedure call, `Set do1`.

Arguments

```
Procedure { Argument }
```

`Procedure`

Identifier

The name of the procedure to be called.

`Argument`

Data type: In accordance with the procedure declaration.

The procedure arguments (in accordance with the parameters of the procedure).

Basic examples

Basic examples of the instruction `ProcCall` are illustrated below.

Example 1

```
weldpipe2 10, lowspeed;
```

Calls the `weldpipe2` procedure including two arguments.

Example 2

```
weldpipe3 10 \speed:=20;
```

Calls the `weldpipe3` procedure including one mandatory and one optional argument.

Continues on next page

Limitations

The procedure's arguments must agree with its parameters:

- All mandatory arguments must be included.
- They must be placed in the same order.
- They must be of the same data type.
- They must be of the correct type with respect to the access-mode (input, variable, or persistent).

A routine can call a routine which, in turn, calls another routine, etc. A routine can also call itself, i.e. a recursive call. The number of routine levels permitted depends on the number of parameters. More than 10 levels are usually permitted.

Syntax

```
(EBNF)
<procedure> [ <argument list> ] ';'

<procedure> ::= <identifier>
```

Related information

For information about	See
Arguments, parameters	*Technical reference manual - RAPID overview*, section *Basic characteristics - Routines*

1.117. ProcerrRecovery - Generate and recover from process-move error

Usage

`ProcerrRecovery` can be used to generate process error during robot movement and get the possibility to handle the error and restart the process and the movement from an ERROR handler.

Basic examples

Basic examples of the instruction `ProcerrRecovery` are illustrated below.

See also *More examples on page 327*.

The examples below are not realistic but are shown for pedagogic reasons.

Example 1

```
MoveL p1, v50, z30, tool2;
ProcerrRecovery \SyncOrgMoveInst;
MoveL p2, v50, z30, tool2;
ERROR
  IF ERRNO = ERR_PATH_STOP THEN
    StartMove;
    RETRY;
  ENDIF
```

The robot movement stops on its way to `p1` and the program execution transfers to the `ERROR` handler in the routine that created the actual path on which the error occurred, in this case the path to `MoveL p1`. The movement is restarted with `StartMove` and the execution is continued with `RETRY`.

Example 2

```
MoveL p1, v50, fine, tool2;
ProcerrRecovery \SyncLastMoveInst;
MoveL p2, v50, z30, tool2;
ERROR
  IF ERRNO = ERR_PATH_STOP THEN
    StartMove;
    RETRY;
  ENDIF
```

The robot movement stops at once on its way to `p2`. The program execution transfers to the `ERROR` handler in the routine where the program is currently executing or is going to execute a move instruction when the error occurred, in this case `MoveL p2`. The movement is restarted with `StartMove` and the execution is continued with `RETRY`.

Continues on next page

Arguments

```
ProcerrRecovery [\SyncOrgMoveInst] | [\SyncLastMoveInst]
    [\ProcSignal]
```

`[\SyncOrgMoveInst]`

Data type: `switch`

The error can be handled in the routine that created the actual path on which the error occurred.

`[\SyncLastMoveInst]`

Data type: `switch`

The error can be handled in the routine where the program is currently executing a move instruction when the error occurred.

If the program is currently not executing a move instruction when the error occurred then the transfer of the execution to the `ERROR` handler will be delayed until the program executes the next move instruction. This means that the transfer to the `ERROR` handler will be delayed if the robot is in a stop point or between the prefetch point and the middle of the corner path. The error can be handled in that routine.

`[\ProcSignal]`

Data type: `signaldo`

Optional parameter that let the user turn on/off the use of the instruction. If this parameter is used and the signal value is 0, an recoverable error will be thrown, and no process error will be generated.

Program execution

Execution of `ProcerrRecovery` in continuous mode results in the following:

- At once the robot is stopped on its path.
- The variable `ERRNO` is set to `ERR_PATH_STOP`.
- The execution is transferred to some `ERROR` handler according the rules for asynchronously raised errors.

This instruction does nothing in any step mode.

For description of asynchronously raised errors that are generated with `ProcerrRecovery` see RAPID kernel reference/Error recovery/Asynchronously raised errors.

`ProcerrRecovery` can also be used in MultiMove system to transfer the execution to the `ERROR` handler in several program tasks if running in synchronized mode.

Continues on next page

More examples

More examples of how to use the instruction `ProcerrRecovery` are illustrated below.

Example with ProcerrRecovery\SyncOrgMoveInst

```
MODULE user_module
  VAR intnum proc_sup_int;

  PROC main()
    ...
    MoveL p1, v1000, fine, tool1;
    do_process;
    ...
  ENDPROC
  PROC do_process()
    my_proc_on;
    MoveL p2, v200, z10, tool1;
    MoveL p3, v200, fine, tool1;
    my_proc_off;
  ERROR
    IF ERRNO = ERR_PATH_STOP THEN
      my_proc_on;
      StartMove;
      RETRY;
    ENDIF
  ENDPROC

  TRAP iprocfail
    my_proc_off;
    ProcerrRecovery \SyncOrgMoveInst;
  ENDTRAP

  PROC my_proc_on()
    SetDO do_myproc, 1;
    CONNECT proc_sup_int WITH iprocfail;
    ISignalDI di_proc_sup, 1, proc_sup_int;
  ENDPROC

  PROC my_proc_off()
    SetDO do_myproc, 0;
    IDelete proc_sup_int;
  ENDPROC
ENDMODULE
```


Continues on next page

Asynchronously raised errors generated by `ProcerrRecovery` with switch `\SyncOrgMoveInst` can, in this example, be treated in the routine do_process because the path on which the error occurred is always created in the routine `do_process`.

A process flow is started by setting the signal `do_myproc` to `1`. The signal `di_proc_sup` supervise the process, and an asynchronous error is raised if `di_proc_sup` becomes `1`. In this simple example the error is resolved by setting `do_myproc` to `1` again before resuming the movement.

Example with ProcerrRecovery\SyncLastMoveInst

```
MODULE user_module
  PROC main()
    ...
    MoveL p1, v1000, fine, tool1;
    do_process;
    ...
  ENDPROC
  PROC do_process()
    proc_on;
    proc_move p2, v200, z10, tool1;
    proc_move p3, v200, fine, tool1;
    proc_off;
  ERROR
    IF ERRNO = ERR_PATH_STOP THEN
      StorePath;
      p4 := CRobT(\Tool:=tool1);
      ! Move to service station and fix the problem
      MoveL p4, v200, fine, tool1;
      RestoPath;
      proc_on;
      StartMoveRetry;
    ENDIF
  ENDPROC
ENDMODULE

MODULE proc_module (SYSMODULE, NOSTEPIN)
  VAR intnum proc_sup_int;
  VAR num try_no := 0;

TRAP iprocfail
    proc_off;
    ProcerrRecovery \SyncLastMoveInst;
  ENDTRAP
```


Continues on next page

```
  PROC proc_on()
    SetDO do_proc, 1;
    CONNECT proc_sup_int WITH iprocfail;
    ISignalDI di_proc_sup, 1, proc_sup_int;
  ENDPROC

  PROC proc_off()
    SetDO do_proc, 0;
    IDelete proc_sup_int;
  ENDPROC

PROC proc_move (robtarget ToPoint, speeddata Speed, zonedata Zone,
     PERS tooldata Tool)
    MoveL ToPoint, Speed, Zone, Tool;
    ERROR
      IF ERRNO = ERR_PATH_STOP THEN
        try_no := try_no + 1;
        IF try_no < 4 THEN
          proc_on;
          StartMoveRetry;
        ELSE
          RaiseToUser \Continue;
      ENDIF
    ENDPROC
ENDMODULE
```

Asynchronously raised errors generated by `ProcerrRecovery` with switch `\SyncLastMoveInst` can in this example be treated in the routine `proc_move` because all move instructions are always created in the routine proc_move. When program pointer is in routine `do_process` the transfer to `ERROR` handler will be delayed until running the next `MoveL` in routine `proc_move.` Note that the movements are always stopped at once.

A process flow is started by setting the signal `do_myproc` to `1`. The signal `di_proc_sup` supervise the process, and an asynchronous error is raised if `di_proc_sup` becomes `1`. In this simple example the error is resolved by setting `do_myproc` to `1` again before resuming the movement.

When using predefined `NOSTEPIN` routine we recommend using the option switch parameter `\SyncLastMoveInst` because then the predefined routine can make the decision to handle some error situation within the routine while others must be handled by the end user.

Error handling

Following recoverable errors can be generated. The errors can be handled in an error handler.

If the optional parameter `\ProcSignal` is used and if the signal is off when the instruction is executed, the system variable `ERRNO` is set to `ERR_PROCSIGNAL_OFF` and the execution continues in the error handler.

If there is no contact with the I/O unit, the system variable `ERRNO` is set to `ERR_NORUNUNIT` and the execution continues in the error handler.

Continues on next page

Limitations

Error recovery from asynchronously raised process errors can only be done if the motion task with the process move instruction is executing on base level when the process error occurs. So error recovery can not be done if the program task with the process instruction executes in:

- any event routine
- any routine handler (`ERROR`, `BACKWARD` or `UNDO`)
- user execution level (service routine)

See *RAPID reference manual - RAPID kernel*, *Error recovery*, *Asynchronously raised errors*.

If no error handler with a `StartMove` + `RETRY` or a `StartMoveRetry` is used, the program execcution will hang. The only way to reset this is to do a PP to main.

Syntax

```
ProcerrRecovery
  [ '\' SyncOrgMoveInst ] | [' \' SyncLastMoveInst ]
  [ '\' ProcSignal' :=' ] < variable (VAR) of signaldo > ';'
```

Related information

For information about	See
Error handlers	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Error Recovery*
Asynchronously raised errors	*RAPID reference manual - RAPID kernel - Error recover*
Propagates an error to user level	*RaiseToUser - Propagates an error to user level on page 337*
Resume movement and program execution	*StartMoveRetry - Restarts robot movement and execution on page 489*

1.118. PulseDO - Generates a pulse on a digital output signal

Usage

`PulseDO` is used to generate a pulse on a digital output signal.

Basic examples

Basic examples of the instruction `PulseDO` are illustrated below.

Example 1

```
PulseDO do15;
```

A pulse with a pulse length of 0.2 s is generated on the output signal `do15`.

Example 2

```
PulseDO \PLength:=1.0, ignition;
```

A pulse of length `1.0` s is generated on the signal `ignition`.

Example 3

```
! Program task MAIN
PulseDO \High, do3;
! At almost the same time in program task BCK1
PulseDO \High, do3;
```

Positive pulse (value 1) is generated on the signal `do3` from two program tasks at almost the same time. It will result in one positive pulse with a pulse length longer than the default 0.2 s or two positive pulses after each other with a pulse length of 0.2 s.

Arguments

```
PulseDO [ \High ] [ \PLength ] Signal
```

`[ \High ]`

High level

Data type: `switch`

Specifies that the signal value should always be set to high (value 1) when the instruction is executed independently of its current state.

`[ \PLength ]`

Pulse Length

Data type: `num`

The length of the pulse in seconds (0.001 - 2000 s). If the argument is omitted a 0.2 second pulse is generated.

`Signal`

Data type: `signaldo`

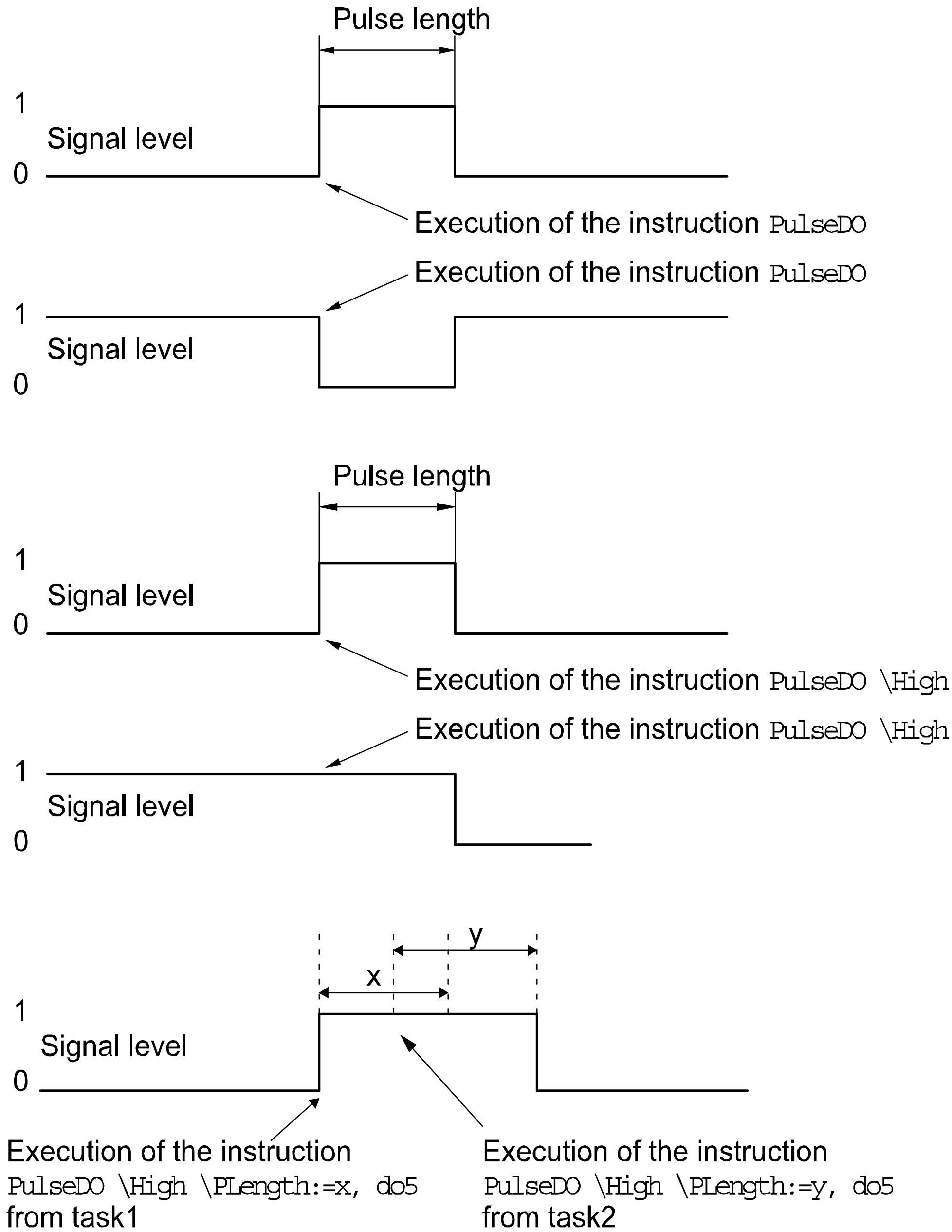
The name of the signal on which a pulse is to be generated.

Continues on next page

Program execution

The next instruction after `PulseDO` is executed directly after the pulse starts. The pulse can then be set/reset without affecting the rest of the program execution.

The figure below shows examples of generation of pulses on a digital output signal.



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The next instruction is executed directly after the pulse starts. The pulse can then be set/reset without affecting the rest of the program execution.

Limitations

The length of the pulse has a resolution off 0.001 seconds. Programmed values that differ from this are rounded off.

Continues on next page

Error handling

Following a recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the unit.

Syntax

```
PulseDO
  [ '\'High]
  [ '\'PLength' :=' < expression (IN) of num >] ´,'
  [ Signal ':=' ] < variable (VAR) of signaldo > ';'
```

Related information

For information about	See
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Input and output signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - I/O principles*
Configuration of I/O	*Technical reference manual - System parameters*

1.119. RAISE - Calls an error handler

Usage

`RAISE` is used to create an error in the program and then to call the error handler of the routine.

`RAISE` can also be used in the error handler to propagate the current error to the error handler of the calling routine.

This instruction can, for example, be used to jump back to a higher level in the structure of the program, e.g. to the error handler in the main routine if an error occurs at a lower level.

Basic examples

Basic examples of the instruction RAISE are illustrated below.

See also *More examples on page 335*.

Example 1

```
MODULE MainModule .
VAR errnum ERR_MY_ERR := -1;

PROC main()
  BookErrNo ERR_MY_ERR;

  IF di1 = 0 THEN
     RAISE ERR_MY_ERR;
  ENDIF

ERROR
  IF ERRNO = ERR_MY_ERR THEN
     TPWrite "di1 equals 0";
  ENDIF

ENDPROC

ENDMODULE
```

For this implementation `di1` equals `0` is regarded as an error. `RAISE` will force the execution to the error handler. In this example the user has created his own error number to handle the specific error. `BookErrNo` belongs to the base functionality *Advanced RAPID*.

Continues on next page

Arguments

```
RAISE [ Error no. ]
```

`Error no.`

Data type: `errnum`

Error number: Any number between 1 and 90 which the error handler can use to locate the error that has occurred (the `ERRNO` system variable).

It is also possible to book an error number outside the range 1-90 with the instruction `BookErrNo`.

The error number must be specified outside the error handler in a RAISE instruction in order to be able to transfer execution to the error handler of that routine.

If the instruction is present in a routine's error handler then the error is propagated to the error handler of the calling routine. In this case the error number does not have to be specified.

More examples

More examples of the instruction RAISE are illustrated below.

Example 1

```
MODULE MainModule
VAR num value1 := 10;
VAR num value2 := 0;

PROC main()
  routine1;

ERROR
  IF ERRNO = ERR_DIVZERO THEN
     value2 := 1;
     RETRY;
  ENDIF
ENDPROC

PROC routine1()
  value1 := 5/value2;!This will lead to an error when value2 is
        equal to 0.
ERROR
  RAISE;
ENDPROC

ENDMODULE
```

In this example the division with zero will result in an error. In the `ERROR`-handler `RAISE` will propagate the error to the ERROR-handler in the calling routine "main". The same error number remains active. `RETRY` will re-run the whole routine "routine1".

Continues on next page

Program execution

Program execution continues in the routine's error handler. After the error handler has been executed the program execution can continue with:

- the routine that called the routine in question (RETURN).
- the error handler of the routine that called the routine in question (RAISE).

A RAISE instruction in a routine's error handler also has another feature. It can be used for long jump (see“ Error Recovery With Long Jump”). With a long jump it is possible to propagate an error from an error handler from a deep nested call chain to a higher level in one step.

If the RAISE instruction is present in a trap routine, the error is dealt with by the system's error handler.

Error handling

If the error number is out of range then the system variable ERRNO is set to ERR_ILLRAISE (see "Data types - errnum"). This error can be handled in the error handler.

Syntax

```
(EBNF)
RAISE [<error number>] ';'

<error number> ::= <expression>
```

Related information

For information about	See
Error handling	*Technical reference manual - System parameters*, section *Basic Characteristics - Error Recovery*
Error recovery with long jump	*Technical reference manual - System parameters*, section *Basic Characteristics - Error Recovery*
Booking error numbers	*BookErrNo - Book a RAPID system error number on page 30*

1.120. RaiseToUser - Propagates an error to user level

Usage

`RaiseToUser` is used in an error handler in nostepin routines to propagate the current error or any other defined error to the error handler at user level. User level is in this case the first routine in a call chain above a nostepin routine.

Basic examples

Basic examples of the instruction RaiseToUser are illustrated below.

Example 1

```
MODULE MyModule
  VAR errnum ERR_MYDIVZERO:= -1;
  PROC main()

       BookErrNo ERR_MYDIVZERO;
       ...
       routine1;
       ...
       ERROR
       IF ERRNO = ERR_MYDIVZERO THEN
          TRYNEXT;
       ELSE
          RETRY;
       ENDIF
  ENDPROC
ENDMODULE

MODULE MySysModule (SYSMODULE, NOSTEPIN, VIEWONLY)
  PROC routine1()
     ...
     routine2;
     ...
  UNDO
  ! Free allocated resources
  ENDPROC

  PROC routine2()
     VAR num n:=0;
     ...
     reg1:=reg2/n;
     ...
     ERROR
     IF ERRNO = ERR_DIVZERO THEN
        RaiseToUser \Continue \ErrorNumber:=ERR_MYDIVZERO;
```


Continues on next page

```
        ELSE
          RaiseToUser \BreakOff;
        ENDIF
      ENDPROC
    ENDMODULE
```

The division by zero in `routine2` will propagate up to the error handler in main routine with the errno set to `ERR_MYDIVZERO`. The `TRYNEXT` instruction in main error handler will then cause the program execution to continue with the instruction after the division by zero in `routine2`. The \Continue switch controls this behavior.

If any other errors occur in `routine2` then the \BreakOff switch forces the execution to continue from the error handler in the main routine. In this case the undo handler in routine1 will be executed while raising it to user level. The RETRY instruction in the error handler in the main routine will execute routine1 from the beginning once again.

The undo handler in routine1 will also be executed in the \Continue case if a following `RAISE` or `RETURN` is done on the user level.

Arguments

```
RaiseToUser[ \Continue] | [ \BreakOff][ \ErrorNumber]
```

`[\Continue]`

Data type: `switch`

Continue the execution in the routine that caused the error.

`[\BreakOff]`

Data type:`switch`

Break off the call chain and continue the execution at the user level. Any undo handler in the call chain will be executed apart from the undo handler in the routine that raised the error.

One of the arguments `\Continue` or `\BreakOff` must be programmed to avoid an execution error.

`[\ErrorNumber]`

Data type: `errnum`

Any number between 1 and 90 that the error handler can use to locate the error that has occurred (the `ERRNO` system variable).

It is also possible to book an error number outside the range 1-90 with the instruction `BookErrNo`.

If the argument `\ErrorNumber` is not specified then the original error number propagates to the error handler in the routine at user level.

Continues on next page

Program execution

`RaiseToUser` can only be used in an error handler in a nostepin routine.

Program execution continues in the error handler of the routine at user level. The error number remains active if the optional parameter `\ErrorNumber` is not present. The system's error handler deals with the error if there is no error handler on user level. The system's error handler is called if none of the argument `\Continue` or `\BreakOff` is specified.

There are two different behaviors after the error handler has been executed. The program execution continues in the routine with `RaiseToUser` if the `\Continue` switch is on. The program execution continues at the user level if the `\BreakOff` switch is on.

Program execution can continue with:

- the instruction that caused the error (`RETRY`)
- the following instruction (`TRYNEXT`)
- the error handler of the routine that called the routine at user level (`RAISE`)
- the routine that called the routine at user level (`RETURN`)

Error handling

If the error number is out of range then the system variable `ERRNO` is set to `ERR_ILLRAISE` (see "Data types - errnum"). The system's error handler deals with this error.

Syntax

```
RaiseToUser
  [ '\'Continue ]
  ´|' [ '\'BreakOff ]
  [ '\'ErrorNumber' :=' ] < expression (IN) of errnum>';'
```

Related information

For information about	See
Error handling	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Error Recovery*
Undo handling	*Technical reference manual - RAPID overview*, section *Basic Characteristics - UNDO*
Booking error numbers	*BookErrNo - Book a RAPID system error number on page 30*

1.121. ReadAnyBin - Read data from a binary serial channel or file

Usage

`ReadAnyBin` (*Read Any Binary*) is used to read any type of data from a binary serial channel or file.

Basic examples

Basic examples of the instruction `ReadAnyBin` are illustrated below.

See also *More examples on page 341*.

Example 1

```
VAR iodev channel2;
VAR robtarget next_target;
...
Open "com2:", channel2 \Bin;
ReadAnyBin channel2, next_target;
```

The next robot target to be executed, `next_target`, is read from the channel referred to by `channel2`.

Arguments

```
ReadAnyBin IODevice Data [\Time]
```

`IODevice`

Data type: `iodev`

The name (reference) of the binary serial channel or file to be read.

`Data`

Data type: `ANYTYPE`

The `VAR` or `PERS` to which the read data will be stored.

`[\Time]`

Data type: `num`

The max. time for the reading operation (timeout) in seconds. If this argument is not specified then the max. time is set to 60 seconds. To wait forever, use the predefined constant `WAIT_MAX`.

If this time runs out before the read operation is finished then the error handler will be called with the error code `ERR_DEV_MAXTIME`. If there is no error handler then the execution will be stopped.

The timeout function is also in use during program stop and will be noticed by the RAPID program at program start.

Program execution

As many bytes as are required for the specified data are read from the specified binary serial channel or file.

Continues on next page

More examples

More examples of the instruction `ReadAnyBin` are illustrated below.

Example 1

```
CONST num NEW_ROBT:=12;
CONST num NEW_WOBJ:=20;
VAR iodev channel;
VAR num input;
VAR robtarget cur_robt;
VAR wobjdata cur_wobj;

Open "com2:", channel\Bin;

! Wait for the opcode character
input := ReadBin (channel \Time:= 0.1);
TEST input
CASE NEW_ROBT:
  ReadAnyBin channel, cur_robt;
CASE NEW_WOBJ:
  ReadAnyBin channel, cur_wobj;
ENDTEST
Close channel;
```

As a first step the `opcode` of the message is read from the serial channel. According to this `opcode` a `robtarget` or a `wobjdata` is read from the serial channel.

Error handling

If an error occurs during reading then the system variable `ERRNO` is set to `ERR_FILEACC`.

If timeout before the read operation is finished then the system variable `ERRNO` is set to `ERR_DEV_MAXTIME`.

If there is a checksum error in the data read then the system variable `ERRNO` is set to `ERR_RANYBIN_CHK`.

If the end of the file is detected before all the bytes are read then the system variable `ERRNO` is set to `ERR_RANYBIN_EOF`.

These errors can then be dealt with by the error handler.

Limitations

This instruction can only be used for serial channels or files that have been opened for binary reading.

The data to be read by this instruction `ReadAnyBin` must be a value data type such as `num`, `bool`, or `string`. Record, record component, array, or array element of these value data types can also be used. Entire data or partial data with semi-value or non-value data types cannot be used.

NOTE!

The `VAR` or `PERS` variable, for storage of the read data, can be updated in several steps. Therefore, always wait until the whole data structure is updated before using read data from a `TRAP` or another program task.

Continues on next page

Because `WriteAnyBin-ReadAnyBin` are designed to only handle internal binary controller data with serial channel or files between or within `IRC5` control systems, no data protocol is released and the data cannot be interpreted on any `PC`.

Control software development can break the compatibility so it is not possible to use `WriteAnyBin-ReadAnyBin` between different software versions of RobotWare. If a `WriteAnyBin` to file is done with RobotWare version 5.07, the file cannot be read by instruction `ReadAnyBin` with RobotWare version 5.08. And the opposite case, if a `WriteAnyBin` to file is done with RobotWare version 5.08, the file cannot be read by instruction `ReadAnyBin` with RobotWare version 5.07.

Version 0 for IRC5 controller software equal or less than `RW5.07`

Version 1 for IRC5 controller software equal or greater than `RW5.08`

Always compatible within all revisions of any software versions.

Syntax

```
ReadAnyBin
  [IODevice':='] <variable (VAR) of iodev>','
  [Data':='] <var or pers (INOUT) of ANYTYPE>
  ['\'Time':=' <expression (IN) of num>]';'
```

Related information

For information about	See
Opening, etc. of serial channels or files	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*
Write data to a binary serial channel or file	*WriteAnyBin - Writes data to a binary serial channel or file on page 713*

1.122. ReadBlock - read a block of data from device

Usage

`ReadBlock` is used to read a block of data from a device connected to the serial sensor interface. *The data is stored in a file.*

The sensor interface communicates with two sensors over serial channels using the RTP1 transport protocol.

This is an example of a sensor channel configuration.

COM_PHY_CHANNEL:

- Name “COM1:”
- Connector “COM1”
- Baudrate 19200

COM_TRP:

- Name “sen1:”
- Type “RTP1”
- PhyChannel “COM1”

Basic examples

Basic examples of the instruction `ReadBlock` are illustrated below.

Example 1

```
CONST string SensorPar := "flp1:senpar.cfg";
CONST num ParBlock:= 1;

! Connect to the sensor device "sen1:" (defined in sio.cfg).
SenDevice "sen1:";

! Read sensor parameters from sensor datablock 1
! and store on flp1:senpar.cfg

ReadBlock "sen1:", ParBlock, SensorPar;
```

Arguments

```
ReadBlock device BlockNo FileName [ \TaskName ]
```

`device`

Data type: string

The I/O device name configured in sio.cfg for the sensor used.

`BlockNo`

Data type: `num`

The argument `BlockNo` is used to select the data block in the sensor to be read.

Continues on next page

`FileName`

Data type: `string`

The argument `FileName` is used to define a file to which data is written from the data block in the sensor selected by the `BlockNo` argument.

`[ \TaskName ]`

Data type: `string`

The argument `TaskName` makes it possible to access devices in other RAPID tasks.

Fault management

Error constant (ERRNO value)	Description
SEN_NO_MEAS	Measurement failure
SEN_NOREADY	Sensor unable to handle command
SEN_GENERRO	General sensor error
SEN_BUSY	Sensor busy
SEN_UNKNOWN	Unknown sensor
SEN_EXALARM	External sensor error
SEN_CAALARM	Internal sensor error
SEN_TEMP	Sensor temperature error
SEN_VALUE	Illegal communication value
SEN_CAMCHECK	Sensor check failure
SEN_TIMEOUT	Communication error

Syntax

```
ReadBlock
  [ device ':=' ] < expression(IN) of string>','
  [ BlockNo' :=' ] < expression (IN) of num > ','
  [ FileName' :=' ] < expression (IN) of string > ','
  [ '\' TaskName' :=' < expression (IN) of string > ] ';'
```

Related information

For information about	See
Connect to a sensor device	*SenDevice - connect to a sensor device on page 425*
Write a sensor variable	*WriteVar - write variable on page 729*
Read a sensor variable	*ReadVar - Read variable from a device on page 958*
Write a sensor data block	*WriteBlock - write block of data to device on page 719*
Configuration of sensor communication	*Technical reference manual - System parameters*, section *Communication*

1.123. ReadCfgData - Reads attribute of a system parameter

Usage

`ReadCfgData` is used to read one attribute of a system parameter (configuration data).

Besides to reading named parameters it is also possible to search for unnamed parameters.

Basic examples

Basic examples of the instruction `ReadCfgData` are illustrated below. Both of these examples show how to read named parameters.

Example 1

```
VAR num offset1;
...
ReadCfgData "/MOC/MOTOR_CALIB/rob1_1","cal_offset",offset1;
```

Reads the value of the calibration offset for axis `1` for `rob_1` into the `num` variable `offset1`.

Example 2

```
VAR string io_unit;
...
ReadCfgData "/EIO/EIO_SIGNAL/process_error","Unit",io_unit;
```

Reads the name of the I/O unit where the signal `process_error` is defined into the `string` variable `io_unit`.

Arguments

```
ReadCfgData InstancePath Attribute CfgData [\ListNo]
```

`InstancePath`

Data type: `string`

Specifies a path to the parameter to be accessed.

For named parameters the format of this string is `/DOMAIN/TYPE/ParameterName`.

For unnamed parameters the format of this string is `/DOMAIN/TYPE/Attribute/AttributeValue`.

`Attribute`

Data type: `string`

The name of the attribute of the parameter to be read.

`CfgData`

Data type: `any type`

The variable where the attribute value will be stored. Depending on the attribute type the valid types are `bool`, `num`, or `string`.

Continues on next page

`[\ListNo]`

Data type: `num`

Variable holding the instance number of the `Attribute + AttributeValue` to be found.

First occurrence of the `Attribute + AttributeValue` has an instance number 0. If more instances are searched for then the returned value in `\ListNo` will be incremented with 1. Otherwise, if there are no more instances then the returned value will be -1. The predefined constant `END_OF_LIST` can be used to check if more instances are to be search for.

Program execution

The value of the attribute specified by the `Attribute` argument is stored in the variable specified by the `CfgData` argument.

If using format `/DOMAIN/TYPE/ParameterName` in `InstancePath`, only named parameters can be accessed, i.e. parameters where the first attribute is `name`, `Name`, or `NAME`.

For unnamed parameters use the optional parameter `\ListNo` to selects from which instance to read the attribute value. It is updated after each successful read to the next available instance.

More examples

More examples of the instruction `ReadCfgdata` are illustrated below. Both these examples show how to read unnamed parameters.

Example 1

```
VAR num list_index;
VAR string read_str;
...
list_index:=0;
ReadCfgData "/EIO/EIO_CROSS/Act1/do_13", "Res", read_str,
     \ListNo:=list_index;
TPWrite "Resultant signal for signal do_13 is: " + read_str;
```

Reads the resultant signal for the unnamed digital actor signal `di_13` and places the name in the `string` variable `read_str`.

In this example domain EIO has the following cfg code:

EIO_CROSS:

-Res "di_1" -Act1 "do_2"

-Res "di_2" -Act1 "do_2"

-Res "di_13" -Act1 "do_13"

Continues on next page

Example 2

```
VAR num list_index;
VAR string read_str;
...
list_index:=0;
WHILE list_index <> END_OF_LIST DO
  ReadCfgData "/EIO/EIO_SIGNAL/Unit/USERIO", "Name", read_str,
       \ListNo:=list_index;
  IF list_index <> END_OF_LIST THEN
    TPWrite "Signal: " + read_str;
  ENDIF
ENDWHILE
```

Read the names of all signals defined for the I/O unit `USERIO`.

In this example domain EIO has the following cfg code:

EIO_SIGNAL:

-Name "USERDO1" -SignalType "DO" -Unit "USERIO" -UnitMap "0"

-Name "USERDO2" -SignalType "DO" -Unit "USERIO" -UnitMap "1"

-Name "USERDO3" -SignalType "DO" -Unit "USERIO" -UnitMap "2"

Error handling

If it is not possible to find the data specified with "`InstancePath + Attribute`" in the configuration database then the system variable `ERRNO` is set to `ERR_CFG_NOTFND`.

If the data type for parameter `CfgData` is not equal to the real data type for the found data specified with"`InstancePath + Attribute`" in the configuration database then the system variable `ERRNO` is set to `ERR_CFG_ILLTYPE`.

If trying to read internal data then the system variable `ERRNO` is set to `ERR_CFG_INTERNAL`.

If variable in argument `\ListNo` has a value outside range of available instances (0 ... n) when executing the instruction then `ERRNO` is set to `ERR_CFG_OUTOFBOUNDS`.

These errors can then be handled in the error handler.

Limitations

The conversion from system parameter units (m, radian, second, etc.) to RAPID program units (mm, degree, second, etc.) for `CfgData` of data type `num` must be done by the user in the RAPID program.

If using format `/DOMAIN/TYPE/ParameterName` in `InstancePath` then only named parameters can be accessed, i.e. parameters where the first attribute is `name`, `Name`, or `NAME`.

RAPID strings are limited to 80 characters. In some cases this can be in theory too small for the definition `InstancePath`, `Attribute` or `CfgData`.

Predefined data

The predefined constant `END_OF_LIST` with value -1 can be used to stop reading when no more instances can be found.

Continues on next page

Syntax

```
ReadCfgData
  [ InstancePath ':=' ] < expression (IN) of string >','
  [ Attribute' :=' ] < expression (IN) of string >','
  [ CfgData' :=' ] < variable (VAR) of anytype >
  ['\'ListNo':=' < variable (VAR) of num >]';'
```

Related information

For information about	See
Definition of string	*string - Strings on page 1195*
Write attribute of a system parameter	*WriteCfgData - Writes attribute of a system parameter on page 721*
Get robot name in current task	*RobName - Get the TCP robot name on page 966*
Configuration	*Technical reference manual - System parameters*

1.124. ReadErrData - Gets information about an error

Usage

`ReadErrData` is to be used in a trap routine, to get information (domain, type, number and intermixed strings %s etc.) about an error, a state change, or a warning that caused the trap routine to be executed.

Basic examples

Basic examples of the instruction `ReadErrData` are illustrated below.

See also *More examples on page 350*

Example 1

```
VAR errdomain err_domain;
VAR num err_number;
VAR errtype err_type;
VAR trapdata err_data;
VAR string string1;
VAR string string2;
...
TRAP trap_err
  GetTrapData err_data;
  ReadErrData err_data, err_domain, err_number,
  err_type \Str1:=string1 \Str2:=string2;
ENDTRAP
```

When an error is trapped to the trap routine `trap_err` the error domain, the error number, the error type, and the two first intermixed strings in the error message are saved into appropriate variables.

Arguments

```
ReadErrData TrapEvent ErrorDomain ErrorId ErrorType
     [\Str1] [\Str2] [\Str3] [\Str4] [\Str5]
```

`TrapEvent`

Data type: `trapdata`

Variable containing the information about what caused the trap to be executed.

`ErrorDomain`

Data type: `errdomain`

Variable to store the error domain to which the error, state change, or warning that occurred belongs. Ref. to predefined data of type `errdomain`.

`ErrorId`

Data type: `num`

Variable to store the number of the error that occurred. The error number is returned without the first digit (error domain) and without the initial zeros of the complete error number.

E.g. 10008 Program restarted is returned as 8.

Continues on next page

`ErrorType`

Data type: `errtype`

Variable to store the type of event such as error, state change, or warning that occurred. Ref. to predefined data of type `errtype`.

`[ \Str1 ] ... [ \Str5 ]`

Data type: `string`

Update the specified string variable with argument that is intermixed in the error message. There could be up to five arguments in a message of type %s, %f, %d or %ld, which always will be converted to a string at execution of this instruction. `Str1` will hold the first argument, `Str2` will hold the second argument, and so on. Information about how many arguments there are in a message is found in *Operating manual - Trouble shooting*. The intermixed arguments is marked as arg in that document.

Program execution

The `ErrorDomain`, `ErrorId`, `ErrorType` and `Str1 ... Str5` variables are updated according to the contents of `TrapEvent`.

If different events are connected to the same trap routine then the program must make sure that the event is related to error monitoring. This can be done by testing that `INTNO` matches the interrupt number used in the instruction `IError`;

More examples

More examples of the instruction `ReadErrData` are illustrated below.

Example 1

```
VAR intnum err_interrupt;
VAR trapdata err_data;
VAR errdomain err_domain;
VAR num err_number;
VAR errtype err_type;
...
CONNECT err_interrupt WITH trap_err;
IError COMMON_ERR, TYPE_ERR, err_interupt;
...
IDelete err_interrupt;
...
TRAP trap_err
  GetTrapData err_data;
  ReadErrData err_data, err_domain, err_number, err_type;
  ! Set domain no 1 ... 11
  SetGO go_err1, err_domain;
  ! Set error no 1 ...9999
  SetGO go_err2, err_number;
ENDTRAP
```

When an error occurs (only errors, not warning or state change) the error number is retrieved in the trap routine and its value is used to set 2 groups of digital output signals.

Continues on next page

Limitation

It is not possible obtain information about internal errors.

Syntax

```
ReadErrData
  [TrapEvent ':='] <variable (VAR) of trapdata>','
  [ErrorDomain' :='] <variable (VAR) of errdomain>','
  [ErrorId':='] <variable (VAR) of num>','
  [ErrorType' :='] <variable (VAR) of errtype>
  ['\'Str1 ´:='<variable (VAR) of string>]
  ['\'Str2 ´:='<variable (VAR) of string>]
  ['\'Str3 ´:='<variable (VAR) of string>]
  ['\'Str4 ´:='<variable (VAR) of string>]
  ['\'Str5 ´:='<variable (VAR) of string>]';'
```

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupts*
More information on interrupt management	*Technical reference manual - RAPID overview*, section *Basic characteristics - Interrupts*
Error domains, predefined constants	*errdomain - Error domain on page 1106*
Error types, predefined constants	*errtype - Error type on page 1115*
Orders an interrupt on errors	*IError - Orders an interrupt on errors on page 126*
Get interrupt data for current TRAP	*GetTrapData - Get interrupt data for current TRAP on page 115*

1.125. ReadRawBytes - Read rawbytes data

Usage

`ReadRawBytes` is used to read data of type `rawbytes` from a device opened with `Open\Bin`.

Basic examples

Basic examples of the instruction `ReadRawBytes` are illustrated below.

Example 1

```
VAR iodev io_device;
VAR rawbytes raw_data_out;
VAR rawbytes raw_data_in;
VAR num float := 0.2;
VAR string answer;

ClearRawBytes raw_data_out;
PackDNHeader "10", "20 1D 24 01 30 64", raw_data_out;
PackRawBytes float, raw_data_out, (RawBytesLen(raw_data_out)+1)
     \Float4;

Open "/FC1:/dsqc328_1", io_device \Bin;
WriteRawBytes io_device, raw_data_out;
ReadRawBytes io_device, raw_data_in \Time:=1;
Close io_device;
UnpackRawBytes raw_data_in, 1, answer \ASCII:=10;
```

In this example `raw_data_out` is cleared and then packed with DeviceNet header and a float with value `0.2`.

A device, `"/FC1:/dsqc328_1"`, is opened and the current valid data in `raw_data_out` is written to the device. Then the program waits for at most `1` second to read from the device, which is stored in the `raw_data_in`.

After having closed the device `"/FC1:/dsqc328_1"`, the read data is unpacked as a string of characters and stored in `answer`.

Arguments

```
ReadRawBytes IODevice RawData [\Time]
```

`IODevice`

Data type: `iodev`

`IODevice` is the identifier of the device from which data shall be read.

`RawData`

Data type: `rawbytes`

`RawData` is the data container that stores read data from `IODevice` starting at index 1.

Continues on next page

`[\Time]`

Data type: `num`

The max. time for the reading operation (timeout) in seconds (resolution 0,001s). If this argument is not specified then the max. time is set to 60 seconds. To wait forever, use the predefined constant `WAIT_MAX`.

If this time runs out before the reading operation is finished then the error handler will be called with the error code `ERR_DEV_MAXTIME`. If there is no error handler then the execution will be stopped.

The timeout function is also in use during program stop and will be noticed by the RAPID program at program start.

Program execution

During program execution the data is read from the device indicated by `IODevice`.

If using `WriteRawBytes` for field bus commands such as DeviceNet then the field bus always sends an answer. The answer must be handled in RAPID with the `ReadRawBytes` instruction.

The current length of valid bytes in the `RawData` variable is set to the read number of bytes. The data starts at index 1 in `RawData`.

Error handling

If an error occurs during reading then the system variable `ERRNO` is set to `ERR_FILEACC`.

If time out before the read operation is finished then nothing in the variable `RawData` is affected, and the system variable `ERRNO` is set to `ERR_DEV_MAXTIME`.

These errors can then be dealt with by the error handler.

Syntax

```
ReadRawBytes
  [IODevice ':=' ] < variable (VAR) of iodev>' ,'
  [RawData ':=' ] < variable (VAR) of rawbytes> ','
  [ '\' Time ´:=' < expression (IN) of num>] ';'
```

Related information

For information about	See
`rawbytes` data	*rawbytes - Raw data on page 1165*
Get the length of `rawbytes` data	*RawBytesLen - Get the length of rawbytes data on page 940*
Clear the contents of `rawbytes` data	*ClearRawBytes - Clear the contents of rawbytes data on page 49*
Copy the contents of `rawbytes` data	*CopyRawBytes - Copy the contents of rawbytes data on page 67*
Pack DeviceNet header into `rawbytes` data	*PackDNHeader - Pack DeviceNet Header into rawbytes data on page 287*
Pack data into `rawbytes` data	*PackRawBytes - Pack data into rawbytes data on page 290*
Write `rawbytes` data	*WriteRawBytes - Write rawbytes data on page 725*

Continues on next page

For information about	See
Unpack data from `rawbytes` data	*UnpackRawBytes - Unpack data from rawbytes data on page 658*

1.126. RemoveDir - Delete a directory

Usage

`RemoveDir` is used to remove a directory.

The user must have write and execute permission for the directory and the directory must be empty.

Basic examples

Basic examples of the instruction `RemoveDir` are illustrated below.

Example 1

```
RemoveDir "HOME:/mydir";
```

In this example the `mydir` directory under `HOME:` is deleted.

Arguments

```
RemoveDir Path
```

`Path`

Data type: `string`

The name of the directory to be removed, specified with full or relative path.

Error handling

If the directory does not exist, or the directory is not empty, or the user does not have write and execute permission to the library then the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

Syntax

```
RemoveDir
[ Path':=' ] < expression (IN) of string>';'
```

Related information

For information about	See
Directory	*dir - File directory structure on page 1103*
Open a directory	*OpenDir - Open a directory on page 285*
Read a directory	*ReadDir - Read next entry in a directory on page 944*
Close a directory	*CloseDir - Close a directory on page 56*
Make a directory	*MakeDir - Create a new directory on page 218*
Rename a file	*RenameFile - Rename a file on page 357*
Remove a file	*RemoveFile - Delete a file on page 356*
Copy a file	*CopyFile - Copy a file on page 65*
Check file type	*IsFile - Check the type of a file on page 878*
Check file size	*FileSize - Retrieve the size of a file on page 842*
Check file system size	*FSSize - Retrieve the size of a file system on page 848*

1.127. RemoveFile - Delete a file

Usage

`RemoveFile` is used to remove a file. The user must have write and execute permission for the directory where the file resides and the user must have write permission for the file itself.

Basic examples

Basic examples of the instruction `RemoveFile` are illustrated below.

Example 1

```
RemoveFile "HOME:/mydir/myfile.log";
```

In this example the file `myfile.log` in directory `mydir` on disk `HOME:` is deleted.

Arguments

```
RemoveFile Path
```

`Path`

Data type: string

The name of the file to be deleted, specified with full or relative path.

Error handling

If the file does not exist then the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

Syntax

```
RemoveFile
[ Path':=' ] < expression (IN) of string>';'
```

Related information

For information about	See
Make a directory	*MakeDir - Create a new directory on page 218*
Remove a directory	*RemoveDir - Delete a directory on page 355*
Rename a file	*RenameFile - Rename a file on page 357*
Copy a file	*CopyFile - Copy a file on page 65*
Check file type	*IsFile - Check the type of a file on page 878*
Check file size	*FileSize - Retrieve the size of a file on page 842*
Check file system size	*FSSize - Retrieve the size of a file system on page 848*

1.128. RenameFile - Rename a file

Usage

`RenameFile` is used to give a new name to an existing file. It can also be used to move a file from one place to another in the directory structure.

Basic examples

Basic examples of the instruction `RenameFile` are illustrated below.

Example 1

```
RenameFile "HOME:/myfile", "HOME:/yourfile;
```

The file `myfile` is given the name `yourfile`.

```
RenameFile "HOME:/myfile", "HOME:/mydir/yourfile";
```

The file `myfile` is given the name `yourfile` and is moved to the directory `mydir`.

Arguments

```
RenameFile OldPath NewPath
```

`OldPath`

Data type: `string`

The complete path of the file to be renamed.

`NewPath`

Data type: `string`

The complete path of the renamed file.

Program execution

The file specified in `OldPath` will be given the name specified in `NewPath`. If the path in `NewPath` is different from the path in `OldPath` then the file will also be moved to the new location.

Error Handling

If the file specified in `NewPath` already exists then the system variable `ERRNO` is set to `ERR_FILEEXIST`. This error can then be handled in the error handler.

Syntax

```
RenameFile
[ OldPath' :=' ] < expression (IN) of string > ','
[ NewPath' :=' ] < expression (IN) of string >';'
```


Continues on next page

Related information

For information about	See
Make a directory	*MakeDir - Create a new directory on page 218*
Remove a directory	*RemoveDir - Delete a directory on page 355*
Remove a file	*RemoveFile - Delete a file on page 356*
Copy a file	*CopyFile - Copy a file on page 65*
Check file type	*IsFile - Check the type of a file on page 878*
Check file size	*FileSize - Retrieve the size of a file on page 842*
Check file system size	*FSSize - Retrieve the size of a file system on page 848*

1.129. Reset - Resets a digital output signal

Usage

`Reset` is used to reset the value of a digital output signal to zero.

Basic examples

Basic examples of the instruction `Reset` are illustrated below.

Example 1

```
Reset do15;
```

The signal `do15` is set to 0.

Example 2

```
Reset weld;
```

The signal `weld` is set to 0.

Arguments

```
Reset Signal
```

`Signal`

Data type: `signaldo`

The name of the signal to be reset to zero.

Program execution

The true value depends on the configuration of the signal. If the signal is inverted in the system parameters then this instruction causes the physical channel to be set to 1.

Error handling

The following recoverable error can be generated. The error can be handled in an error handler. The system variable ERRNO will be set to:

`ERR_NORUNUNIT` if there is no contact with the unit.

Syntax

```
Reset
  [ Signal ':=' ] < variable (VAR) of signaldo > ';'
```

Related information

For information about	See
Setting a digital output signal	*Set - Sets a digital output signal on page 427*
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Input and output signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - I/O principles*
Configuration of I/O	*Technical reference manual - System parameters*

1.130. ResetPPMoved - Reset state for the program pointer moved in manual mode

Usage

`ResetPPMoved` reset state for the program pointer moved in manual mode.

`PPMovedInManMode` returns TRUE if the user has moved the program pointer while the controller is in manual mode - that is, the operator key is at Man Reduced Speed or Man Full Speed. The program pointer moved state is reset when the key is switched from Auto to Man, or when using the instruction `ResetPPMoved`.

Basic examples

Basic example of the instruction `ResetPPMoved` is illustrated below.

Example 1

```
IF PPMovedInManMode() THEN
  WarnUserOfPPMovement;
  ! DO THIS ONLY ONCE
  ResetPPMoved;
  DoJob;
ELSE
  DoJob;
ENDIF
```

Program execution

Resets state for the program pointer moved in manual mode for current program task.

Syntax

```
ResetPPMoved';'
```

Related information

For information about	See
Test whether program pointer has been moved in manual mode	*PPMovedInManMode - Test whether the program pointer is moved in manual mode on page 936*

1.131. ResetRetryCount - Reset the number of retries

Usage

`ResetRetryCount` is used to reset the number of retries that has been done from an error handler. The maximum number of retries that can be done is defined in the configuration.

Basic examples

Basic examples of the instruction `ResetRetryCount` are illustrated below.

Example 1

```
VAR num myretries := 0;
...
ERROR
  IF myretries > 2 THEN
    ResetRetryCount;
    myretries := 0;
    TRYNEXT;
  ENDIF
  myretries:= myretries + 1;
  RETRY;
...
```

This program will retry the faulty instruction 3 times and then try the next instruction. The internal system retry counter is reset before trying the next instruction (even if this is done by the system at `TRYNEXT`).

Program execution

For every RETRY made from an error handler an internal system counter will check that the maximum number of retries, specified in the configuration, isn't exceeded. Executing the instruction `ResetRetryCount` will reset the counter and make it possible to redo a maximum number of retries again.

Syntax

```
ResetRetryCount ';'
```

Related information

For information about	See
Error handlers	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Error Recovery*
Resume execution after an error	*RETRY - Resume execution after an error on page 364*
Configure maximum number of retries	*Technical reference manual - System parameters*, section *System Misc*
Number of remaining retries	*RemainingRetries - Remaining retries left to do on page 963*

1.132. RestoPath - Restores the path after an interrupt

Usage

`RestoPath` is used to restore a path that was stored at a previous stage using the instruction `StorePath`.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Basic examples

Basic examples of the instruction `RestoPath` are illustrated below.

See also *More examples* below.

Example 1

```
RestoPath;
```

Restores the path that was stored earlier using `StorePath`.

Program execution

The current movement path of the robot and the external axes are deleted and the path stored earlier using `StorePath` is restored. Note that nothing moves until the instruction `StartMove` is executed or a return is made using `RETRY` from an error handler.

More examples

More examples of how to use the instruction `RestoPath` are illustrated below.

Example 1

```
ArcL p100, v100, seam1, weld5 \Weave:=weave1, z10, gun1;
...
ERROR
  IF ERRNO=AW_WELD_ERR THEN
     gun_cleaning;
     StartMoveRetry;
  ENDIF
...
PROC gun_cleaning()
  VAR robtarget p1;
  StorePath;
  p1 := CRobT();
  MoveL pclean, v100, fine, gun1;
  ...
  MoveL p1, v100, fine, gun1;
  RestoPath;
ENDPROC
```

In the event of a welding error the program execution continues in the error handler of the routine which in turn calls `gun_cleaning`. The movement path being executed at the time is then stored and the robot moves to the position `pclean` where the error is rectified. When this has been done, the robot returns to the position where the error occurred, `p1`, and stores

Continues on next page

the original movement once again. The weld then automatically restarts, meaning that the robot is first reversed along the path before welding starts and ordinary program execution can continue.

Limitations

Only the movement path data is stored with the instruction `StorePath`. If the user wants to order movements on the new path level then the actual stop position must be stored directly after `StorePath` and before `RestoPath` make a movement to the stored stop position on the path.

If this instruction is preceded by a move instruction then that move instruction must be programmed with a stop point (zonedata `fine`), not a fly-by point, otherwise restart after power failure will not be possible.

`RestoPath` cannot be executed in a RAPID routine connected to any of following special system events: PowerOn, Stop, QStop, Restart or Step.

Syntax

```
RestoPath´;´
```

Related information

For information about	See
Storing paths	*StorePath - Stores the path when an interrupt occurs on page 521*
More examples	*StorePath - Stores the path when an interrupt occurs on page 521* *PathRecStart - Start the path recorder on page 308* *SyncMoveSuspend - Set independent-semicoordinated movements on page 543*

1.133. RETRY - Resume execution after an error

Usage

The `RETRY` instruction is used to resume program execution after an error starting with (re-executing) the instruction that caused the error.

Basic examples

Basic examples of the instruction RETRY are illustrated below.

Example 1

```
reg2 := reg3/reg4;
...
ERROR
  IF ERRNO = ERR_DIVZERO THEN
    reg4 :=1;
    RETRY;
  ENDIF
```

An attempt is made to divide `reg3` by reg4. If `reg4` is equal to 0 (division by zero) then a jump is made to the error handler, which initializes `reg4`. The `RETRY` instruction is then used to jump from the error handler and another attempt is made to complete the division.

Program execution

Program execution continues with (re-executes) the instruction that caused the error.

Error handling

If the maximum number of retries (4 retries) is exceeded then the program execution stops with an error message. The maximum number of retries can be configured in System Parameters (type *System Misc*).

Limitations

The instruction can only exist in a routine's error handler. If the error was created using a `RAISE` instruction then program execution cannot be restarted with a `RETRY` instruction. Then the instruction TRYNEXT should be used.

Syntax

```
RETRY ';'
```

Related information

For information about	See
Error handlers	Technical reference manual - RAPID overview, section *Basic Characteristics-Error Recovery*
Configure maximum number of retries	*Technical reference manual - System parameters*, section *System Misc*
Continue with the next instruction	*TRYNEXT - Jumps over an instruction which has caused an error on page 636*

1.134. RETURN - Finishes execution of a routine

Usage

`RETURN` is used to finish the execution of a routine. If the routine is a function then the function value is also returned.

Basic examples

Basic examples of the instruction `RETURN` are illustrated below.

Example 1

```
errormessage;
Set do1;
...
PROC errormessage()
  IF di1=1 THEN
    RETURN;
  ENDIF
  TPWrite "Error";
ENDPROC
```

The `errormessage` procedure is called. If the procedure arrives at the RETURN instruction then program execution returns to the instruction following the procedure call, `Set do 1`.

Example 2

```
FUNC num abs_value(num value)
  IF value<0 THEN
    RETURN -value;
  ELSE
    RETURN value;
  ENDIF
ENDFUNC
```

The function returns the absolute value of a number.

Arguments

```
RETURN [ Return value ]
```

`Return value`

Data type: According to the function declaration.

The return value of a function.

The return value must be specified in a `RETURN` instruction present in a function.

If the instruction is present in a procedure or trap routine then a return value shall not be specified.

Continues on next page

Program execution

The result of the `RETURN` instruction may vary depending on the type of routine it is used in:

- Main routine: If a program has run mode single cycle then the program stops. Otherwise, program execution continues with the first instruction of the main routine.
- Procedure: Program execution continues with the instruction following the procedure call.
- Function: Returns the value of the function.
- Trap routine: Program execution continues from where the interrupt occurred.
- Error handler in a procedure: Program execution continues with the routine that called the routine with the error handler (with the instruction following the procedure call).
- Error handler in a function: The function value is returned.

Syntax

```
(EBNF)
RETURN [ <expression> ]';'
```

Related information

For information about	See
Functions and Procedures	*Technical reference manual - RAPID overview*, section *Basic characteristics - Routines*
Trap routines	*Technical reference manual - RAPID overview*, section *Basic characteristics - Interrupts*
Error handlers	*Technical reference manual - RAPID overview*, section *Basic characteristics - Error recovery*

1.135. Rewind - Rewind file position

Usage

`Rewind` sets the file position to the beginning of the file.

Basic examples

Basic examples of the instruction `Rewind` are illustrated below.

See also *More examples on page 367*.

Example 1

```
Rewind iodev1;
```

The file referred to by `iodev1` will have the file position set to the beginning of the file.

Arguments

```
Rewind IODevice
```

`IODevice`

Data type: `iodev`

Name (reference) of the file to be rewound.

Program execution

The specified file is rewound to the beginning.

More examples

More examples of the instruction `Rewind` are illustrated below.

Example 1

```
! IO device and numeric variable for use together with a binary
! file
VAR iodev dev;
VAR num bindata;

! Open the binary file with \Write switch to erase old contents
Open "HOME:"\File := "bin_file",dev \Write;
Close dev;

! Open the binary file with \Bin switch for binary read and write
! acess
Open "HOME:"\File := "bin_file",dev \Bin;
WriteStrBin dev,"Hello world";

! Rewind the file pointer to the beginning of the binary file
! Read contents of the file and write the binary result on TP
! (gives 72 101 108 108 111 32 119 111 114 108 100 )
Rewind dev;
bindata := ReadBin(dev);
```

Continues on next page

```
WHILE bindata <> EOF_BIN DO
  TPWrite " " \Num:=bindata; bindata := ReadBin(dev);
ENDWHILE

! Close the binary file
Close dev;
```

The instruction `Rewind` is used to rewind a binary file to the beginning so that the contents of the file can be read back with `ReadBin`

Limitations

For the`Virtual Controller` there is a limitation, if the used file has been opened with a `\Bin` or `\Bin \Append` switch, a `Rewind` before any type of a`Write` instruction will be ineffective. The writing will be done at the end of the file.

Error handling

If an error occurs during the rewind then the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

Syntax

```
Rewind [IODevice ':='] <variable (VAR) of iodev>';'
```

Related information

For information about	See
Opening, etc. of files	*Technical reference manual - RAPID overview* , section *RAPID summary - Communication*

1.136. RMQEmptyQueue - Empty RAPID Message Queue

Usage

`RMQEmptyQueue` empties the RAPID Message Queue (RMQ) in the task that is executing the instruction.

Basic examples

A basic example of the instruction `RMQEmptyQueue` is illustrated below.

Example

```
RMQEmptyQueue;
```

The `RMQEmptyQueue` instruction removes all messages from RMQ in the executing task.

Program execution

The RAPID Message Queue owned by the executing task is emptied. The instruction can be used on all execution levels.

Limitations

`RMQEmptyQueue` only empties the RAPID Message Queue in the task that is executing the instruction. All other RAPID Message Queues are left as is.

Syntax

```
RMQEmptyQueue ';'
```

Related information

For information about	See
Description of the RAPID Message Queue functionality	*Application manual - Robot communication and I/O control*, section *RAPID Message Queue*.
`rmqmessage` data type	*rmqmessage - RAPID Message Queue message on page 1173*.
Send data to the queue of a RAPID task or Robot Application Builder client	*RMQSendMessage - Send an RMQ data message on page 386*.
Send data to the queue of a RAPID task or Robot Application Builder client, and wait for an answer from the client	*RMQSendWait - Send an RMQ data message and wait for a response on page 390*.
Find the identity number of a RAPID Message Queue task or Robot Application Builder client	*RMQFindSlot - Find a slot identity from the slot name on page 371*.
Extract the header data from an `rmqmessage`	*RMQGetMsgHeader - Get header information from an RMQ message on page 380*.
Extract the data from an `rmqmessage`	*RMQGetMsgData - Get the data part from an RMQ message on page 377*.
Order and enable interrupts for a specific data type	*IRMQMessage - Orders RMQ interrupts for a data type on page 167*.
Get the slot name from a specified slot identity	*RMQGetSlotName - Get the name of an RMQ client on page 964*.

Continues on next page

For information about	See
Receive message from RMQ	*RMQReadWait - Returns message from RMQ on page 383*.
Get the first message from a RAPID Message Queue	*RMQGetMessage - Get an RMQ message on page 373*.

1.137. RMQFindSlot - Find a slot identity from the slot name

Usage

`RMQFindSlot` (*RAPID Message Queue Find Slot*) is used to find the slot identity to an RMQ configured for a RAPID task, or the slot identity to a Robot Application Builder client.

Basic examples

Basic examples of the instruction `RMQFindSlot` name are illustrated below.

Example 1

```
VAR rmqslot myrmqslot;
RMQFindSlot myrmqslot, "RMQ_T_ROB2";
```

Get the identity number for the RMQ `"RMQ_T_ROB2"` configured for the RAPID task `"T_ROB2"`.

Arguments

```
RMQFindSlot Slot Name
```

`Slot`

Data type: `rmqslot`

The variable in which the numeric identifier is returned.

`Name`

Data type: `string`

The name of the client to find the identity number for. The name must be right regarding small and big letters. If the RAPID task is named T_ROB1, and using the name RMQ_t_rob1 for the RMQ, this will end up in a error (see error handling chapter below.)

Program execution

The `RMQFindSlot` instruction is used to find the slot identity for a named RMQ or Robot Application Builder client.

Error handling

The following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

`ERR_RMQ_NAME`	The given slot name is not valid or not found.

Syntax

```
RMQFindSlot
  [ Slot ':=' ] < variable (VAR) of rmqslot > ','
  [ Name ':=' ] < expression (IN) of string >';'
```


Continues on next page

Related information

For information about	See
Description of the RAPID Message Queue functionality	*Application manual - Robot communication and I/O control*, section *RAPID Message Queue*.
Send data to the queue of a RAPID task or Robot Application Builder client	*RMQSendMessage - Send an RMQ data message on page 386*
Get the first message from a RAPID Message Queue.	*RMQGetMessage - Get an RMQ message on page 373*
Send data to the queue of a RAPID task or Robot Application Builder client, and wait for an answer from the client	*RMQSendWait - Send an RMQ data message and wait for a response on page 390*
Extract the header data from a `rmqmessage`	*RMQGetMsgHeader - Get header information from an RMQ message on page 380*
Order and enable interrupts for a specific data type	*IRMQMessage - Orders RMQ interrupts for a data type on page 167*
Extract the data from a `rmqmessage`	*RMQGetMsgData - Get the data part from an RMQ message on page 377*
Get the slot name from a specified slot identity	*RMQGetSlotName - Get the name of an RMQ client on page 964*
`RMQ Slot`	*rmqslot - Identity number of an RMQ client on page 1174*

1.138. RMQGetMessage - Get an RMQ message

Usage

`RMQGetMessage` (*RAPID Message Queue Get Message*) is used to fetch the first RMQ message from the queue for the actual program task.

Basic examples

Basic examples of the instruction `RMQGetMessage` are illustrated below.

See also *More examples on page 374*.

Example 1

```
TRAP msghandler
  VAR rmqmessage myrmqmsg;
  RMQGetMessage myrmqmsg;
  ...
ENDTRAP
```

In the TRAP routine `msghandler` the `rmqmessage` is fetched from the RMQ and copied to the variable `myrmqmsg`.

Arguments

```
RMQGetMessage Message
```

`Message`

Data type: `rmqmessage`

Variable for storage of the RMQ message.

The maximum size of the data that can be received in a `rmqmessage` is about 3000 bytes.

Program execution

The instruction `RMQGetMessage` is used to get the first message from the queue of the task executing the instruction. If there is a message, it will be copied to the `Message` variable, and then removed from the queue to make room for new messages. The instruction is only supported on the TRAP level.

Continues on next page

More examples

More examples of how to use the instruction `RMQGetMessage` are illustrated below.

Example 1

```
RECORD mydatatype
  int x;
  int y;
ENDRECORD

VAR intnum msgreceive;
VAR mydatatype mydata;

PROC main()
  ! Setup interrupt
  CONNECT msgreceive WITH msghandler;
  ! Order cyclic interrupt to occur for data type mydatatype
  IRMQMessage mydata, msgreceive;
  WHILE TRUE DO
     ! Performing cycle
     ...
  ENDWHILE
ENDPROC

TRAP msghandler
  VAR rmgmessage message;
  VAR rmqheader header;

  ! Get the RMQ message
  RMQGetMessage message;
  ! Copy RMQ header information
  RMQGetMsgHeader message \Header:=header;

  IF header.datatype = "mydatatype" AND header.ndim = 0 THEN
     ! Copy the data from the message
     RMQGetMsgData message, mydata;
  ELSE
     TPWrite "Received a type not handled or with wrong dimension";
  ENDIF
ENDTRAP
```

When a new message is received, the TRAP routine `msghandler` is executed and the new message is copied to the variable `message` (instruction `RMQGetMessage`). Then the RMQ header data is copied (instruction `RMQGetMsgHeader`). If the message is of the expected data type and has the right dimension, the data is copied to the variable `mydata` (instruction `RMQGetMsgData`).

Continues on next page

Error handling

The following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

`ERR_RMQ_NOMSG`	No message for the moment in the queue. If executing `RMQGetMessage` twice in a TRAP routine, this can happen. The error can also be generated if there is a power failure between the TRAP being ordered and the instruction `RMQGetMessage` being executed.The messages in the RMQ will be lost at power fail.
`ERR_RMQ_INVMSG`	This error will be thrown if the message is invalid. This may for instance happen if a PC application sends a corrupt message.

Limitations

`RMQGetMessage` is not supported on the user execution level (i.e. in service routines) or normal execution level.

The maximum size of the data that can be received in a `rmqmessage` is about 3000 bytes.

A recommendation is to reuse a variable of the data type `rmqmessage` as much as possible to save RAPID memory.

Syntax

```
RMQGetMessage
  [ Message ':=' ] < variable (VAR) of rmqmessage >';'
```

Related information

For information about	See
Description of the RAPID Message Queue functionality	*Application manual - Robot communication and I/O control*, section *RAPID Message Queue*.
Find the identity number of a RAPID Message Queue task or Robot Application Builder client	*RMQFindSlot - Find a slot identity from the slot name on page 371*
Send data to the queue of a RAPID task or Robot Application Builder client	*RMQSendMessage - Send an RMQ data message on page 386*
Send data to the queue of a RAPID task or Robot Application Builder client, and wait for an answer from the client	*RMQSendWait - Send an RMQ data message and wait for a response on page 390*
Extract the header data from an `rmqmessage`	*RMQGetMsgHeader - Get header information from an RMQ message on page 380*
Extract the data from an `rmqmessage`	*RMQGetMsgData - Get the data part from an RMQ message on page 377*
Order and enable interrupts for a specific data type	*IRMQMessage - Orders RMQ interrupts for a data type on page 167*
Get the slot name from a specified slot identity	*RMQGetSlotName - Get the name of an RMQ client on page 964*

Continues on next page

For information about	See
`RMQ Message`	*rmqmessage - RAPID Message Queue message on page 1173*

1.139. RMQGetMsgData - Get the data part from an RMQ message

Usage

`RMQGetMsgData` (*RAPID Message Queue Get Message Data*) is used to get the actual data within the RMQ message.

Basic examples

Basic examples of the instruction `RMQGetMsgData` are illustrated below.

See also *More Examples*.

Example 1

```
VAR rmqmessage myrmqmsg;
VAR num data;
...
RMQGetMsgData myrmqmsg, data;
! Handle data
```

Data of the data type `num` is fetched from the variable `myrmqmsg` and stored in the variable `data`.

Arguments

```
RMQGetMsgData Message Data
```

`Message`

Data type: `rmqmessage`

Varible containing the received RMQ message.

`Data`

Data type: `anytype`

Variable of the expected data type, used for storage of the received data.

Program execution

The instruction `RMQGetMsgData` is used to get the actual data within the RMQ message, convert it from ASCII character format to binary data, compile the data to see if it is possible to store it in the variable specified in the instruction, and then copy it to the variable.

Continues on next page

More examples

More examples of how to use the instruction `RMQGetMsgData` are illustrated below.

Example 1

```
RECORD mydatatype
  int x;
  int y;
ENDRECORD

VAR intnum msgreceive;
VAR mydatatype mydata;

PROC main()
  ! Setup interrupt
  CONNECT msgreceive WITH msghandler;
  ! Order cyclic interrupt to occur for data type mydatatype
  IRMQMessage mydata, msgreceive;
  WHILE TRUE DO
     ! Performing cycle
     ...
  ENDWHILE
ENDPROC

TRAP msghandler
  VAR rmgmessage message;
  VAR rmqheader header;

  ! Get the RMQ message
  RMQGetMessage message;
  ! Copy RMQ header information
  RMQGetMsgHeader message \Header:=header;

  IF header.datatype = "mydatatype" AND header.ndim = 0 THEN
     ! Copy the data from the message
     RMQGetMsgData message, mydata;
  ELSE
     TPWrite "Received a type not handled or with wrong dimension";
  ENDIF
ENDTRAP
```

When a new message is received, the TRAP routine `msghandler` is executed and the new message is copied to the variable `message` (instruction `RMQGetMessage`). Then the RMQ header data is copied (instruction `RMQGetMsgHeader`). If the message is of the expected data type and has the right dimension, the data is copied to the variable `mydata` (instruction `RMQGetMsgData`).

Continues on next page

Error handling

The following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

`ERR_RMQ_VALUE`	The received message and the data type used in argument `Data` does not have the same data type.
`ERR_RMQ_DIM`	The data types are equal, but the dimensions differ between the data in the message and the variable used in argument `Data`.
`ERR_RMQ_MSGSIZE`	The size of the received data is bigger than the maximum configured size for the RMQ for the receiving task.
`ERR_RMQ_INVMSG`	This error will be thrown if the message is invalid. This may for instance happen if a PC application sends a corrupt message.

Syntax

```
RMQGetMsgData
  [ Message ':=' ] < variable (VAR) of rmqmessage > ','
  [ Data ':=' ] < reference (VAR) of anytype >';'
```

Related information

For information about	See
Description of the RAPID Message Queue functionality	*Application manual - Robot communication and I/O control*, section *RAPID Message Queue*.
Find the identity number of a RAPID Message Queue task or Robot Application Builder client	*RMQFindSlot - Find a slot identity from the slot name on page 371*
Send data to the queue of a RAPID task or Robot Application Builder client	*RMQSendMessage - Send an RMQ data message on page 386*
Get the first message from a RAPID Message Queue.	*RMQGetMessage - Get an RMQ message on page 373*
Send data to the queue of a RAPID task or Robot Application Builder client, and wait for an answer from the client	*RMQSendWait - Send an RMQ data message and wait for a response on page 390*
Extract the header data from an `rmqmessage`	*RMQGetMsgHeader - Get header information from an RMQ message on page 380*
Order and enable interrupts for a specific data type	*IRMQMessage - Orders RMQ interrupts for a data type on page 167*
Get the slot name from a specified slot identity	*RMQGetSlotName - Get the name of an RMQ client on page 964*
`RMQ Message`	*rmqmessage - RAPID Message Queue message on page 1173*

1.140. RMQGetMsgHeader - Get header information from an RMQ message

Usage

`RMQGetMsgHeader` (*RAPID Message Queue Get Message Header*) get the header information within the received RMQ message and store it in variables of type `rmqheader`, `rmqslot` or `num`.

Basic examples

Basic examples of the instruction `RMQGetMsgHeader` are illustrated below.

See also *More examples on page 381*.

Example 1

```
VAR rmqmessage myrmqmsg;
VAR rmqheader myrmqheader;
...
RMQGetMsgHeader myrmqmsg, \Header:=myrmqheader;
```

In this example the variable `myrmqheader` is filled with data copied from the `rmqheader` part of the variable `myrmqmsg`.

Example 2

```
VAR rmqmessage rmqmessage1;
VAR rmqheader rmqheader1;
VAR rmqslot rmqslot1;
VAR num userdef := 0;
...
RRMQGetMsgHeader rmqmessage1 \Header:=rmqheader1
     \SenderId:=rmqslot1 \UserDef:=userdef;
```

In this example the variables `rmqheader1`, `rmqslot1` and `userdef` are filled with data copied from the variable `rmqmessage1`.

Arguments

```
RMQGetMsgHeader Message [\Header] [\SenderId] [\UserDef]
```

`Message`

Data type: `rmqmessage`

Variable containing the received RMQ message from which the information about the message should be copied.

`[\Header]`

Data type: `rmqheader`

Variable for storage of the RMQ header information that is copied from the variable specified as the parameter `Message`.

`[\SenderId]`

Data type: `rmqslot`

Variable for storage of the sender identity information that is copied from the variable specified as the parameter `Message`.

Continues on next page

[\UserDef]

User Defined data

Data type: num

Variable for storage of user-defined data that is copied from the variable specified as the parameter Message. To get any valid data in this variable, the sender needs to specify that this should be included when sending an RMQ message. If it is not used, the value will be set to -1.

Program execution

The instruction RMQGetMsgHeader gets the header information within the received RMQ message and copies it to to variables of type rmqheader, rmqslot or num depending on what arguments are used.

More examples

More examples of how to use the instruction RMQGetMsgHeader are illustrated below.

Example 1

```
RECORD mydatatype
  int x;
  int y;
ENDRECORD

VAR intnum msgreceive;
VAR mydatatype mydata;

PROC main()
  ! Setup interrupt
  CONNECT msgreceive WITH msghandler;
  ! Order cyclic interrupt to occur for data type mydatatype
  IRMQMessage mydata, msgreceive;
  WHILE TRUE DO
     ! Performing cycle
     ...
  ENDWHILE
ENDPROC

TRAP msghandler
  VAR rmgmessage message;
  VAR rmqheader header;
  ! Get the RMQ message
  RMQGetMessage message;
  ! Copy RMQ header information
  RMQGetMsgHeader message \Header:=header;
```


Continues on next page

```
    IF header.datatype = "mydatatype" AND header.ndim = 0 THEN
      ! Copy the data from the message
      RMQGetMsgData message, mydata;
    ELSE
      TPWrite "Received a type not handled or with wrong dimension";
    ENDIF
  ENDTRAP
```

When a new message is received, the TRAP routine `msghandler` is executed and the new message is copied to the variable `message` (instruction `RMQGetMessage`). Then the RMQ header data is copied (instruction `RMQGetMsgHeader`). If the message is of the expected data type and has the right dimension, the data is copied to the variable `mydata` (instruction `RMQGetMsgData`).

Syntax

```
RMQGetMsgHeader
  [ Message ':=' ] < variable (VAR) of rmqmessage > ','
  [ '\' Header' :=' < variable (VAR) of rmqheader >
  [ '\' SenderId' :=' < variable (VAR) of rmqslot >
  [ '\' UserDef' :=' < variable (VAR) of num >';'
```

Related information

For information about	See
Description of the RAPID Message Queue functionality	*Application manual - Robot communication and I/O control*, section *RAPID Message Queue*.
Find the identity number of a RAPID Message Queue task or Robot Application Builder client	*RMQFindSlot - Find a slot identity from the slot name on page 371*
Send data to the queue of a RAPID task or Robot Application Builder client	*RMQSendMessage - Send an RMQ data message on page 386*
Get the first message from a RAPID Message Queue.	*RMQGetMessage - Get an RMQ message on page 373*
Send data to the queue of a RAPID task or Robot Application Builder client, and wait for an answer from the client	*RMQSendWait - Send an RMQ data message and wait for a response on page 390*
Extract the data from an `rmqmessage`	*RMQGetMsgData - Get the data part from an RMQ message on page 377*
Order and enable interrupts for a specific data type	*IRMQMessage - Orders RMQ interrupts for a data type on page 167*
Get the slot name from a specified slot identity	*RMQGetSlotName - Get the name of an RMQ client on page 964*
`RMQ Slot`	*rmqslot - Identity number of an RMQ client on page 1174*
`RMQ Header`	*rmqmessage - RAPID Message Queue message on page 1173*
`RMQ Message`	*rmqheader - RAPID Message Queue Message header on page 1171*

1.141. RMQReadWait - Returns message from RMQ

Usage

`RMQReadWait` is used in synchronous mode to receive any type of message.

Basic examples

A basic example of the instruction `RMQReadWait` is illustrated below.

See also *More examples on page 383*.

Example

```
VAR rmqmessage myrmqmsg;
RMQReadWait myrmqmsg;
```

The first message in the queue is received in the variable `myrmqmsg`.

Arguments

```
RMQReadWait Message [\TimeOut]
```

`Message`

Data type: `rmqmessage`

The variable in which the received message is placed.

`[\Timeout]`

Data type: `num`

The maximum amount of time [s] that program execution waits for a message. If this time runs out before the condition is met, the error handler will be called, if there is one, with the error code `ERR_RMQ_TIMEOUT`. If there is no error handler, the execution will be stopped. It is possible to set the timeout to 0 (zero) seconds, so that there is no wait at all.

If the parameter `\Timeout` is not used, the waiting time is 60 sec. To wait forever, use the predefined constant `WAIT_MAX`.

Program execution

All incoming messages are queued and `RMQReadWait` handles the messages in FIFO order, one message at a time. It is the users responsibility to avoid a full queue and to be prepared to handle any type of message supported by RAPID Message Queue.

More examples

More examples of how to use the instruction `RMQReadWait` are illustrated below.

Example 1

```
VAR rmqmessage myrmqmsg;
RMQReadWait myrmqmsg \TimeOut:=30;
```

The first message in the queue is received in the variable `myrmqmsg`. If no message is received within 30 seconds the program execution is stopped.

Continues on next page

Example 2

```
PROC main()
  VAR rmqmessage myrmqmsg;

  FOR i FROM 1 TO 25 DO
     RMQReadWait myrmqmsg \TimeOut:=30;
     ...
  ENDFOR

ERROR
  IF ERRNO = ERR_RMQ_TIMEOUT THEN
     TPWrite "ERR_RMQ_TIMEOUT error reported";
     ...
  ENDIF

ENDPROC
```

Messages are received from the queue and stored in the variable `myrmqmsg`. If receiving a message takes longer than 30 seconds, the error handler is called.

Error handling

The following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

Error code	Description
`ERR_RMQ_TIMEOUT`	No answer has been received within the time-out time
`ERR_RMQ_INVMSG`	This error will be thrown if the message is invalid. This can for example happen if a PC application sends a corrupt message

Limitations

`RMQReadWait` is only supported in synchronous mode. Executing this instruction in interrupt based mode will cause a fatal runtime error.

`RMQReadWait` is not supported in trap execution level or user execution level. Executing this instruction in either of these levels will cause a fatal runtime error.

Syntax

```
RMQReadWait
  [ Message ':=' ] < variable (VAR) of rmqmessage>
  [ '\' TimeOut':=' < expression (IN) of num > ] ';'
```

Related information

For information about	See
Description of the RAPID Message Queue functionality	*Application manual - Robot communication and I/O control,* section *RAPID Message Queue*.
Description of task execution modes	*Technical reference manual - System parameters,* section *Topic Controller, Type Task*.

Continues on next page

For information about	See
`rmqmessage` data type	*rmqmessage - RAPID Message Queue message on page 1173*.
Send data to the queue of a RAPID task or Robot Application Builder client	*RMQSendMessage - Send an RMQ data message on page 386*.
Send data to the queue of a RAPID task or Robot Application Builder client, and wait for an answer from the client	*RMQSendWait - Send an RMQ data message and wait for a response on page 390*.
Find the identity number of a RAPID Message Queue task or Robot Application Builder client.	*RMQFindSlot - Find a slot identity from the slot name on page 371*.
Extract the header data from an `rmqmessage`	*RMQGetMsgHeader - Get header information from an RMQ message on page 380*.
Extract the data from an `rmqmessage`	*RMQGetMsgData - Get the data part from an RMQ message on page 377*.
Order and enable interrupts for a specific data type	*IRMQMessage - Orders RMQ interrupts for a data type on page 167*.
Get the slot name from a specified slot identity	*RMQGetSlotName - Get the name of an RMQ client on page 964*.
Empty RAPID Message Queue	*RMQEmptyQueue - Empty RAPID Message Queue on page 369* *rmqmessage - RAPID Message Queue message on page 1173*
Get the first message from a RAPID Message Queue	*RMQGetMessage - Get an RMQ message on page 373*.

1.142. RMQSendMessage - Send an RMQ data message

Usage

`RMQSendMessage` (*RAPID Message Queue Send Message*) is used to send data to an RMQ configured for a RAPID task, or to a Robot Application Builder client.

Basic examples

Basic examples of the instruction `RMQSendMessage` are illustrated below.

See also *More examples on page 387*.

Example 1

```
VAR rmqslot destination_slot;
VAR string data:="Hello world";
..
RMQFindSlot destination_slot,"RMQ_Task2";
RMQSendMessage destination_slot,data;
```

The example shows how to send the value in the variable `data` to the RAPID task `"Task2"` with the configured RMQ "`RMQ_Task2`".

Example 2

```
VAR rmqslot destination_slot;
CONST robtarget p5:=[ [600, 500, 225.3], [1, 0, 0, 0], [1, 1, 0,
     0], [ 11, 12.3, 9E9, 9E9, 9E9, 9E9] ];
VAR num my_id:=1;
..
RMQFindSlot destination_slot,"RMQ_Task2";
RMQSendMessage destination_slot, p5 \UserDef:=my_id;
my_id:=my_id + 1;
```

The example shows how to send the value in the constant `p5` to the RAPID task `"Task2"` with the configured RMQ "RMQ_Task2". A user-defined number is also sent. This number can be used by the receiver as an identifier.

Arguments

```
RMQSendMessage Slot SendData [\UserDef]
```

`Slot`

Data type: `rmqslot`

The identity slot number of the client that should receive the message.

`SendData`

Data type: `anytype`

Reference to a variable, persistent or constant containing the data to be sent to the client with identity as in argument `Slot`.

Continues on next page

[\UserDef]

User Defined data

Data type: num

Data specifying user-defined information to the receiver of the SendData, i.e the client with identity number as in variable Slot. The value must be an integer between 0 and 32767.

Program execution

The instruction RMQSendMessage is used to send data to a specified client. The instruction packs the indata in a storage container and sends it.

If the receiving client is not interested in receiving messages, i.e has not setup any interrupt to occur for the data type specified in the RMQSendMessage instruction or is not waiting in an RMQSendWait instruction, the message will be discarded, and a warning will be generated.

Not all data types can be sent with the instruction (see limitations).

More examples

More examples of how to use the instruction RMQSendMessage are illustrated below.

Example 1

```
MODULE SenderMod
  RECORD msgrec
     num x;
     num y;
  ENDRECORD

  PROC main()
     VAR rmqslot destinationSlot;
     VAR msgrec msg :=[0, 0, 0];

     ! Connect to a Robot Application Builder client
     RMQFindSlot destinationSlot ”My_RAB_client”;

     ! Perform cycle
     WHILE TRUE DO
        ! Update msg with valid data
        ...
        ! Send message
        RMQSendMessage destinationSlot, msg;
        ...
     ENDWHILE
```


Continues on next page

```
    ERROR
      IF ERRNO = ERR_RMQ_INVALID THEN
        ! Handle destination client lost
        WaitTime 1;
        ! Reconnect to Robot Application Builder client
        RMQFindSlot destinationSlot "My_RAB_client";
        ! Avoid execution stop due to retry count exceed
        ResetRetryCount;
        RETRY;
      ELSIF ERRNO = ERR_RMQ_FULL THEN
        ! Handle destination queue full
        WaitTime 1;
        ! Avoid execution stop due to retry count exceed
        ResetRetryCount;
        RETRY;
      ENDIF
    ENDPROC
  ENDMODULE
```

The example shows how to use instruction `RMQSendMessage` with errorhandling of occuring run-time errors. The program sends user-defined data of the type `msgrec` to a Robot Application Builder client called "`My_RAB_client`".

Error handling

The following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

`ERR_RMQ_MSGSIZE`	The size of message is too big. Either the data exceeds the maximum allowed message size, or the receiving client is not configured to receive the size of the data that is sent.
`ERR_RMQ_FULL`	The destination message queue is full
`ERR_RMQ_INVALID`	The destination slot has not been connected or the destination slot is no longer available. If not connected, a call to `RMQFindSlot` must be done. If not available, the reason is that a remote client has disconnected from the controller.

Limitations

It is not possible to set up interrupts, or send or receive data instances of data types that are of non-value, semi-value types or data type `motsetdata`.

The maximum size of data that can be sent to a Robot Application Builder client is about 5000 bytes. The maximum size of data that can be received by a RMQ and stored in a `rmqmessage` data type is about 3000 bytes. The size of the data that can be received by an RMQ can be configured (default size 400, max size 3000).

Syntax

```
RMQSendMessage
  [ Slot ':=' ] < variable (VAR) of rmqslot > ','
  [ SendData' :=' ] < reference (REF) of anytype >
  [ '\' UserDef' :=' < expression (IN) of num > ] ';'
```

Continues on next page

Related information

For information about	See
Description of the RAPID Message Queue functionality	*Application manual - Robot communication and I/O control*, section *RAPID Message Queue*.
Find the identity number of a RAPID Message Queue task or Robot Application Builder client	*RMQFindSlot - Find a slot identity from the slot name on page 371*
Get the first message from a RAPID Message Queue.	*RMQGetMessage - Get an RMQ message on page 373*
Send data to the queue of a RAPID task or Robot Application Builder client, and wait for an answer from the client	*RMQSendWait - Send an RMQ data message and wait for a response on page 390*
Extract the header data from an `rmqmessage`	*RMQGetMsgHeader - Get header information from an RMQ message on page 380*
Extract the data from an `rmqmessage`	*RMQGetMsgData - Get the data part from an RMQ message on page 377*
Order and enable interrupts for a specific data type	*IRMQMessage - Orders RMQ interrupts for a data type on page 167*
Get the slot name from a specified slot identity	*RMQGetSlotName - Get the name of an RMQ client on page 964*
`RMQ Slot`	*rmqslot - Identity number of an RMQ client on page 1174*

1.143. RMQSendWait - Send an RMQ data message and wait for a response

Usage

With the `RMQSendWait` (*RAPID Message Queue Send Wait*) instruction it is possible to send data to an RMQ or to a Robot Application Builder client, and wait for an answer from the specified client. If using this instruction, the user needs to know what kind of data type will be sent in the answer from the client.

Basic examples

Basic examples of the instruction `RMQSendWait` are illustrated below.

See also *More examples on page 393*.

Example 1

```
VAR rmqslot destination_slot;
VAR string sendstr:="This string is from T_ROB1";
VAR rmqmessage receivemsg;
VAR num mynum;
..
RMQFindSlot destination_slot, "RMQ_T_ROB2";
RMQSendWait destination_slot, sendstr, receivemsg, mynum;
RMQGetMsgData receivemsg, mynum;
```

The example shows how to send the data in the variable `sendstr` to the RAPID task "`T_ROB2`" with the configured RMQ "`RMQ_T_ROB2`". Now the instruction `RMQSendWait` waits for a reply from the task "T_ROB2". The instruction in "T_ROB2" needs to send data that is stored in a `num` data type to terminate the waiting instruction `RMQSendWait`. When the message has been received, the data is copied to the variable `mynum` from the variable `receivemsg` with the instruction `RMQGetMsgData`.

Example 2

```
VAR rmqslot rmqslot1;
VAR string mysendstr;
VAR rmqmessage rmqmessage1;
VAR string receivestr;
VAR num mysendid:=1;
..
mysendstr:="Message from Task1";
RMQFindSlot rmqslot1, "RMQ_Task2";
RMQSendWait rmqslot1, mysendstr \UserDef:=mysendid, rmqmessage1,
     receivestr \TimeOut:=20;
RMQGetMsgData rmqmessage1, receivestr;
mysendid:=mysendid + 1;
```

The example shows how to send the data in the variable `mysendstr` to the RAPID task "`Task2`" with the configured RMQ `"RMQ_Task2"`. A user-defined number is also sent. This number can be used by the receiver as an identifier and must be bounced back to the sender

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to terminate the waiting `RMQSendWait` instruction. Another demand to terminate the waiting instruction is that the right data type is sent from the client. That data type is specified by the variable `receivestr` in the `RMQSendWait` instruction. After the message has been received, the actual data is copied to the variable `receivestr` with the instruction `RMQGetMsgData`.

Arguments

```
RMQSendWait Slot SendData [\UserDef] Message ReceiveDataType
    [\TimeOut]
```

`Slot`

Data type: `rmqslot`

The identity number of the client that should receive the message.

`SendData`

Data type: `anytype`

Reference to a variable, persistent or constant containing the data to be sent to the client with identity number as in the variable `Slot`.

`[\UserDef]`

User Defined data

Data type: `num`

Data specifying user-defined information to the receiver of the `SendData`, that is, the client with the identity number as in the variable `Slot`. If using this optional argument, the `RMQSendWait` instruction will only terminate if the `ReceiveDataType` and the specified `UserDef` is as specified in the message answer. The value must be an integer between 0 and 32767.

`Message`

Data type: `rmqmessage`

The variable in which the received message is placed.

`ReceiveDataType`

Data type: `anytype`

A reference to a persistent, variable or constant of the data type that the instruction is waiting for. The actual data is not copied to this variable when the `RMQSendWait` is executed. This argument is only used to specify the actual data type the `RMQSendWait` instruction is waiting for.

`[\Timeout]`

Data type: `num`

The maximum amount of time [s] that program execution waits for an answer. If this time runs out before the condition is met, the error handler will be called, if there is one, with the error code `ERR_RMQ_TIMEOUT`. If there is no error handler, the execution will be stopped.

If the parameter `\Timeout` is not used, the waiting time is 60 s. To wait forever, use the predefined constant `WAIT_MAX`.

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Program execution

The instruction `RMQSendWait` sends data and waits for an answer from the client with the specified slot identity. The answer must be an `rmqmessage` from the client that got the message and the answer must be of the same data type that is specified in the argument `ReceiveDataType`. The message will be sent in the same way as when using `RMQSendMessage`, i.e.the receiver will get a normal RAPID Message Queue message. It is the responsibility of the sender that the receiver knows that a reply is needed. If the optional argument `UserDef` is used in the `RMQSendWait`, the demand is that the receiving client uses the same `UserDef` in the answer.

If the receiving client is not interested in receiving messages, that is, has not set up any interrupt to occur for the data type specified in the `RMQSendWait` instruction, the message will be discarded, and a warning will be generated. The instruction returns an error after the time used in the argument `TimeOut`, or the default time-out time 60 s. This error can be dealt with in an error handler.

The `RMQSendWait` instruction has the highest priority if a message is received and it fits the description for both the expected answer and a message connected to a TRAP routine (see instruction `IRMQMessage`).

If a power failure occurs when waiting for an answer from the client, the variable used in the argument `Slot` is set to 0 and the instruction is executed again. The instruction will then fail due to an invalid slot identity and the error handler will be called, if there is one, with the error code `ERR_RMQ_INVALID`. The slot identity can be reinitialized there.

Not all data types can be sent with the instruction (see limitations).

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More examples

More examples of how to use the instruction `RMQSendWait` are illustrated below.

Example 1

```
MODULE RMQ_Task1_mod

  PROC main()
    VAR rmqslot destination_slot;
    VAR string mysendstr:="String sent from RMQ_Task1_mod";
    VAR string myrecstr;
    VAR rmqmessage recmsg;
    VAR rmqheader header;

    !Get slot identity to client called RMQ_Task2
    RMQFindSlot destination_slot, "RMQ_Task2";

    WHILE TRUE DO
      ! Do something
      ...
      !Send data in mysendstr, wait for an answer of type string
      RMQSendWait destination_slot, mysendstr, recmsg, myrecstr;
      !Get information about the received message
      RMQGetMsgHeader recmsg \Header:=header;

      IF header.datatype = "string" AND header.ndim = 0 THEN
        ! Copy the data in recmsg
        RMQGetMsgData recmsg, myrecstr;
        TPWrite "Received string: " + myrecstr;
      ELSE
        TPWrite "Not a string that was received";
      ENDIF
    ENDWHILE
  ENDPROC
ENDMODULE
```

The data in the variable `mysendstr` is sent to the RAPID task "`Task2`" with the configured RAPID Message Queue "`RMQ_Task2`" with the instruction `RMQSendWait`. The answer from the RAPID task "`Task2`" should be a string (specified of the data type of the variable `myrecstr`). The RMQ message received as an answer is received in the variable `recmsg`. The use of the variable `myrecstr` in the call to `RMQSendWait` is just specification of the data type the sender is expecting as an answer. No valid data is placed in the variable in the `RMQSendWait` call.

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Error handling

The following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

`ERR_RMQ_MSGSIZE`	The size of message is too big. Either the data exceeds the maximum allowed message size, or the receiving client is not configured to receive the size of the data that is sent.
`ERR_RMQ_FULL`	The destination message queue is full.
`ERR_RMQ_INVALID`	The `rmqslot` has not been initialized, or the destination slot is no longer available. This can happen if the destination slot is a remote client and the remote client has disconnected from the controller. `RMQSendWait` was interrupted by a power failure, and at restart the `rmqslot` is set to 0.
`ERR_RMQ_TIMEOUT`	No answer has been received within the time-out time.
`ERR_RMQ_INVMSG`	This error will be thrown if the message is invalid. This may for instance happen if a PC application sends a corrupt message.

Limitations

It is not allowed to execute `RMQSendWait` in synchronous mode. That will cause a fatal runtime error.

It is not possible to set up interrupts, or send or receive data instances of data types that are of non-value, semi-value types or data type `motsetdata`.

The maximum size of data that can be sent to a Robot Application Builder client is about 5000 bytes. The maximum size of data that can be received by an RMQ and stored in an `rmqmessage` data type is about 3000 bytes. The size of the data that can be received by an RMQ can be configured (default size 400, max size 3000).

Syntax

```
RMQSendWait
  [ Slot ':=' ] < variable (VAR) of rmqslot > ','
  [ SendData' :=' ] < reference (REF) of anytype >
  [ '\' UserDef' :=' < expression (IN) of num > ] ','
  [ Message' :=' ] < variable (VAR) of rmqmessage > ','
  [ ReceiveDataType' :=' ] < reference (REF) of anytype > ','
  [ '\' Timeout' :=' < expression (IN) of num > ] ';'
```

Related information

For information about	See
Description of the RAPID Message Queue functionality	*Application manual - Robot communication and I/O control*, section *RAPID Message Queue*.
Find the identity number of a RAPID Message Queue task or Robot Application Builder client	*RMQFindSlot - Find a slot identity from the slot name on page 371*
Send data to the queue of a RAPID task or Robot Application Builder client	*RMQSendMessage - Send an RMQ data message on page 386*
Get the first message from a RAPID Message Queue.	*RMQGetMessage - Get an RMQ message on page 373*

Continues on next page

For information about	See
Extract the header data from an `rmqmessage`	*RMQGetMsgHeader - Get header information from an RMQ message on page 380*
Extract the data from an `rmqmessage`	*RMQGetMsgData - Get the data part from an RMQ message on page 377*
Order and enable interrupts for a specific data type	*IRMQMessage - Orders RMQ interrupts for a data type on page 167*
Get the slot name from a specified slot identity	*RMQGetSlotName - Get the name of an RMQ client on page 964*
`RMQ Slot`	*rmqslot - Identity number of an RMQ client on page 1174*
`RMQ Message`	*rmqmessage - RAPID Message Queue message on page 1173*

1.144. Save - Save a program module

Usage

`Save` is used to save a program module.

The specified program module in the program memory will be saved with the original (specified in `Load` or `StartLoad`) or specified file path.

It is also possible to save a system module at the specified file path.

Basic examples

Basic examples of the instruction `Save` are illustrated below.

See also *More examples on page 397*.

Example 1

```
Load "HOME:/PART_B.MOD";
...
Save "PART_B";
```

Load the program module with the file name `PART_B.MOD` from `HOME:` into the program memory.

Save the program module `PART_B` with the original file path `HOME:` and with the original file name `PART_B.MOD`.

Arguments

```
Save [\TaskRef]|[\TaskName] ModuleName [\FilePath] [\File]
```

`[\TaskRef]`

Task Reference

Data type: `taskid`

The program task identity in which the program module should be saved.

For all program tasks in the system the predefined variables of the data type `taskid` will be available. The variable identity will be "taskname"+"Id", e.g. for the `T_ROB1` task the variable identity will be `T_ROB1Id`.

`[\TaskName]`

Data type: `string`

The program task name in which the program module should be saved.

If none of the arguments `\TaskRef` or `\TaskName` is specified then the specified program module in the current (executing) program task will be saved.

`ModuleName`

Data type: `string`

The program module to save.

`[\FilePath]`

Data type: `string`

The file path and the file name to the place where the program module is to be saved. The file name shall be excluded when the argument `\File` is used.

Continues on next page

[\File]

Data type: string

When the file name is excluded in the argument \FilePath it must be specified with this argument.

The argument \FilePath \File can only be omitted for program modules loaded with Load or StartLoad-WaitLoad and the program module will be stored at the same destination as specified in these instructions. To store the program module at another destination it is also possible to use the argument \FilePath \File.

The argument \FilePath \File must be used to be able to save a program module that previously was loaded from the FlexPendant, external computer, or system configuration.

Program execution

Program execution waits for the program module to finish saving before proceeding with the next instruction.

More examples

More examples of how to use the instruction Save are illustrated below.

Example 1

```
Save "PART_A" \FilePath:="HOME:/DOORDIR/PART_A.MOD";
```

Save the program module PART_A to HOME: in the file PART_A.MOD and in the directory DOORDIR.

Example 2

```
Save "PART_A" \FilePath:="HOME:" \File:="DOORDIR/PART_A.MOD";
```

Same as in the above example 1 but another syntax.

Example 3

```
Save \TaskRef:=TSK1Id, "PART_A" \FilePath:="HOME:/DOORDIR/
     PART_A.MOD";
```

Save program module PART_A in program task TSK1 to the specified destination. This is an example where the instruction Save is executing in one program task and the saving is done in another program task.

Example 4

```
Save \TaskName:="TSK1", "PART_A" \FilePath:="HOME:/DOORDIR/
     PART_A.MOD";
```

Save program module PART_A in program task TSK1 to the specified destination. This is another example of where the instruction Save is executing in one program task and the saving is done in another program task.

Continues on next page

Limitations

TRAP routines, system I/O events, and other program tasks cannot execute during the saving operation. Therefore, any such operations will be delayed.

The save operation can interrupt update of PERS data done step by step from other program tasks. This will result in inconsistent whole PERS data.

A program stop during execution of the Save instruction can result in a guard stop with motors off. The error message "20025 Stop order timeout" will be displayed on the FlexPendant.

Avoid ongoing robot movements during the saving.

Error handling

If the program task name in argument `\TaskName` cannot be found in the system, the system variable ERRNO is set to ERR_TASKNAME.

If the program module cannot be saved because there is no module name, unknown, or ambiguous module name then the system variable ERRNO is set to ERR_MODULE.

If the save file cannot be opened because of denied permission, no such directory, or no space left on device then the system variable ERRNO is set to ERR_IOERROR.

If argument `\FilePath` is not specified for program modules loaded from the FlexPendant, System Parameters, or an external computer then the system variable ERRNO is set to ERR_PATH.

The errors above can be handled in the error handler.

Syntax

```
Save
  [[ '\' TaskRef ':=' <variable (VAR) of taskid>]
  |[ '\' TaskName' :=' <expression (IN) of string>] ',']
  [ ModuleName' :=' ] <expression (IN) of string>
  [ '\' FilePath' :='<expression (IN) of string> ]
  [ '\' File' :=' <expression (IN) of string>] ';'
```

Related information

For information about	See
Program tasks	*taskid - Task identification on page 1203*

1.145. SCWrite - Send variable data to a client application

Usage

`SCWrite` (*Superior Computer Write*) is used to send the name, type, dimension, and value of a persistent variable to a client application. It is possible to send both single variables and arrays of variables.

Basic examples

Basic examples of the instruction `instruction` name are illustrated below.

Example 1

```
PERS num cycle_done;

PERS num numarr{2}:=[1,2];

SCWrite cycle_done;
```

The name, type, and value of the persistent variable `cycle_done` is sent to all client applications.

Example 2

```
SCWrite \ToNode := "138.221.228.4", cycle_done;
```

The name, type, and value of the persistent variable `cycle_done` is sent to all client applications. The argument `\ToNode` will be ignored.

Example 3

```
SCWrite numarr;
```

The name, type, dim, and value of the persistent variable `numarr` is sent to all client applications.

Example 4

```
SCWrite \ToNode := "138.221.228.4", numarr;
```

The name, type, dim, and value of the persistent variable `numarr` is sent to all client applications. The argument `\ToNode` will be ignored.

Arguments

```
SCWrite [ \ToNode ] Variable
```

`[\ToNode]`

Data type: `datatype`

The argument will be ignored.

`Variable`

Data type: `anytype`

The name of a persistent variable.

Program execution

The name, type, dim, and value of the persistent variable is sent to all client applications. ‘dim’ is the dimension of the variable and is only sent if the variable is an array.

Continues on next page

Error handling

The `SCWrite` instruction will return an error in the following cases:

The variable could not be sent to the client. This can have the following cause:

- The `SCWrite` messages comes so close so that they cannot be sent to the client. Solution: Put in a `WaitTime` instruction between the `SCWrite` instructions.
- The variable value is too large decreasing the size of the ARRAY or RECORD.
- The error message will be:
  `41473 System access error`
  `Failed to send YYYYYY`
  Where YYYY is the name of the variable.

When an error occurs the program halts and must be restarted. The `ERRNO` system variable will contain the value `ERR_SC_WRITE`.

The `SCWrite` instruction will not return an error if the client application may, for example, be closed down or the communication is down. The program will continue executing.

`SCWrite` error recovery

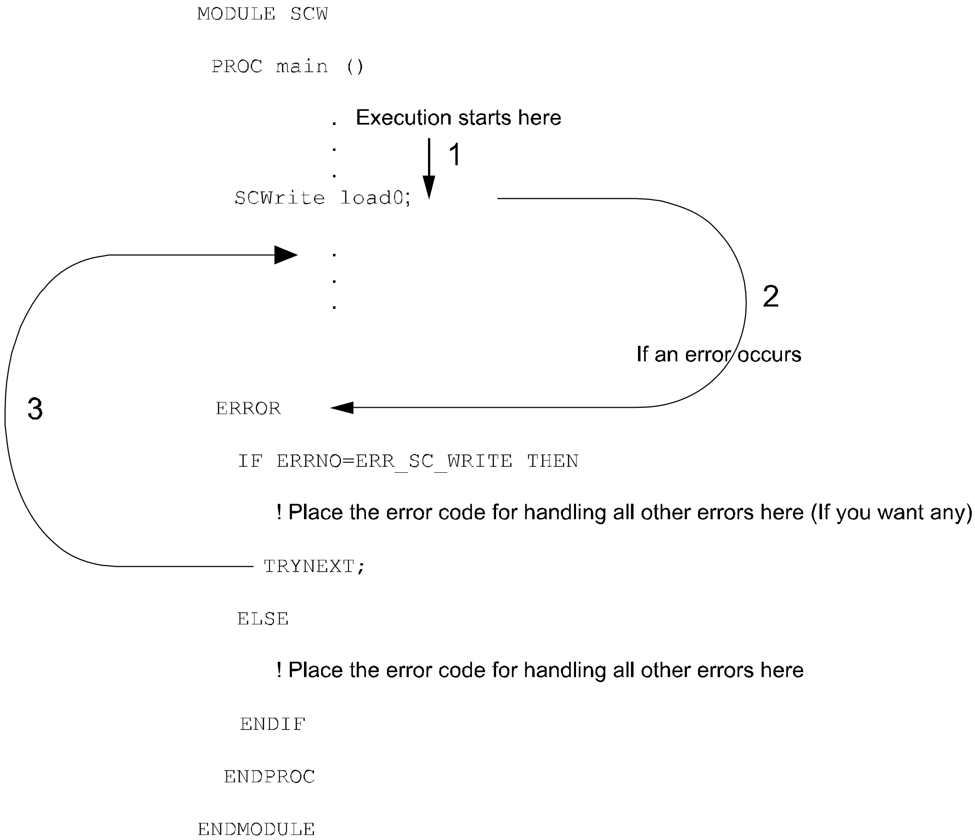
To avoid stopping the program when a error occurs in a `SCWrite` instruction it has to be handled by an *error handler*. The error will only be reported to the log, and the program will continue running.

Remember that the error handling will make it more difficult to find errors in the client communication since the error is never reported to the display on the FlexPendant (but it can be found in the log).

Continues on next page

Using RobotWare 5.0 or later

The RAPID program looks as follows:



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1.146. SearchC - Searches circularly using the robot

Usage

`SearchC` (*Search Circular*) is used to search for a position when moving the tool center point (TCP) circularly.

During the movement the robot supervises a digital input signal. When the value of the signal changes to the requested one the robot immediately reads the current position.

This instruction can typically be used when the tool held by the robot is a probe for surface detection. The outline coordinates of a work object can be obtained using the `SearchC` instruction.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

When using search instructions it is important to configure the I/O system to have a very short time from setting the physical signal to the system to get information about the setting (use I/O unit with interrupt control, not poll control). How to do this can differ between fieldbuses. If using DeviceNet then the ABB units DSQC 651 (AD Combi I/O) and DSQC 652 (Digital I/O) will give short times since they are using connection type Change of State. If using other fieldbuses make sure to configure the network in a proper way to get the right conditions.

Basic examples

Basic examples of the instruction `SearchC` are illustrated below.

See also *More examples on page 406*.

Example 1

```
SearchC di1, sp, cirpoint, p10, v100, probe;
```

The TCP of the `probe` is moved circularly towards the position `p10` at a speed of `v100`. When the value of the signal `di1` changes to active the position is stored in `sp`.

Example 1

```
SearchC \Stop, di2, sp, cirpoint, p10, v100, probe;
```

The TCP of the `probe` is moved circularly towards the position `p10`. When the value of the signal `di2` changes to active the position is stored in `sp` and the robot stops immediately.

Continues on next page

Arguments

```
SearchC [\Stop] | [\PStop] | [\SStop] | [\Sup] Signal [\Flanks]
     SearchPoint CirPoint ToPoint [\ID] Speed [\V] | [\T] Tool
     [\WObj] [\Corr]
```

`[ \Stop ]`

Stiff Stop

Data type: `switch`

The robot movement is stopped as quickly as possible without keeping the TCP on the path (hard stop) when the value of the search signal changes to active. However, the robot is moved a small distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed.

-

WARNING!

To stop the searching with stiff stop (switch `\Stop`) is only allowed if the TCP-speed is lower than 100 mm/s. At a stiff stop with higher speeds some axes can move in unpredictable direction.

`[ \PStop ]`

Path Stop

Data type: `switch`

The robot movement is stopped as quickly as possible while keeping the TCP on the path (soft stop), when the value of the search signal changes to active. However, the robot is moved a distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed.

`[ \SStop ]`

Soft Stop

Data type: `switch`

The robot movement is stopped as quickly as possible while keeping the TCP close to or on the path (soft stop) when the value of the search signal changes to active. However, the robot is moved only a small distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed. `SStop` is faster then `PStop`. But when the robot is running faster than 100 mm/s it stops in the direction of the tangent of the movement which causes it to marginally slide of the path.

Continues on next page

`[ \Sup ]`

Supervision

Data type: `switch`

The search instruction is sensitive to signal activation during the complete movement (flying search), i.e. even after the first signal change has been reported. If more than one match occurs during a search then a recoverable error is generated with the robot in the `ToPoint`.

If the argument `\Stop`, `\PStop`, `\SStop`, or `\Sup` is omitted (no switch used at all):

- the movement continues (flying search) to the position specified in the `ToPoint` argument (same as with argument `\Sup`)
- error is reported for none search hit but is not reported for more than one search hit (first search hit is returned as the `SearchPoint`)

`Signal`

Data type: `signaldi`

The name of the signal to supervise.

`[ \Flanks ]`

Data type: `switch`

The positive and the negative edge of the signal is valid for a search hit.

If the argument `\Flanks` is omitted then only the positive edge of the signal is valid for a search hit, and a signal supervision will be activated at the beginning of a search process. This means that if the signal has a positive value already at the beginning of the search process or the communication with the signal is lost, then the robot movement is stopped as quickly as possible, while keeping the TCP on the path (soft stop). However, the robot is moved a small distance before it stops and is not moved back to the start position. A user recovery error (ERR_SIGSUPSEARCH) will be generated and can be dealt with by the error handler.

`SearchPoint`

Data type: `robtarget`

The position of the TCP and external axes when the search signal has been triggered. The position is specified in the outermost coordinate system taking the specified tool, work object, and active `ProgDisp/ExtOffs` coordinate system into consideration.

`CirPoint`

Data type: `robtarget`

The circle point of the robot. See the instruction `MoveC` for a more detailed description of circular movement. The circle point is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction). `SearchC` always uses a stop point as zone data for the destination.

Continues on next page

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove System if it is a coordinated synchronized movement, and is not allowed in any other cases.

The specified ID number must be the same in all cooperating program tasks. The ID number gives a guarantee that the movements are not mixed up at runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the tool center point, the external axes and the tool reorientation.

`[ \V ]`

Velocity

Data type: `num`

This argument is used to specify the velocity of the TCP in mm/s directly in the instruction. It is then substituted for the corresponding velocity specified in the speed data.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point that is moved to the specified destination position.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot positions in the instruction are related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used then this argument must be specified for a linear movement relative to the work object to be performed.

`[ \Corr ]`

Correction

Data type: `switch`

When this argument is present the correction data written to a corrections entry by the instruction `CorrWrite` will be added to the path and destination position.

Continues on next page

Program execution

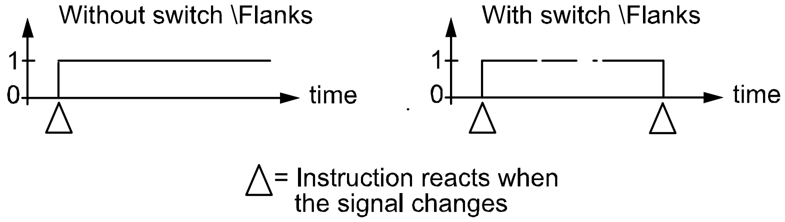
See the instruction `MoveC` for information about circular movement.

The movement is always ended with a stop point, i.e. the robot stops at the destination point.

When a flying search is used, i.e. the `\Sup` argument is specified or none switch at all is specified, the robot movement always continues to the programmed destination point. When a search is made using the switch `\Stop`, `\PStop`, or `\SStop` the robot movement stops when the first search hit is detected.

The `SearchC` instruction returns the position of the TCP when the value of the digital signal changes to the requested one, as illustrated in figure below.

The figure shows how flank-triggered signal detection is used (the position is stored when the signal is changed the first time only).



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More examples

More examples of how to use the instruction `SearchC` are illustrated below.

Example 1

```
SearchC \Sup, di1\Flanks, sp, cirpoint, p10, v100, probe;
```

The TCP of the `probe` is moved circularly towards the position `p10`. When the value of the signal `di1` changes to active or passive the position is stored in `sp`. If the value of the signal changes twice then program generates an error.

Limitations

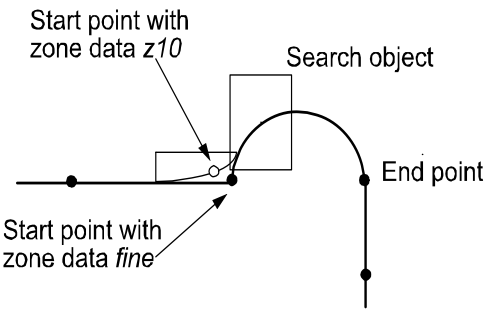
General limitations according to instruction `MoveC`.

Zone data for the positioning instruction that precedes `SearchC` must be used carefully. The start of the search, i.e. when the I/O signal is ready to react, is not, in this case, the programmed destination point of the previous positioning instruction but a point along the real robot path. The figure below illustrates an example of something that may go wrong when zone data other than `fine` is used.

The instruction `SearchC` should never be restarted after the circle point has been passed. Otherwise the robot will not take the programmed path (positioning around the circular path in another direction compared to that which is programmed).

Continues on next page

The figure shows how a match is made on the wrong side of the object because the wrong zone data was used.



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WARNING!

Limitations for searching if coordinated synchronized movements:

- If using `SearchL`, `SearchC` or `SearchExtJ` for one program task and some other move instruction in other program task, it is only possible to use flying search with switch `\Sup`. Besides that, only possible to do error recovery with `TRYNEXT`.
- It's possible to use all searching functionality, if using some of the instructions `SearchL`, `SearchC` or `SearchExtJ` in all involved program tasks with coordinated synchronized movements and generate search hit from same digital input signal. This will generate search hit synchronously in all search instructions. Any error recovery must also be the same in all involved program tasks.

While searching is active, it isn't possible to store current path with instruction `StorePath`.

Repetition accuracy for search hit position with TCP speed 20 - 1000 mm/s 0.1 - 0.3 mm.

Typical stop distance using a search velocity of 50 mm/s:

- without TCP on path (switch `\Stop`) 1-3 mm
- with TCP on path (switch `\PStop`) 15-25 mm
- with TCP near path (switch `\SStop`) 4-8 mm

Limitations for searching on a conveyor:

- a search will stop the robot when hit or if the search fails, so make the search in the same direction as the conveyor moves and continue after the search-stop with a move to a safe position. Use error handling to move to a safe position when search fails.
- the repetition accuracy for the search hit position will be poorer when searching on a conveyor and depends on the speed of the conveyor and how stabil the speed is.

Continues on next page

Error handling

An error is reported during a search when:

- no signal detection occurred - this generates the error ERR_WHLSEARCH.
- more than one signal detection occurred – this generates the error ERR_WHLSEARCH only if the `\Sup` argument is used.
- the signal already has a positive value at the beginning of the search process or the communication with the signal is lost. This generates the error ERR_SIGSUPSEARCH only if the `\Flanks` argument is omitted.

Errors can be handled in different ways depending on the selected running mode:

- **Continuous forward** / **Instruction forward** / ERR_WHLSEARCH: No position is returned and the movement always continues to the programmed destination point. The system variable ERRNO is set to ERR_WHLSEARCH and the error can be handled in the error handler of the routine.
- **Continuous forward** / **Instruction forward** / ERR_SIGSUPSEARCH: No position is returned and the movement always stops as quickly as possible at the beginning of the search path. The system variable ERRNO is set to ERR_SIGSUPSEARCH and the error can be handled in the error handler of the routine.
- **Instruction backward**: During backward execution the instruction carries out the movement without any signal supervision.

Syntax

```
SearchC
  [ '\' Stop',' ] | [ '\' PStop ','] | [ '\' SStop ',' ] | [ '\'
       Sup ',' ]
  [ Signal':=' ] < variable (VAR) of signaldi >
  ['\' Flanks]','
  [ SearchPoint':=' ] < var or pers (INOUT) of robtarget > ','
  [ CirPoint':=' ] < expression (IN) of robtarget > ','
  [ ToPoint':=' ] < expression (IN) of robtarget > ','
  [ '\' ID ':=' < expression (IN) of identno >]','
  [ Speed':=' ] < expression (IN) of speeddata >
  [ '\' V ':=' < expression (IN) of num > ]|
  [ '\' T ':=' < expression (IN) of num > ] ','
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\' WObj':=' < persistent (PERS) of wobjdata > ]
  [ '\' Corr ]';'
```


Continues on next page

Related information

For information about	See
Linear searches	*SearchL - Searches linearly using the robot on page 416*
Writes to a corrections entry	*CorrWrite - Writes to a correction generator on page 77*
Moves the robot circularly	*MoveC - Moves the robot circularly on page 236*
Circular movement	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Using error handlers	*Technical reference manual - RAPID overview*, section *RAPID summary - Error recovery*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*

1.147. SearchExtJ - Search with one or several mechanical units without TCP

Usage

`SearchExtJ` (*Search External Joints*) is used to search for an external axes position when moving only linear or rotating external axes. The external axes can belong to one or several mechanical units without TCP.

During the movement the system supervises a digital input signal. When the value of the signal changes to the requested one the system immediately reads the current position.

This instruction can only be used if:

- The actual program task is defined as a Motion Task
- The task controls one or several mechanical units without TCP

When using search instructions it is important to configure the I/O system to have a very short time delay from setting the physical signal until the system gets the information about the setting (use I/O unit with interrupt control, not poll control). How to do this can differ between fieldbuses. If using DeviceNet, the ABB units DSQC 651 (AD Combi I/O) and DSQC 652 (Digital I/O) will give a short time delay since they are using the connection type Change of State. If using other fieldbuses, make sure the network is properly configured in order to get the correct conditions.

Basic examples

Basic examples of the instruction `SearchExtJ` are illustrated below.

See also *More examples on page 413*.

Example 1

```
SearchExtJ di1, searchp, jpos10, vrot20;
```

The mec. unit with rotational axes is moved towards the position `jpos10` at a speed of `vrot20`. When the value of the signal `di1` changes to active, the position is stored in `searchp`.

Example 2

```
SearchExJ \Stop, di2, posx, jpos20, vlin50;
```

The mec. unit with linear axis is moved towards the position `jpos20`. When the value of the signal `di2` changes to active, the position is stored in `posx` and the ongoing movement is stopped immediately.

Arguments

```
SearchExtJ [\Stop] | [\PStop] | [\SStop] | [\Sup] Signal [\Flanks]
     SearchJointPos ToJointPos [\ID] [\UseEOffs] Speed [\T]
```

`[ \Stop ]`

Stiff Stop

Data type: `switch`

The movement is stopped as quickly as possible with hard stop when the value of the search signal changes to active. However, the external axes are moved a small distance before they stop and are not moved back to the searched position, i.e. to the position where the signal changed.

Continues on next page

`[ \PStop ]`

Path Stop

Data type: `switch`

The movement is stopped with path stop (Program Stop) when the value of the search signal changes to active. However, the external axes are moved a rather long distance before they stop and are not moved back to the searched position, i.e. to the position where the signal changed.

`[ \SStop ]`

Soft Stop

Data type: `switch`

The movement is stopped as quickly as possible with fast soft stop when the value of the search signal changes to active. However, the external axes are moved only a small distance before they stop and are not moved back to the searched position, i.e. to the position where the signal changed.

`Stop` is faster compare to `SStop`. `SStop` is faster compare to `PStop`.

`[ \Sup ]`

Supervision

Data type: `switch`

The search instruction is sensitive to signal activation during the complete movement (flying search), i.e. even after the first signal change has been reported. If more than one match occurs during a search a recoverable error is generated with the mec. units in the `ToJointPos`.

If the argument `\Stop`, `\PStop`, `\SStop` or `\Sup` is omitted (no switch used at all):

- The movement continues (flying search) to the position specified in the `ToJointPos` argument (same as with argument `\Sup`)
- An error is reported for one search hit but is not reported for more than one search hit (the first search hit is returned as the `SearchJointPos`)

`Signal`

Data type: `signaldi`

The name of the signal to supervise.

`[ \Flanks ]`

Data type: `switch`

The positive and the negative edge of the signal is valid for a search hit.

If the argument `\Flanks` is omitted, only the positive edge of the signal is valid for a search hit and a signal supervision will be activated at the beginning of a search process. This means that if the signal already has the positive value at the beginning of a search process or the communication with the signal is lost, the movement is stopped as quickly as possible with soft stop. A user recovery error (ERR_SIGSUPSEARCH) will be generated and can be handled in the error handler.

Continues on next page

`SearchJointPos`

Data type: `jointtarget`

The position of the external axes when the search signal has been triggered. The position takes any active `ExtOffs` into consideration.

`ToJointPos`

Data type: `jointtarget`

The destination point for the external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction). `SearchExtJ` always uses a stop point as zone data for the destination.

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a *MultiMove* system, if coordinated synchronized movement, and is not allowed in any other cases.

The specified ID number must be the same in all cooperating program tasks. The ID number gives a guarantee that the movements are not mixed up at runtime.

`[ \UseEOffs ]`

Use External Offset

Data type: `switch`

The offset for external axes, setup by instruction `EOffsSet`, is activated for `SearchExtJ` instruction when the argument `UseEOffs` is used. See instruction `EOffsSet` for more information about external offset.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the linear or rotating external axis.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the mec. units move. It is then substituted for the corresponding speed data.

Continues on next page

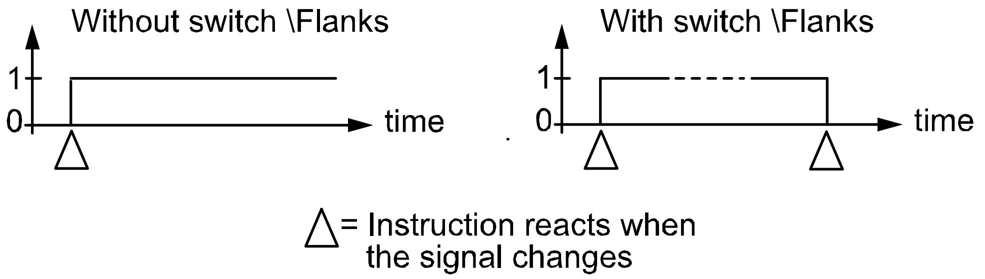
Program execution

See the instruction `MoveExtJ` for information about movement of mechanical units without TCP.

The movement always ends with a stop point, i.e. the external axes stop at the destination point. If a flying search is used, that is, the `\Sup` argument is specified or no switch is specified the movement always continues to the programmed destination point. If a search is made using the switch `\Stop`, `\PStop` or `\SStop`, the movement stops when the first search hit is detected.

The `SearchExtJ` instruction stores the position of the external axes when the value of the digital signal changes to the requested one, as illustrated in figure below.

The figure shows how flank-triggered signal detection is used (the position is only stored when the signal is changed the first time).



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More examples

More examples of how to use the instruction `SearchExtJ` are illustrated below.

Example 1

```
SearchExtJ \Sup, di1\Flanks, searchp,jpos10, vrot20;
```

The mec. unit is moved towards the position `jpos10`. When the value of the signal `di1` changes to active or passive, the position is stored in `searchp`. If the value of the signal changes twice, the program generates an error after the search process is finished.

Example 2

```
SearchExtJ \Stop, di1, sp, jpos20, vlin50;
MoveExtJ sp, vlin50, fine \Inpos := inpos50;
```

A check on the signal `di1` will be made at the beginning of the search process and if the signal already has a positive value or the communication with the signal is lost, the movement stops. Otherwise the mec. unit is moved towards the position `jpos20`. When the value of the signal `di1` changes to active, the position is stored in `sp`. The mec. unit is moved back to this point using an accurately defined stop point.

Continues on next page

Error handling

An error is reported during a search when:

- No signal detection occurred - this generates the error ERR_WHLSEARCH.
- More than one signal detection occurred – this generates the error ERR_WHLSEARCH, but only if the `\Sup` argument is used.
- The signal already has a positive value at the beginning of the search process or the communication with the signal is lost - this generates the error ERR_SIGSUPSEARCH, but only if the `\Flanks` argument is omitted.

Errors can be handled in different ways depending on the selected running mode:

- **Continuous forward** / **Instruction forward** / ERR_WHLSEARCH: No position is returned and the movement always continues to the programmed destination point. The system variable ERRNO is set to ERR_WHLSEARCH and the error can be handled in the error handler of the routine.
- **Continuous forward** / **Instruction forward** / ERR_SIGSUPSEARCH: No position is returned and the movement always stops as quickly as possible at the beginning of the search movement. The system variable ERRNO is set to ERR_SIGSUPSEARCH and the error can be handled in the error handler of the routine.
- **Instruction backward**: During backward execution, the instruction just carries out the movement without any signal supervision.

Example

```
VAR num fk;
...
MoveExtJ jpos10, vrot100, fine;
SearchExtJ \Stop, di1, sp, jpos20, vrot5;
...
ERROR
  IF ERRNO=ERR_WHLSEARCH THEN
    StorePath;
    MoveExtJ jpos10, vrot50, fine;
    RestoPath;
    RETRY;
  ELSEIF ERRNO=ERR_SIGSUPSEARCH THEN
    TPWrite "The signal of the SearchExtJ instruction is already
         high!";
    TPReadFK fk,"Try again after manual reset of signal
         ?","YES","stEmpty","stEmpty","stEmpty","NO";
    IF fk = 1 THEN
      MoveExtJ jpos10, vrot50, fine;
      RETRY;
    ELSE
      Stop;
    ENDIF
  ENDIF
```


Continues on next page

If the signal is already active at the beginning of the search process or the communication with the signal is lost, a user dialog will be activated (`TPReadFK ...;`). Reset the signal and push YES on the user dialog and the mec. unit moves back to `jpos10` and tries once more. Otherwise program execution will stop.

If the signal is passive at the beginning of the search process, the mec. unit searches from position `jpos10` to `jpos20`. If no signal detection occurs, the robot moves back to `jpos10` and tries once more.

Limitations

Limitations for searching if coordinated synchronized movements:

- If using `SearchL`, `SearchC` or `SearchExtJ` for one program task and some other move instruction in another program task, it is only possible to use flying search with switch `\Sup`. Besides that, it is only possible to do error recovery with `TRYNEXT`.
- It is possible to use all searching functions if using some of the instructions `SearchL`, `SearchC` or `SearchExtJ` in all involved program tasks with coordinated synchronized movements and generate search hits from the same digital input signal. This will generate search hits synchronously in all search instructions. Any error recovery must also be the same in all involved program tasks.
- While searching is active, it isn't possible to store current path with instruction `StorePath`.

Syntax

```
SearchExtJ
  [ '\' Stop ',' ] | [ '\' PStop ','] | [ '\' SStop ','] | [ '\'
       Sup ',' ]
  [ Signal ':=' ] < variable (VAR) of signaldi >
  ['\' Flanks]','
  [ SearchJointPos' :=' ] < var or pers (INOUT) of jointtarget > ','
  [ ToJointPos'  :=' ] < expression (IN) of jointtarget >
  [ '\' ID ':=' < expression (IN) of identno >]','
  [ '\' UseEOffs' ,' ]
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' T ':=' < expression (IN) of num > ] ';'
```

Related information

For information about	See
Move mec. units without TCP	*MoveExtJ - Move one or several mechanical units without TCP on page 250*
Definition of jointtarget	*jointtarget - Joint position data on page 1129*
Definition of velocity	*speeddata - Speed data on page 1185*
Using error handlers	*Technical reference manual - RAPID overview*, section *RAPID summary - Error recovery*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*

1.148. SearchL - Searches linearly using the robot

Usage

`SearchL` (*Search Linear*) is used to search for a position when moving the tool center point (TCP) linearly.

During the movement the robot supervises a digital input signal. When the value of the signal changes to the requested one the robot immediately reads the current position.

This instruction can typically be used when the tool held by the robot is a probe for surface detection. Using the `SearchL` instruction the outline coordinates of a work object can be obtained.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

When using search instructions it is important to configure the I/O system to have a very short time from setting the physical signal to the system to getting the information regarding the setting (use I/O unit with interrupt control, not poll control). How to do this can differ between fieldbuses. If using DeviceNet the ABB units DSQC 651 (AD Combi I/O) and DSQC 652 (Digital I/O) will give short times since they are using connection type Change of State. If using other fieldbuses make sure to configure the network in a proper way to get right conditions.

Basic examples

Basic examples of the instruction `SearchL` are illustrated below.

See also *More examples on page 420*.

Example 1

```
SearchL di1, sp, p10, v100, probe;
```

The TCP of the `probe` is moved linearly towards the position `p10` at a speed of `v100`. When the value of the signal `di1` changes to active the position is stored in `sp`.

Example 2

```
SearchL \Stop, di2, sp, p10, v100, probe;
```

The TCP of the `probe` is moved linearly towards the position `p10`. When the value of the signal `di2` changes to active the position is stored in `sp` and the robot stops immediately.

Continues on next page

Arguments

```
SearchL [\Stop] | [\PStop] | [\SStop] | [\Sup] Signal [\Flanks]
     SearchPoint ToPoint [\ID] Speed [\V] | [\T] Tool [\WObj]
     [\Corr]
```

`[ \Stop ]`

Stiff Stop

Data type: `switch`

The robot movement is stopped as quickly as possible without keeping the TCP on the path (hard stop) when the value of the search signal changes to active. However, the robot is moved a small distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed.

WARNING!

To stop the searching with stiff stop (switch `\Stop`) is only allowed if the TCP-speed is lower than 100 mm/s. At a stiff stop with higher speeds some axes can move in unpredictable directions.

`[ \PStop ]`

Path Stop

Data type: `switch`

The robot movement is stopped as quickly as possible while keeping the TCP on the path (soft stop) when the value of the search signal changes to active. However, the robot is moved a distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed.

`[ \SStop ]`

Soft Stop

Data type: `switch`

The robot movement is stopped as quickly as possible while keeping the TCP close to or on the path (soft stop) when the value of the search signal changes to active. However, the robot is only moved a small distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed. `SStop` is faster than `PStop`. But when the robot is running faster than 100 mm/s it stops in the direction of the tangent of the movement which causes it to marginally slide off the path.

Continues on next page

`[ \Sup ]`

Supervision

Data type: `switch`

The search instruction is sensitive to signal activation during the complete movement (flying search), i.e. even after the first signal change has been reported. If more than one match occurs during a search then a recoverable error is generated with the robot in the `ToPoint`.

If the argument `\Stop`, `\PStop`, `\SStop`, or `\Sup` is omitted then (no switch used at all):

- the movement continues (flying search) to the position specified in the `ToPoint` argument (same as with argument `\Sup`)
- error is reported for none search hit but is not reported for more than one search hit (first search hit is returned as the `SearchPoint`)

`Signal`

Data type: `signaldi`

The name of the signal to supervise.

`[ \Flanks ]`

Data type: `switch`

The positive and the negative edge of the signal is valid for a search hit.

If the argument `\Flanks` is omitted, only the positive edge of the signal is valid for a search hit and a signal supervision will be activated at the beginning of a search process. This means that if the signal has the positive value already at the beginning of a search process or the communication with the signal is lost then the robot movement is stopped as quickly as possible, while keeping the TCP on the path (soft stop). A user recovery error (ERR_SIGSUPSEARCH) will be generated and can be handled in the error handler.

`SearchPoint`

Data type: `robtarget`

The position of the TCP and external axes when the search signal has been triggered. The position is specified in the outermost coordinate system taking the specified tool, work object, and active `ProgDisp/ExtOffs` coordinate system into consideration.

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction). `SearchL` always uses a stop point as zone data for the destination.

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a *MultiMove* system if it is a coordinated synchronized movement, and is not allowed in any other cases.

The specified ID number must be the same in all cooperating program tasks. The ID number gives a guarantee that the movements are not mixed up at runtime.

Continues on next page

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the tool center point, the external axes, and the tool reorientation.

`[ \V ]`

Velocity

Data type: `num`

This argument is used to specify the velocity of the TCP in mm/s directly in the instruction. It is then substituted for the corresponding velocity specified in the speed data.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point that is moved to the specified destination position.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used then this argument must be specified for a linear movement relative to the work object to be performed.

`[ \Corr ]`

Correction

Data type: `switch`

Correction data written to a corrections entry by the instruction `CorrWrite` will be added to the path and destination position if this argument is present.

Continues on next page

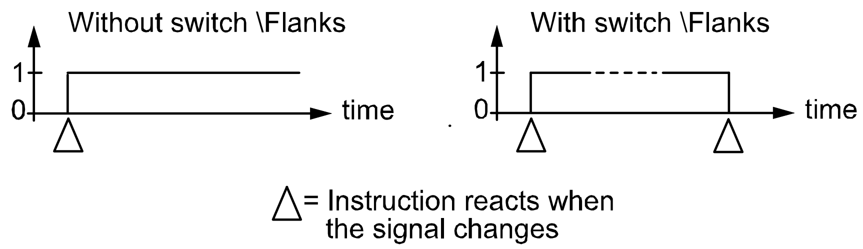
Program execution

See the instruction `MoveL` for information about linear movement.

The movement always ends with a stop point, i.e. the robot stops at the destination point. If a flying search is used, i.e. the `\Sup` argument is specified or none switch at all is specified then the robot movement always continues to the programmed destination point. If a search is made using the switch `\Stop`, `\PStop`, or `\SStop` the robot movement stops when the first search hit is detected.

The `SearchL` instruction stores the position of the TCP when the value of the digital signal changes to the requested one, as illustrated in figure below.

The figure shows how flank-triggered signal detection is used (the position is stored when the signal is changed the first time only).



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More examples

More examples of how to use the instruction `SearchL` are illustrated below.

Example 1

```
SearchL \Sup, di1\Flanks, sp, p10, v100, probe;
```

The TCP of the `probe` is moved linearly towards the position `p10`. When the value of the signal `di1` changes to active or passive the position is stored in `sp`. If the value of the signal changes twice then the program generates an error after the search process is finished.

Example 2

```
SearchL \Stop, di1, sp, p10, v100, tool1;
MoveL sp, v100, fine \Inpos := inpos50, tool1;
PDispOn *, tool1;
MoveL p100, v100, z10, tool1;
MoveL p110, v100, z10, tool1;
MoveL p120, v100, z10, tool1;
PDispOff;
```

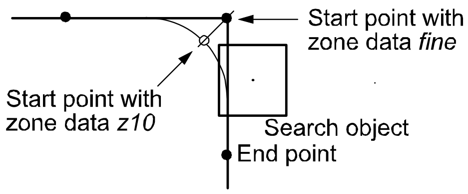
At the beginning of the search process, a check on the signal `di1` will be done and if the signal already has a positive value or the communication with the signal is lost, the robot stops. Otherwise the TCP of `tool1` is moved linearly towards the position `p10`. When the value of the signal `di1` changes to active, the position is stored in `sp`. The robot is moved back to this point using an accurately defined stop point. Using program displacement, the robot then moves relative to the searched position, `sp`.

Continues on next page

Limitations

Zone data for the positioning instruction that precedes `SearchL` must be used carefully. The start of the search, i.e. when the I/O signal is ready to react, is not, in this case, the programmed destination point of the previous positioning instruction but a point along the real robot path. The figures below illustrate examples of things that may go wrong when zone data other than `fine` is used.

The following figure shows that a match is made on the wrong side of the object because the wrong zone data was used.



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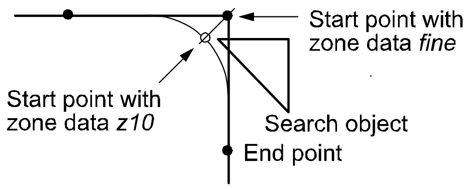
The following figure shows that no match was detected because the wrong zone data was used.



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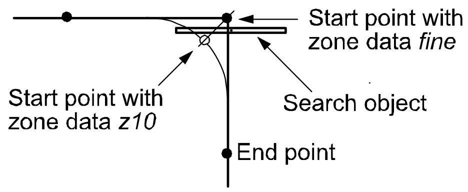
The following figure shows that no match was detected because the wrong zone data was used.



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Limitations for searching if coordinated synchronized movements:

- If using `SearchL`, `SearchC` or `SearchExtJ` for one program task and some other move instruction in other program task, it is only possible to use flying search with switch `\Sup`. Besides that, only possible to do error recovery with `TRYNEXT`.
- It's possible to use all searching functionality, if using some of the instructions `SearchL`, `SearchC` or `SearchExtJ` in all involved program tasks with coordinated synchronized movements and generate search hit from same digital input signal. This will generate search hit synchronously in all search instructions. Any error recovery must also be the same in all involved program tasks.

While searching is active, it isn't allowed to store current path with instruction `StorePath`.

Repetition accuracy for search hit position with TCP speed 20 - 1000 mm/s 0.1 - 0.3 mm.

Typical stop distance using a search velocity of 50 mm/s:

- without TCP on path (switch `\Stop`) 1-3 mm
- with TCP on path (switch `\PStop`) 15-25 mm
- with TCP near path (switch `\SStop`) 4-8 mm

Continues on next page

Limitations for searching on a conveyor:

- a search will stop the robot when hit or if the search fails, so make the search in the same direction as the conveyor moves and continue after the search-stop with a move to a safe position. Use error handling to move to a safe position when search fails.
- the repetition accuracy for the search hit position will be poorer when searching on a conveyor and depends on the speed of the conveyor and how stabil the speed is.

Error handling

An error is reported during a search when:

- no signal detection occurred - this generates the error ERR_WHLSEARCH.
- more than one signal detection occurred – this generates the error ERR_WHLSEARCH only if the `\Sup` argument is used.
- the signal already has a positive value at the beginning of the search process or the communication with the signal is lost - this generates the error ERR_SIGSUPSEARCH only if the `\Flanks` argument is omitted.

Errors can be handled in different ways depending on the selected running mode:

- **Continuous forward / Instruction forward** / ERR_WHLSEARCH: No position is returned and the movement always continues to the programmed destination point. The system variable ERRNO is set to ERR_WHLSEARCH and the error can be handled in the error handler of the routine.
- **Continuous forward / Instruction forward** / ERR_SIGSUPSEARCH No position is returned and the movement always stops as quickly as possible at the beginning of the search path. The system variable ERRNO is set to ERR_SIGSUPSEARCH and the error can be handled in the error handler of the routine.
- **Instruction backward**: During backward execution the instruction carries out the movement without any signal supervision.

Example

```
VAR num fk;
...
MoveL p10, v100, fine, tool1;
SearchL \Stop, di1, sp, p20, v100, tool1;
...
ERROR
  IF ERRNO=ERR_WHLSEARCH THEN
     StorePath;
     MoveL p10, v100, fine, tool1;
     RestoPath;
     RETRY;
```


Continues on next page

```
ELSEIF ERRNO=ERR_SIGSUPSEARCH THEN
  TPWrite "The signal of the SearchL instruction is already
      high!";
  TPReadFK fk,"Try again after manual reset of signal
      ?","YES","stEmpty","stEmpty","stEmpty","NO";
  IF fk = 1 THEN
    MoveL p10, v100, fine, tool1;
    RETRY;
  ELSE
    Stop;
  ENDIF
ENDIF
```

If the signal is already active at the beginning of the search process or the communication with the signal is lost then a user dialog will be activated (`TPReadFK ...;`). Reset the signal and push YES on the user dialog, and the robot moves back to `p10` and tries once more. Otherwise program execution will stop.

If the signal is passive at the beginning of the search process then the robot searches from position `p10` to `p20`. If no signal detection occurs then the robot moves back to `p10` and tries once more.

Syntax

```
SearchL
  [ '\' Stop ',' ] | [ '\' PStop ','] | [ '\' SStop ','] | [ '\'
      Sup ',' ]
  [ Signal ':=' ] < variable (VAR) of signaldi >
  ['\' Flanks]','
  [ SearchPoint' :=' ] < var or pers (INOUT) of robtarget > ','
  [ ToPoint' :=' ] < expression (IN) of robtarget >
  [ '\' ID ':=' < expression (IN) of identno >]','
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' V ':=' < expression (IN) of num > ] |
  [ '\' T ':=' < expression (IN) of num > ] ','
  [ Tool ´:=´ ] < persistent (PERS) of tooldata >
  [ '\' WObj' :=' < persistent (PERS) of wobjdata > ]
  [ '\' Corr ]';'
```

Related information

For information about	See
Circular searches	*SearchC - Searches circularly using the robot on page 402*
Writes to a corrections entry	*CorrWrite - Writes to a correction generator on page 77*
Moves the robot linearly	*MoveL - Moves the robot linearly on page 264*
Linear movement	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of tools	*tooldata - Tool data on page 1207*

Continues on next page

For information about	See
Definition of work objects	*wobjdata - Work object data on page 1224*
Using error handlers	*Technical reference manual - RAPID overview*, section *RAPID summary - Error recovery*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*

1.149. SenDevice - connect to a sensor device

Usage

`SenDevice` is used to connect to a sensor device connected to the serial sensor interface.

The sensor interface communicates with sensors over serial channels using the RTP1 transport protocol.

This is an example of a sensor channel configuration.

COM_PHY_CHANNEL:

- Name “COM1:”
- Connector “COM1”
- Baudrate 19200

COM_TRP:

- Name “sen1:”
- Type “RTP1”
- PhyChannel “COM1”

Basic examples

Basic examples of the instruction `SenDevice` are illustrated below.

Example 1

```
! Define variable numbers
CONST num SensorOn := 6;
CONST num XCoord := 8;
CONST num YCoord := 9;
CONST num ZCoord := 10;
VAR pos SensorPos;

! Connect to the sensor device“ sen1:” (defined in sio.cfg).
SenDevice "sen1:";

! Request start of sensor meassurements
WriteVar "sen1:", SensorOn, 1;

! Read a cartesian position from the sensor.
SensorPos.x := ReadVar "sen1:", XCoord;
SensorPos.y := ReadVar "sen1:", YCoord;
SensorPos.z := ReadVar "sen1:", ZCoord;

! Stop sensor
WriteVar "sen1:", SensorOn, 0;
```


Continues on next page

Arguments

```
SenDevice device
```

`device`

Data type: `string`

The I/O device name configured in sio.cfg for the sensor used.

Syntax

```
ReadBlock
  [ device' :=' ] < expression(IN) of string>','
  [ BlockNo' :=' ] < expression (IN) of num > ','
  [ FileName' :=' ] < expression (IN) of string > ';'
```

Related information

For information about	See
Write a sensor variable	*WriteVar - write variable on page 729*
Read a sensor variable	*ReadVar - Read variable from a device on page 958*
Write a sensor data block	*WriteBlock - write block of data to device on page 719*
Configuration of sensor communication	*Technical reference manual - System parameters*, section *Communication*

1.150. Set - Sets a digital output signal

Usage

`Set` is used to set the value of a digital output signal to one.

Basic examples

Basic examples of the instruction `Set` are illustrated below.

Example 1

```
Set do15;
```

The signal `do15` is set to 1.

Example 2

```
Set weldon;
```

The signal `weldon` is set to 1.

Arguments

```
Set Signal
```

`Signal`

Data type: `signaldo`

The name of the signal to be set to one.

Program execution

There is a short delay before the signal physically gets its new value. If you do not want the program execution to continue until the signal has got its new value then you can use the instruction `SetDO` with the optional parameter `\Sync`.

The true value depends on the configuration of the signal. If the signal is inverted in the system parameters then this instruction causes the physical channel to be set to zero.

Error handling

The following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT` if there is no contact with the unit.

Syntax

```
Set
  [ Signal ':=' ] < variable (VAR) of signaldo > ';'
```


Continues on next page

Related information

For information about	See
Setting a digital output signal to zero	*Reset - Resets a digital output signal on page 359*
Change the value of a digital output signal	*SetDO - Changes the value of a digital output signal on page 440*
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and output signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - I/O Principles*
Configuration of I/O	*Technical reference manual - System parameters*

1.151. SetAllDataVal - Set a value to all data objects in a defined set

Usage

`SetAllDataVal`(*Set All Data Value*) makes it possible to set a new value to all data objects of a certain type that match the given grammar.

Basic examples

Basic examples of the instruction `SetAllDataVal` are illustrated below.

```
VAR mydata mydata0:=0;
...
SetAllDataVal "mydata"\TypeMod:="mytypes"\Hidden,mydata0;
```

This will set all data objects of data type `mydata` in the system to the same value that the variable `mydata0` has (in the example to `0`). The user defined data type `mydata` is defined in the module `mytypes`.

Arguments

```
SetAllDataVal Type [\TypeMod] [\Object] [\Hidden] Value
```

`Type`

Data type: `string`

The type name of the data objects to be set.

`[ \TypeMod ]`

Type Module

Data type: `string`

The module name where the data type is defined if using user defined data types.

`[ \Object ]`

Data type: `string`

The default behavior is to set all data object of the data type above but this option makes it possible to name one or several objects with a regular expression. (see also instruction `SetDataSearch`)

`[ \Hidden ]`

Data type: `switch`

This also matches data objects that are in routines (routine data or parameters) hidden by some routine in the call chain.

`Value`

Data type: `anytype`

Variable which holds the new value to be set. The data type must be the same as the data type for the object to be set.

Continues on next page

Program running

The instruction will fail if the specification for `Type` or `TypeMod` is wrong.

If the matching data object is an array then all elements of the array will be set to the specified value.

If the matching data object is read-only data then the value will not be changed.

If the system doesn't have any matching data objects then the instruction will accept it and return successfully.

Limitations

For a semivalue data type it is not possible to search for the associated value data type. E.g. if searching for `dionum` then there are no search hits for signal `signaldi` and if searching for `num` then there are no search hits for signals `signalgi` or `signalai`.

It is not possible to set a value to a variable declared as `LOCAL` in a built in RAPID module.

Syntax

```
SetAllDataVal
  [ Type ':=' ] < expression (IN) of string >
  ['\'TypeMod' :='<expression (IN) of string>]
  ['\'Object' :='<expression (IN) of string>]
  ['\'Hidden ] ','
  [ Value ':='] <variable (VAR) of anytype>';'
```

Related information

For information about	See
Define a symbol set in a search session	*SetDataSearch - Define the symbol set in a search sequence on page 433*
Get next matching symbol	*GetNextSym - Get next matching symbol on page 855*
Get the value of a data object	*GetDataVal - Get the value of a data object on page 110*
Set the value of a data object	*SetDataVal - Set the value of a data object on page 437*
The related data type datapos	*datapos - Enclosing block for a data object on page 1101*

1.152. SetAO - Changes the value of an analog output signal

Usage

`SetAO` is used to change the value of an analog output signal.

Basic examples

Basic examples of the instruction `SetAO` are illustrated below.

See also *More examples on page 432*.

Example 1

```
SetAO ao2, 5.5;
```

The signal `ao2` is set to `5.5`.

Arguments

```
SetAO Signal Value
```

`Signal`

Data type: `signalao`

The name of the analog output signal to be changed.

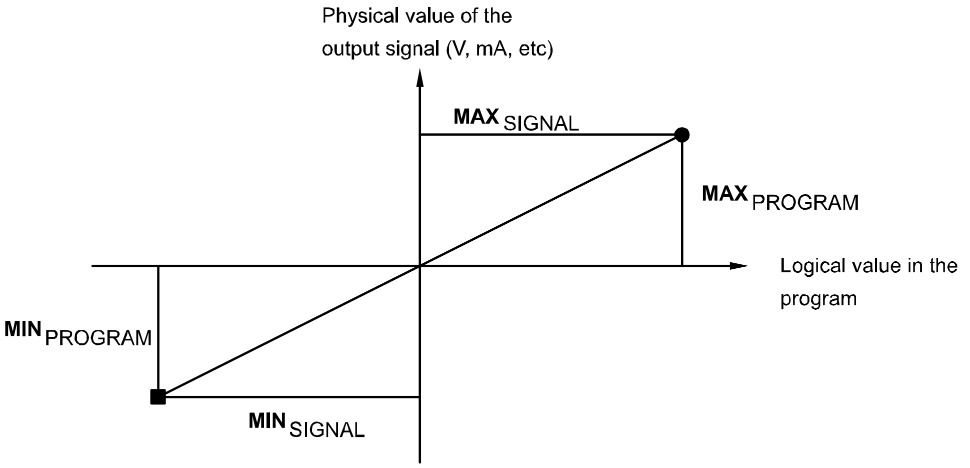
`Value`

Data type: `num`

The desired value of the signal.

Program execution

The programmed value is scaled (in accordance with the system parameters) before it is sent on the physical channel. A diagram of how analog signal values are scaled is shown in the figure below.



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Error handling

Following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the unit.

`ERR_AO_LIM`

if the programmed `Value` argument for the specified analog output signal `Signal` is outside limits.

More examples

More examples of the instruction `SetAO` are illustrated below.

Example 1

```
SetAO weldcurr, curr_outp;
```

The signal `weldcurr` is set to the same value as the current value of the variable `curr_outp`.

Syntax

```
SetAO
  [ Signal ':=' ] < variable (VAR) of signalao > ','
  [ Value ':=' ] < expression (IN) of num > ';'
```

Related information

For information about	See
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and output signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - I/O principles*
Configuration of I/O	*Technical reference manual - System parameters*

1.153. SetDataSearch - Define the symbol set in a search sequence

Usage

`SetDataSearch` is used together with function `GetNextSym` to retrieve data objects from the system.

Basic examples

Basic examples of the instruction `SetDataSearch` are illustrated below.

Example 1

```
VAR datapos block;
VAR string name;
...
SetDataSearch "robtarget"\InTask;
WHILE GetNextSym(name,block \Recursive) DO
...
```

This session will find all `robtarget`'s object in the task.

Arguments

```
SetDataSearch Type [\TypeMod] [\Object] [\PersSym]
      [\VarSym][\ConstSym] [\InTask] | [\InMod]
      [\InRout][\GlobalSym] | [\LocalSym]
```

`Type`

Data type: `string`

The data type name of the data objects to be retrieved.

`[ \TypeMod ]`

Type Module

Data type: `string`

The module name where the data type is defined, if using user defined data types.

`[ \Object ]`

Data type: `string`

The default behavior is to set all data objects of the data type above, but this option makes it possible to name one or several data objects with a regular expression.

A regular expression is a powerful mechanism to specify a grammar to match the data object names. The string could consist of either ordinary characters and meta characters. A meta character is a special operator used to represent one or more ordinary characters in the string with the purpose to extend the search. It is possible to see if a string matches a specified pattern as a whole or search within a string for a substring matching a specified pattern.

Within a regular expression all alphanumeric characters match themselves. That is to say that the pattern "abc" will only match a data object named "abc". To match all data object names containing the character sequence "abc" it is necessary to add some meta characters. The regular expression for this is ".*abc.*".

Continues on next page

The available meta character set is shown below.

Expression	Meaning
.	Any single character.
[s]	Any single character in the non-empty set s, where s is a sequence of characters. Ranges may be specified as c-c.
[^s]	Any single character not in the set s.
r*	Zero or more occurrences of the regular expression r.
r+	One or more occurrences of the regular expression r
r?	Zero or one occurrence of the regular expression r.
(r)	The regular expression r. Used for separate that regular expression from another.
r | r'	The regular expressions r or r'.
.*	Any character sequence (zero, one, or several characters).

The default behavior is to accept any symbols but if one or several of following `PersSym`, `VarSym`, or `ConstSym` is specified then only symbols that match the specification are accepted:

`[ \PersSym ]`

Persistent Symbols

Data type: `switch`

Accept persistent variable (`PERS`) symbols.

`[ \VarSym ]`

Variable Symbols

Data type: `switch`

Accept variable (`VAR`) symbols.

`[ \ConstSym ]`

Constant Symbols

Data type: `switch`

Accept constant (`CONST`) symbols.

If not one of the flags `\InTask` or `\InMod` are specified then the search is started at system level. The system level is the root to all other symbol definitions in the symbol tree. At the system level all build- in symbols are located plus the handle to the task level. At the task level all loaded global symbols are located plus the handle to the modules level.

If the `\Recursive` flag is set in `GetNextSym` then the search session will enter all loaded modules and routines below the system level.

Continues on next page

`[ \InTask ]`

In Task

Data type: `switch`

Start the search at the task level. At the task level all loaded global symbols are located plus the handle to the modules level.

If the `\Recursive` flag is set in `GetNextSym` then the search session will enter all loaded modules and routines below the task level.

`[ \InMod ]`

In Module

Data type: `string`

Start the search at the specified module level. At the module level all loaded global and local symbols declared in the specified module are located plus the handle to the routines level.

If the `\Recursive` flag is set in `GetNextSym` then the search session will enter all loaded routines below the specified module level (declared in the specified module).

`[ \InRout ]`

In Routine

Data type: `string`

Search only at the specified routine level.

The module name for the routine must be specified in the argument `\InMod`.

The default behavior is to match both local and global module symbols, but if one of following `\GlobalSym` or `\LocalSym` is specified then only symbols that match the specification are accepted:

`[ \GlobalSym ]`

Global Symbols

Data type: `switch`

Skip local module symbols.

`[ \LocalSym ]`

Local Symbols

Data type: `switch`

Skip global module symbols.

Program running

The instruction will fail if the specification for one of `Type`, `TypeMod`, `InMod`, or `InRout` is wrong.

If the system doesn’t have any matching objects the instruction will accept it and return successfully but the first `GetNextSym` will return `FALSE`.

Continues on next page

Limitations

Array data objects cannot be defined in the symbol search set and cannot be found in a search sequence.

For a semivalue data type it is not possible to search for the associated value data type. E.g. if searching for `dionum` then there are no search hits for signal `signaldi` and if searching for `num` then there are no search hits for signals `signalgi` or `signalai`.

Installed built-in symbols declared as `LOCAL` will never be found, irrespective of use of argument `\GlobalSym`, `\LocalSym` or none of these.

Installed built-in symbols declared as global or as `TASK` will always be found, irrespective of use of argument `\GlobalSym`, `\LocalSym` or none of these.

It is not possible to use `SetDataSearch` for searching for data of some `ALIAS` data type defined with `RAPID` code. No limitation for predefined `ALIAS` data type.

Syntax

```
SetDataSearch
  [ Type ':=' ] < expression (IN) of string >
  ['\'TypeMod ':='<expression (IN) of string>]
  ['\'Object ':='<expression (IN) of string>]
  ['\'PersSym ]
  ['\'VarSym ]
  ['\'ConstSym ]
  ['\'InTask ]
  | ['\'InMod' :='<expression (IN) of string>]
  ['\'InRout ':='<expression (IN) of string>]
  ['\'GlobalSym ]
  | ['\'LocalSym]' ;'
```

Related information

For information about	See
Get next matching symbol	*GetNextSym - Get next matching symbol on page 855*
Get the value of a data object	*GetDataVal - Get the value of a data object on page 110*
Set the value of many data objects	*SetAllDataVal - Set a value to all data objects in a defined set on page 429*
The related data type datapos	*datapos - Enclosing block for a data object on page 1101*

1.154. SetDataVal - Set the value of a data object

Usage

`SetDataVal` (*Set Data Value*) makes it possible to set a value for a data object that is specified with a string variable.

Basic examples

Basic examples of the instruction `SetDataVal` are illustrated below.

Example 1

```
VAR num value:=3;
...
SetDataVal "reg"+ValToStr(ReadNum(mycom)),value;
```

This will set the value `3` to a register with a number that is received from the serial channel `mycom`.

Example 2

```
VAR datapos block;
VAR bool truevar:=TRUE;
...
SetDataSearch "bool" \Object:="my.*" \InMod:="mymod"\LocalSym;
WHILE GetNextSym(name,block) DO
  SetDataVal name\Block:=block,truevar;
ENDWHILE
```

This session will set all local `bool` that begin with `my` in the module `mymod` to `TRUE`.

Example 3

```
VAR string StringArrVar_copy{2};
...
StringArrVar_copy{1} := "test1";
StringArrVar_copy{2} := "test2";
SetDataVal "StringArrVar", StringArrVar_copy;
```

This session will set the array `StringArrVar` to contain the two strings `test1` and `test2`.

Arguments

```
SetDataVal Object [\Block]|[\TaskRef]|[\TaskName] Value
```

`Object`

Data type: `string`

The name of the data object.

`[ \Block ]`

Data type: `datapos`

The enclosed block to the data object. This can only be fetched with the `GetNextSym` function.

If this argument is omitted then the value of the visible data object in the current program execution scope will be set.

Continues on next page

`[\TaskRef]`

Task Reference

Data type: `taskid`

The program task identity in which to search for the data object specified. When using this argument, you may search for `PERS` or `TASK PERS` declarations in other tasks, any other declarations will result in an error.

For all program tasks in the system the predefined variables of the data type `taskid` will be available. The variable identity will be "taskname"+"Id", e.g. for the `T_ROB1` task the variable identity will be `T_ROB1Id`.

`[\TaskName]`

Data type: `string`

The program task name in which to search for the data object specified. When using this argument, you may search for `PERS` or `TASK PERS` declarations in other tasks, any other declarations will result in an error.

`Value`

Data type: `anytype`

Variable which holds the new value to be set. The data type must be the same as the data type for the data object to be set. The set value must be fetched from a variable but can be stored in a variable or persistent.

Error handling

The system variable `ERRNO` is set to `ERR_SYM_ACCESS` if:

- the data object is non-existent
- the data object is read-only data
- the data object is routine data or routine parameter and not located in the current active routine
- searching in other tasks for other declarations then `PERS` or `TASK PERS`

When using the arguments `TaskRef` or `TaskName` you may search for `PERS` or `TASK PERS` declarations in other tasks, any other declarations will result in an error and the system variable `ERRNO` is set to `ERR_SYM_ACCESS`. Searching for a `PERS` declared as `LOCAL` in other tasks will also result in an error and the system variable `ERRNO` is set to `ERR_SYM_ACCESS`.

The system variable `ERRNO` is set to `ERR_INVDIM` if the data object and the variable used in argument `Value` have different dimensions.

The error can be handled in the error handler of the routine.

Limitations

For a semivalue data type it is not possible to search for the associated value data type. E.g. if searching for `dionum` then no search hit for signal `signaldi` will be obtained and if searching for `num` then no search hit for signals `signalgi` or `signalai` will be obtained.

It is not possible to set a value to a variable declared as `LOCAL` in a built-in RAPID module.

Continues on next page

Syntax

```
SetDataVal
  [ Object ':=' ] < expression (IN) of string >
  ['\'Block' :='<variable (VAR) of datapos>]
  |[ '\'TaskRef' :=' <variable (VAR) of taskid>]
  |[ '\'TaskName' :=' <expression (IN) of string>] ',']
  [ Value ':=' ] <variable (VAR) of anytype>]';'
```

Related information

For information about	See
Define a symbol set in a search session	*SetDataSearch - Define the symbol set in a search sequence on page 433*
Get next matching symbol	*GetNextSym - Get next matching symbol on page 855*
Get the value of a data object	*GetDataVal - Get the value of a data object on page 110*
Set the value of many data objects	*SetAllDataVal - Set a value to all data objects in a defined set on page 429*
The related data type datapos	*datapos - Enclosing block for a data object on page 1101*

1.155. SetDO - Changes the value of a digital output signal

Usage

`SetDO` is used to change the value of a digital output signal, with or without a time delay or synchronization.

Basic examples

Basic examples of the instruction `SetDO` are illustrated below.

Example 1

```
SetDO do15, 1;
```

The signal `do15` is set to `1`.

Example 2

```
SetDO weld, off;
```

The signal `weld` is set to `off`.

Example 3

```
SetDO \SDelay := 0.2, weld, high;
```

The signal `weld` is set to `high` with a delay of `0.2` s. However, program execution continues with the next instruction.

Example 4

```
SetDO \Sync ,do1, 0;
```

The signal `do1` is set to `0`. Program execution waits until the signal is physically set to the specified value.

Arguments

```
SetDO [ \SDelay ]|[ \Sync ] Signal Value
```

`[ \SDelay ]`

Signal Delay

Data type: `num`

Delays the change for the amount of time given in seconds (max. 2000 s). Program execution continues directly with the next instruction. After the given time delay the signal is changed without the rest of the program execution being affected.

`[ \Sync ]`

Synchronization

Data type: `switch`

If this argument is used then the program execution will wait until the signal is physically set to the specified value.

`Signal`

Data type: `signaldo`

The name of the signal to be changed.

Continues on next page

`Value`

Data type: `dionum`

The desired value of the signal 0 or 1.

Specified Value	Set digital output to
0	0
Any value except 0	1

Program execution

The true value depends on the configuration of the signal. If the signal is inverted in the system parameters then the value of the physical channel is the opposite.

If neither of the arguments `\SDelay` or `\Sync` are used then the signal will be set as fast as possible, and the next instruction will be executed at once without waiting for the signal to be physically set.

Limitations

If a `SetDO` with a `\SDelay` argument is followed by a new `SetDO` on the same signal, with or without `\SDelay` argument, then the first `SetDO` will be cancelled if the second `SetDO` is executed before the delay time of the first `SetDO` have expired.

Error handling

The following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the unit.

`ERR_ARGVALERR`

if the value for the `SDelay` argument exceeds the maximum value allowed (2000 s).

Syntax

```
SetDO
  [ '\' SDelay ':=' < expression (IN) of num > ',' ]
  |[ '\' Sync ',' ]
  [ Signal ':=' ] < variable (VAR) of signaldo > ','
  [ Value ':=' ] < expression (IN) of dionum > ';'
```

Related information

For information about	See
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - input and output signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - I/O Principles*
Configuration of I/O	*Technical reference manual - System parameters*

1.156. SetGO - Changes the value of a group of digital output signals

Usage

`SetGO` is used to change the value of a group of digital output signals with or without a time delay.

Basic examples

Basic examples of the instruction `SetGO` are illustrated below.

Example 1

```
SetGO go2, 12;
```

The signal `go2` is set to `12`. If `go2` comprises 4 signals, e.g. outputs 6-9, then outputs 6 and 7 are set to zero while outputs 8 and 9 are set to one.

Example 2

```
SetGO \SDelay := 0.4, go2, 10;
```

The signal `go2` is set to `10`. If `go2` comprises 4 signals, e.g. outputs 6-9, then outputs 6 and 8 are set to zero while outputs 7 and 9 are set to one with a delay of `0.4` s. However program execution continues with the next instruction.

Example 3

```
SetGO go32, 4294967295;
```

The signal `go32` is set to `4294967295`. `go32` comprises 32 signals, which are all set to one.

Arguments

```
SetGO [ \SDelay ] Signal Value | Dvalue
```

`[ \SDelay ]`

Signal Delay

Data type: `num`

Delays the change for the period of time stated in seconds (max. 2000 s). Program execution continues directly with the next instruction. After the specified time delay the value of the signals is changed without the rest of the program execution being affected.

If the argument is omitted then the signal values are changed directly.

`Signal`

Data type: `signalgo`

The name of the signal group to be changed.

`Value`

Data type: `num`

The desired value of the signal group (a positive integer) is shown in the table below.

The permitted value is dependent on the number of signals in the group. A `num` datatype can hold the value for a group of 23 signals or less.

Continues on next page

`Dvalue`

Data type: `dnum`

The desired value of the signal group (a positive integer) is shown in the table below.

The permitted value is dependent on the number of signals in the group. A dnum datatype can hold the value for a group of 32 signals or less.

No. of signals	Permitted Value	Permitted Dvalue
1	0-1	0-1
2	0-3	0-3
3	0-7	0-7
4	0-15	0-15
5	0-31	0-31
6	0-63	0-63
7	0-127	0-127
8	0-255	0-255
9	0-511	0-511
10	0-1023	0-1023
11	0-2047	0-2047
12	0-4095	0-4095
13	0-8191	0-8191
14	0-16383	0-16383
15	0-32767	0-32767
16	0-65535	0-65535
17	0-131071	0-131071
18	0-262143	0-262143
19	0-524287	0-524287
20	0-1048575	0-1048575
21	0-2097151	0-2097151
22	0-4194303	0-4194303
23	0-8388607	0-8388607
24	*	0-16777215
25	*	0-33554431
26	*	0-67108863
27	*	0-134217727
28	*	0-268435455
29	*	0-536870911
30	*	0-1073741823
31	*	0-2147483647
32	*	0-4294967295

*) The `Value` argument of type `num` can only hold up to 23 signals compared to the `Dvalue` argument of type`dnum` that can hold up to 32 signals.

Continues on next page

Program execution

The programmed value is converted to an unsigned binary number. This binary number is sent on the signal group with the result that individual signals in the group are set to 0 or 1. Due to internal delays the value of the signal may be undefined for a short period of time.

Limitations

Maximum number of signals that can be used for a group is 23 if argument `Value` is used and 32 if argument `Dvalue` is used. This limitation is valid for all instructions and functions using group signals.

Error handling

The following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the unit.

`ERR_ARGVALERR`

if the value for the `SDelay` argument exceeds the maximum value allowed (2000 s).

`ERR_GO_LIM`

if the programmed `Value` or `Dvalue` argument for the specified digital group output signal `Signal` is outside limits.

Syntax

```
SetGO
  [ '\' SDelay ':=' < expression (IN) of num > ',' ]
  [ Signal ':=' ] < variable (VAR) of signalgo > ','
  [ Value ':=' ] < expression (IN) of num >
  | [ Dvalue' :=' ] < expression (IN) of dnum > ';'
```

Related information

For information about	See
Other input/output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and output signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - I/O principles*
Configuration of I/O (system parameters)	*Technical reference manual - System parameters*

1.157. SetSysData - Set system data

Usage

`SetSysData` activates the specified system data name for the specified data type.

With this instruction it is possible to change the current active Tool, Work Object, or PayLoad for the robot in actual or connected motion task.

Basic examples

Basic examples of the instruction `SetSysData` are illustrated below.

Example 1

```
SetSysData tool5;
```

The tool `tool5` is activated.

```
SetSysData tool0 \ObjectName := "tool6";
```

The tool `tool6` is activated.

```
SetSysData anytool \ObjectName := "tool2";
```

The tool `tool2` is activated.

Arguments

```
SetSysData SourceObject [\ObjectName]
```

`SourceObject`

Data type: `anytype`

Persistent variable that should be active as current system data.

The data type of this argument also specifies the type of system data to be activated for the robot in actual or connected motion task.

Data type	Type of system data
tooldata	Tool
wobjdata	Work Object
loaddata	Payload

Entire array or record component can not be used.

`[ \ObjectName ]`

Data type: `string`

If this optional argument is specified then it specifies the name of the data object to be active (overrides name specified in argument `SourceObject`). The data type of the data object to be active is always fetched from the argument `SourceObject`.

Program execution

The current active system data object for the Tool, Work Object, or PayLoad is set according to the arguments.

Note that this instruction only activates a new data object (or the same as before) and never changes the value of any data object.

Continues on next page

Syntax

```
SetSysData
[ SourceObject':='] < persistent(PERS) of anytype>
     ['\'ObjectName':=' < expression (IN) of string> ] ';'
```

Related information

For information about	See
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Definition of payload	*loaddata - Load data on page 1132*
Get system data	*GetSysData - Get system data on page 113*

1.158. SingArea - Defines interpolation around singular points

Usage

`SingArea` is used to define how the robot is to move in the proximity of singular points.

`SingArea` is also used to define linear and circular interpolation for robots with less than six axes.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `SingArea` are illustrated below.

Example 1

```
SingArea \Wrist;
```

The orientation of the tool may be changed slightly in order to pass a singular point (axes 4 and 6 in line).

Robots with less than six axes may not be able to reach an interpolated tool orientation. By using `SingArea \Wrist` the robot can achieve the movement but the orientation of the tool will be slightly changed.

Example 2

```
SingArea \Off;
```

The tool orientation is not allowed to differ from the programmed orientation. If a singular point is passed then one or more axes may perform a sweeping movement resulting in a reduction in velocity.

Robots with less than six axes may not be able to reach a programmed tool orientation. As a result the robot will stop.

Arguments

```
SingArea [\Wrist]|[\Off]
```

[`\Wrist`]

Data type: `switch`

The tool orientation is allowed to differ somewhat in order to avoid wrist singularity. Used when axes 4 and 6 are parallel (axis 5 at 0 degrees). Also used for linear and circular interpolation of robots with less than six axes where the tool orientation is allowed to differ.

[`\Off`]

Data type: `switch`

The tool orientation is not allowed to differ. Used when no singular points are passed or when the orientation is not permitted to be changed.

If none of the arguments are specified the system will be set to `\Off`.

Continues on next page

Program execution

If the arguments `\Wrist` is specified then the orientation is joint-interpolated to avoid singular points. In this way the TCP follows the correct path, but the orientation of the tool deviates somewhat. This will also happen when a singular point is not passed.

The specified interpolation applies to all subsequent movements until a new `SingArea` instruction is executed.

The movement is only affected on execution of linear or circular interpolation.

By default, program execution automatically uses the `Off` argument for robots with six axes. Robots with less than six axes may use either the `Off` argument or the `/Wrist` argument by default. This is automatically set in event routine `SYS_RESET`.

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

Syntax

```
SingArea
  [ '\' Wrist ] | ['\' Off ] ';'
```

Related information

For information about	See
Singularity	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Singularities*
Interpolation	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution*

1.159. SkipWarn - Skip the latest warning

Usage

`SkipWarn` (*Skip Warning*) is used to skip the latest generated warning message to be stored in the Event Log during execution in running mode continuously or cycle (no warnings skipped in FWD or BWD step).

With `SkipWarn` it is possible to repeatedly do error recovery in RAPID without filling the Event Log with only warning messages.

Basic examples

Basic examples of the instruction `SkipWarn` are illustrated below.

Example 1

```
  %"notexistingproc"%;
  nextinstruction;
ERROR
  IF ERRNO = ERR_REFUNKPRC THEN
    SkipWarn;
    TRYNEXT;
  ENDIF
ENDPROC
```

The program will execute the `nextinstruction` and no warning message will be stored in the Event Log.

Syntax

```
SkipWarn ';'
```

Related information

For information about	See
Error recovery	*Technical reference manual - RAPID overview*, section *RAPID Summary - Error Recovery* *Technical reference manual - RAPID overview*, section *Basic Characteristics - Error Recovery*
Error number	*errnum - Error number on page 1108*

1.160. SocketAccept - Accept an incoming connection

Usage

`SocketAccept` is used to accept incoming connection requests. `SocketAccept` can only be used for server applications.

Basic examples

Basic examples of the instruction `SocketAccept` are illustrated below.

See also *More examples on page 451*.

Example 1

```
VAR socketdev server_socket;
VAR socketdev client_socket;
...
SocketCreate server_socket;
SocketBind server_socket,"192.168.0.1", 1025;
SocketListen server_socket;
SocketAccept server_socket, client_socket;
```

A server socket is created and bound to port `1025` on the controller network address `192.168.0.1`. After execution of `SocketListen` the server socket starts to listen for incoming connections on this port and address. `SocketAccept` waits for any incoming connections, accepts the connection request, and returns a client socket for the established connection.

Arguments

```
SocketAccept Socket ClientSocket [\ClientAddress] [ \Time ]
```

`Socket`

Data type: `socketdev`

The server sockets that are waiting for incoming connections. The socket must already be created, bounded, and ready for listening.

`ClientSocket`

Data type: `socketdev`

The returned new client socket that will be updated with the accepted incoming connection request.

`[\ClientAddress]`

Data type: `string`

The variable that will be updated with the IP-address of the accepted incoming connection request.

Continues on next page

`[\Time]`

Data type: `num`

The maximum amount of time [s] that program execution waits for incoming connections. If this time runs out before any incoming connection then the error handler will be called, if there is one, with the error code `ERR_SOCK_TIMEOUT`. If there is no error handler then the execution will be stopped.

If parameter `\Time` is not used then the waiting time is 60 s. To wait forever, use the predefined constant `WAIT_MAX`.

Program execution

The server socket will wait for any incoming connection requests. When accepting the incoming connection request the instruction is ready and the returned client socket is by default connected and can be used in `SocketSend` and `SocketReceive` instructions.

More examples

More examples of the instruction `SocketAccept` are illustrated below.

Example 1

```
VAR socketdev server_socket;
VAR socketdev client_socket;
VAR string receive_string;
VAR string client_ip;
...
SocketCreate server_socket;
SocketBind server_socket, "192.168.0.1", 1025;
SocketListen server_socket;
WHILE TRUE DO
  SocketAccept server_socket, client_socket
       \ClientAddress:=client_ip;
  SocketReceive client_socket \Str := receive_string;
  SocketSend client_socket \Str := "Hello client with ip-address "
       +client_ip;
  ! Wait for client acknowledge
  ...
  SocketClose client_socket;
ENDWHILE
ERROR
  RETRY;
UNDO
  SocketClose server_socket;
  SocketClose client_socket;
```

A server socket is created and bound to port `1025` on the controller network address `192.168.0.1`. After execution of `SocketListen` the server socket starts to listen for incoming connections on this port and address. `SocketAccept` will accept the incoming connection from some client and store the client address in the string `client_ip`. Then the server receives a string message from the client and stores the message in `receive_string`. Then the server responds with the message `" Hello client with ip-address xxx.xxx.x.x"` and closes the client connection.

Continues on next page

After that the server is ready for a connection from the same or some other client in the `WHILE` loop. If PP is moved to main in the program then all open sockets are closed (`SocketClose` can always be done even if the socket is not created).

Error handling

The following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

`ERR_SOCK_CLOSED`	The socket is closed (has been closed or is not created). Use `SocketCreate` to create a new socket.
`ERR_SOCK_TIMEOUT`	The connection was not established within the time out time

Syntax

```
SocketAccept
  [ Socket ´:=´ ] < variable (VAR) of socketdev > ','
  [ ClientSocket ´:=´ ] < variable (VAR) of socketdev >
  [ '\' ClientAddress ´:=´ < variable (VAR) of string> ]
  [ '\' Time ´:=´ < expression (IN) of num > ] ';'
```

Related information

For information about	See
Socket communication in general	*Application manual - Robot communication and I/O control*, section *Socket Messaging*
Create a new socket	*SocketCreate - Create a new socket on page 460*
Connect to remote computer (only client)	*SocketConnect - Connect to a remote computer on page 457*
Send data to remote computer	*SocketSend - Send data to remote computer on page 469*
Receive data from remote computer	*SocketReceive - Receive data from remote computer on page 464*
Close the socket	*SocketClose - Close a socket on page 455*
Bind a socket (only server)	*SocketBind - Bind a socket to my IP-address and port on page 453*
Listening connections (only server)	*SocketListen - Listen for incoming connections on page 462*
Get current socket state	*SocketGetStatus - Get current socket state on page 973*
Example client socket application	*SocketSend - Send data to remote computer on page 469*
Example of server socket application	*SocketReceive - Receive data from remote computer on page 464*

1.161. SocketBind - Bind a socket to my IP-address and port

Usage

`SocketBind` is used to bind a socket to the specified server IP-address and port number. `SocketBind` can only be used for server applications.

Basic examples

Basic examples of the instruction `SocketBind` are illustrated below.

Example 1

```
VAR socketdev server_socket;

SocketCreate server_socket;
SocketBind server_socket, "192.168.0.1", 1025;
```

A server socket is created and bound to port `1025` on the controller network address `192.168.0.1`. The server socket can now be used in an `SocketListen` instruction to listen for incoming connections on this port and address.

Arguments

```
SocketBind Socket LocalAddress LocalPort
```

`Socket`

Data type: `socketdev`

The server socket to bind. The socket must be created but not already bound.

`LocalAddress`

Data type: `string`

The server network address to bind the socket to. The only valid addresses are any public LAN addresses or the controller service port address 192.168.125.1.

`LocalPort`

Data type: `num`

The server port number to bind the socket to. Generally ports 1025-4999 are free to use. Ports below 1025 can already be taken.

Program execution

The server socked is bound to the specified server port and IP-address.

An error is generated if the specified port is already in use.

Use the `SocketBind` and `SocketListen` instructions in the startup of the program to associate a local address with a socket and then listen for incoming connections on the specified port. This is recommended to do only once for each socket and port that is used.

Continues on next page

Error handling

The following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

`ERR_SOCK_CLOSED`	The socket is closed (has been closed or is not created) Use `SocketCreate` to create a new socket.
`ERR_SOCK_ADDR_INUSE`	The address and port is already in use and can not be used again. Use a different port number..

Syntax

```
SocketBind
  [ Socket ´:=´ ] < variable (VAR) of socketdev > ','
  [ LocalAddress ´:=´ ] < expression (IN) of string > ','
  [ LocalPort ´:=´ ] < expression (IN) of num > ';'
```

Related information

For information about	See
Socket communication in general	*Application manual - Robot communication and I/O control*, section *Socket Messaging*
Create a new socket	*SocketCreate - Create a new socket on page 460*
Connect to remote computer (only client)	*SocketConnect - Connect to a remote computer on page 457*
Send data to remote computer	*SocketSend - Send data to remote computer on page 469*
Receive data from remote computer	*SocketReceive - Receive data from remote computer on page 464*
Close the socket	*SocketClose - Close a socket on page 455*
Listening connections (only server)	*SocketListen - Listen for incoming connections on page 462*
Accept connections (only server)	*SocketAccept - Accept an incoming connection on page 450*
Get current socket state	*SocketGetStatus - Get current socket state on page 973*
Example client socket application	*SocketSend - Send data to remote computer on page 469*
Example server socket application	*SocketReceive - Receive data from remote computer on page 464*

1.162. SocketClose - Close a socket

Usage

`SocketClose` is used when a socket connection is no longer going to be used.

After a socket has been closed it cannot be used in any socket call except `SocketCreate`.

Basic examples

Basic examples of the instruction `SocketClose` are illustrated below.

Example 1

```
SocketClose socket1;
```

The socket is closed and can not be used anymore.

Arguments

```
SocketClose Socket
```

`Socket`

Data type: `socketdev`

The socket to be closed.

Program execution

The socket will be closed and its allocated resources will be released.

Any socket can be closed at any time. The socket can not be used after closing. However it can be reused for a new connection after a call to `SocketCreate`.

Limitations

Closing the socket connection immediately after sending the data with `SocketSend` can lead to loss of sent data. This is because `TCP/IP` socket has built-in functionality to resend the data if there is some communication problem.

To avoid such problems with loss of data, do the following before `SocketClose`:

- handshake the shutdown or
- `WaitTime` 2

Avoid fast loops with `SocketCreate ... SocketClose`, because the socket is not really closed until a certain time (TCP/IP functionality).

Syntax

```
SocketClose
  [ Socket ':=' ] < variable (VAR) of socketdev > ';'
```


Continues on next page

Related information

For information about	See
Socket communication in general	*Application manual - Robot communication and I/O control*, section *Socket Messaging*
Create a new socket	*SocketCreate - Create a new socket on page 460*
Connect to a remote computer (only client)	*SocketConnect - Connect to a remote computer on page 457*
Send data to remote computer	*SocketSend - Send data to remote computer on page 469*
Receive data from remote computer	*SocketReceive - Receive data from remote computer on page 464*
Bind a socket (only server)	*SocketBind - Bind a socket to my IP-address and port on page 453*
Listening connections (only server)	*SocketListen - Listen for incoming connections on page 462*
Accept connections (only server)	*SocketAccept - Accept an incoming connection on page 450*t
Get current socket state	*SocketGetStatus - Get current socket state on page 973*
Example client socket application	*SocketSend - Send data to remote computer on page 469*
Example server socket application	*SocketReceive - Receive data from remote computer on page 464*

1.163. SocketConnect - Connect to a remote computer

Usage

`SocketConnect` is used to connect the socket to a remote computer in a client application.

Basic examples

Basic examples of the instruction `SocketConnect` are illustrated below.

See also *More examples on page 458*.

Example 1

```
SocketConnect socket1, "192.168.0.1", 1025;
```

Trying to connect to a remote computer at ip-address `192.168.0.1` and port `1025`.

Arguments

```
SocketConnect Socket Address Port [\Time]
```

`Socket`

Data type: `socketdev`

The client socket to connect. The socket must be created but not already connected.

`Address`

Data type: `string`

The address of the remote computer. The remote computer must be specified as an IP address. It is not possible to use the name of the remote computer.

`Port`

Data type: `num`

The port on the remote computer. Generally ports 1025-4999 are free to use. Ports below 1025 can already be taken.

`[ \Time ]`

Data type: `num`

The maximum amount of time [s] that program execution waits for the connection to be accepted or denied. If this time runs out before the condition is met then the error handler will be called, if there is one, with the error code `ERR_SOCK_TIMEOUT`. If there is no error handler then the execution will be stopped.

If parameter `\Time` is not used the waiting time is 60 s. To wait forever, use the predefined constant `WAIT_MAX`.

Program execution

The socket tries to connect to the remote computer on the specified address and port. The program execution will wait until the connection is established, failed, or a timeout occurs.

Continues on next page

More examples

More examples of the instruction `SocketConnect` are illustrated below.

Example 1

```
VAR num retry_no := 0;
VAR socketdev my_socket;
...
SocketCreate my_socket;
SocketConnect my_socket, "192.168.0.1", 1025;
...
ERROR
  IF ERRNO = ERR_SOCK_TIMEOUT THEN
    IF retry_no < 5 THEN
      WaitTime 1;
      retry_no := retry_no + 1;
      RETRY;
    ELSE
      RAISE;
    ENDIF
  ENDIF
```

A socket is created and tries to connect to a remote computer. If the connection is not established within the default time-out time, i.e. 60 seconds, then the error handler retries to connect. Four retries are attemped then the error is reported to the user.

Error handling

The following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

`ERR_SOCK_CLOSED`	The socket is closed (has been closed or is not created). Use `SocketCreate` to create a new socket.
`ERR_SOCK_TIMEOUT`	The connection was not established within the time-out time.

Syntax

```
SocketConnect
  [ Socket ´:=´ ] < variable (VAR) of socketdev > ','
  [ Address ´:=´ ] < expression (IN) of string > ','
  [ Port ´:=´ ] < expression (IN) of num >
  [ '\' Time ´:=´ < expression (IN) of num > ] ';'
```


Continues on next page

Related information

For information about	Described in:
Socket communication in general	*Application manual - Robot communication and I/O control*
Create a new socket	*SocketCreate - Create a new socket on page 460*
Send data to remote computer	*SocketSend - Send data to remote computer on page 469*
Receive data from remote computer	*SocketReceive - Receive data from remote computer on page 464*
Bind a socket (only server)	*SocketBind - Bind a socket to my IP-address and port on page 453*
Listening connections (only server)	*SocketListen - Listen for incoming connections on page 462*
Accept connections (only server)	*SocketAccept - Accept an incoming connection on page 450*
Get current socket state	*SocketGetStatus - Get current socket state on page 973*
Example client socket application	*SocketSend - Send data to remote computer on page 469*
Example server socket application	*SocketReceive - Receive data from remote computer on page 464*

1.164. SocketCreate - Create a new socket

Usage

`SocketCreate` is used to create a new socket for connection based communication.

The socket messaging is of stream type protocol TCP/IP with delivery guarantee. Both server and client application can be developed. Datagram protocol UDP/IP with broadcast is not supported.

Basic examples

Basic examples of the instruction `SocketCreate` are illustrated below.

Example 1

```
VAR socketdev socket1;
...
SocketCreate socket1;
```

A new socket device is created and assigned into the variable `socket1`.

Arguments

```
SocketCreate Socket
```

`Socket`

Data type: `socketdev`

The variable for storage of the system's internal socket data.

Program execution

The instruction creates a new socket device.

The socket must not already be in use. The socket is in use between `SocketCreate` and `SocketClose`.

Limitations

Any number of sockets can be declared but it is only possible to use 8 sockets at the same time.

Avoid fast loops with `SocketCreate ... SocketClose`, because the socket is not really closed until a certain time (TCP/IP functionality).

Syntax

```
SocketCreate
  [ Socket ':=' ] < variable (VAR) of socketdev > ';'
```


Continues on next page

Related information

For information about	See
Socket communication in general	*Application manual - Robot communication and I/O control*, section *Socket Messaging*
Connect to remote computer (only client)	*SocketConnect - Connect to a remote computer on page 457*
Send data to remote computer	*SocketSend - Send data to remote computer on page 469*
Receive data from remote computer	*SocketReceive - Receive data from remote computer on page 464*
Close the socket	*SocketClose - Close a socket on page 455*
Bind a socket (only server)	*SocketBind - Bind a socket to my IP-address and port on page 453*
Listening connections (only server)	*SocketListen - Listen for incoming connections on page 462*
Accept connections (only server)	*SocketAccept - Accept an incoming connection on page 450*
Get current socket state	*SocketGetStatus - Get current socket state on page 973*
Example client socket application	*SocketSend - Send data to remote computer on page 469*
Example server socket application	*SocketReceive - Receive data from remote computer on page 464*

1.165. SocketListen - Listen for incoming connections

Usage

`SocketListen` is used to start listening for incoming connections, i.e. start acting as a server. `SocketListen` can only used for server applications.

Basic examples

Basic examples of the instruction `SocketListen` are illustrated below.

Example 1

```
VAR socketdev server_socket;
VAR socketdev client_socket;
...
SocketCreate server_socket;
SocketBind server_socket, "192.168.0.1", 1025;
SocketListen server_socket;
WHILE listening DO;
  ! Waiting for a connection request
  SocketAccept server_socket, client_socket;
```

A server socket is created and bound to port `1025` on the controller network address `192.168.0.1`. After execution of `SocketListen` the server socket starts to listen for incoming connections on this port and address.

Arguments

```
SocketListen Socket
```

`Socket`

Data type: `socketdev`

The server socket that should start listening for incoming connections. The socket must already be created and bound.

Program execution

The server socket start listening for incoming connections. When the instruction is ready the socket is ready to accept an incoming connection.

Use the `SocketBind` and `SocketListen` instructions in the startup of the program to associate a local address with a socket and then listen for incoming connections on the specified port. This is recommended to do only once for each socket and port that is used.

Error handling

The following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

`ERR_SOCK_CLOSED`	The socket is closed (has been closed or is not created). Use `SocketCreate` to create a new socket.

Syntax

```
SocketListen
  [ Socket ':=' ] < variable (VAR) of socketdev > ';'
```

Continues on next page

Related information

For information about	See
Socket communication in general	*Application manual - Robot communication and I/O control*, section *Socket Messaging*
Create a new socket	*SocketCreate - Create a new socket on page 460*
Connect to remote computer (only client)	*SocketConnect - Connect to a remote computer on page 457*
Send data to remote computer	*SocketSend - Send data to remote computer on page 469*
Receive data from remote computer	*SocketReceive - Receive data from remote computer on page 464*
Close the socket	*SocketClose - Close a socket on page 455*
Bind a socket (only server)	*SocketBind - Bind a socket to my IP-address and port on page 453*
Accept connections (only server)	*SocketAccept - Accept an incoming connection on page 450*
Get current socket state	*SocketGetStatus - Get current socket state on page 973*
Example client socket application	*SocketSend - Send data to remote computer on page 469*
Example server socket application	*SocketReceive - Receive data from remote computer on page 464*

1.166. SocketReceive - Receive data from remote computer

Usage

`SocketReceive` is used for receiving data from a remote computer. `SocketReceive` can be used both for client and server applications.

Basic examples

Basic examples of the instruction `SocketReceive` are illustrated below.

See also *More examples on page 466*.

Example 1

```
VAR string str_data;
...
SocketReceive socket1 \Str := str_data;
```

Receive data from a remote computer and store it in the string variable `str_data`.

Arguments

```
SocketReceive Socket [ \Str ] | [ \RawData ] | [ \Data ]
      [\ReadNoOfBytes] [\NoRecBytes] [\Time]
```

`Socket`

Data type: `socketdev`

In a client application where the socket receives the data, the socket must already be created and connected.

In a server application where the socket receives the data, the socket must already be accepted.

`[ \Str ]`

Data type: `string`

The variable in which the received `string` data should be stored. Max. number of characters 80 can be handled.

`[ \RawData ]`

Data type: `rawbytes`

The variable in which the received rawbytes data should be stored. Max. number of `rawbytes` 1024 can be handled.

`[ \Data ]`

Data type: `array of byte`

The variable in which the received byte data should be stored. Max. number of `byte` 1024 can be handled.

Only one of the optional parameters `\Str`, `\RawData`, and `\Data` can be used at the same time.

Continues on next page

`[ \ReadNoOfBytes ]`

Read number of Bytes

Data type: `num`

The number of bytes to read. The minimum value of bytes to read is 1, and the maximum amount is the value of the size of the data type used, i.e. 80 bytes if using a variable of the data type `string`.

If communicating with a client that always sends a fixed number of bytes, this optional parameter can be used to specify that the same amount of bytes should be read for each `SocketReceive` instruction.

If the sender sends RawData, the receiver needs to specify that 4 bytes should be received for each `rawbytes` sent.

`[ \NoRecBytes ]`

Number Received Bytes

Data type: `num`

Variable for storage of the number of bytes needed from the specified `socketdev`.

The same result can also be achieved with

- function `StrLen` on varable in argument `\Str`
- function `RawBytesLen` on variable in argument `\RawData`

`[ \Time ]`

Data type: `num`

The maximum amount of time [s] that program execution waits for the data to be received. If this time runs out before the data is transferred then the error handler will be called, if there is one, with the error code `ERR_SOCK_TIMEOUT`. If there is no error handler then the execution will be stopped.

If parameter `\Time` is not used then the waiting time is 60 s. To wait forever, use the predefined constant `WAIT_MAX`.

Program execution

The execution of `SocketReceive` will wait until the data is available or fail with a timeout error.

The amount of bytes read is specified by the the data type used in the instruction. If using a `string` data type to receive data in, 80 bytes is received if there is 80 bytes that can be read. If using optional argument `ReadNoOfBytes` the user can specify how many bytes that should be received for each `SocketReceive`.

The data that is transferred on the cable is always bytes, max. 1024 bytes in one message. No header is added by default to the message. The usage of any header is reserved for the actual application.

Parameter	Input data	Cable data	Output data
`\Str`	1 char	1 byte (8 bits)	1 char
`\RawData`	1 rawbytes	1 byte (8 bits)	1 rawbytes
`\Data`	1 byte	1 byte (8 bits)	1 byte

Continues on next page

It is possible to mix the used data type (`string`, `rawbytes`, or `array of byte`) between `SocketSend` and `SocketReceive`.

More examples

More examples of the instruction `SocketReceive` are illustrated below.

Example 1

```
VAR socketdev server_socket;
VAR socketdev client_socket;
VAR string client_ip;

PROC server_messaging()
  VAR string receive_string;
  ...
  ! Create, bind, listen and accept of sockets in error handlers
  SocketReceive client_socket \Str := receive_string;
  SocketSend client_socket \Str := "Hello client with
       ip-address "+client_ip;
  ! Wait for acknowlegde from client
  ...
  SocketClose server_socket;
  SocketClose client_socket;
ERROR
  IF ERRNO=ERR_SOCK_TIMEOUT THEN
    RETRY;
  ELSEIF ERRNO=SOCK_CLOSED THEN
    server_recover;
    RETRY;
  ELSE
  ! No error recovery handling
  ENDIF
ENDPROC

PROC server_recover()
  SocketClose server_socket;
  SocketClose client_socket;
  SocketCreate server_socket;
  SocketBind server_socket, "192.168.0.1", 1025;
  SocketListen server_socket;
  SocketAccept server_socket,
       client_socket\ClientAddress:=client_ip;
ERROR
  IF ERRNO=ERR_SOCK_TIMEOUT THEN
    RETRY;
  ELSEIF ERRNO=ERR_SOCK_CLOSED THEN
    RETURN;
  ELSE
    ! No error recovery handling
```


Continues on next page

```
    ENDIF
  ENDPROC
```

This is an example of a server program with creation, binding, listening, and accepting of sockets in error handlers. In this way the program can handle power fail restart.

In the procedure `server_recover`, a server socket is created and bound to port `1025` on the controller network address `192.168.0.1`. After execution of `SocketListen` the server socket starts to listen for incoming connections on this port and address. `SocketAccept` will accept the incoming connection from some client and store the client address in the string `client_ip`.

In the communication procedure `server_messaging` the server receives a string message from the client and stores the message in `receive_string`. Then the server responds with the message `"Hello client with ip-address xxx.xxx.x.x"`.

Error handling

The following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

`ERR_SOCK_CLOSED`	The socket is closed. Broken connection.
`ERR_SOCK_TIMEOUT`	No data was received within the time out time.

Limitations

There is no built-in synchronization mechanism in Socket Messaging to avoid received messages that are compounded of several sent messages. It is up to the programmer to handle the synchronization with “Ack” messages (one sequence of `SocketSend - SocketReceive` in the client or server program must be completed before next sequence of `SocketSend - SocketReceive`).

All sockets are closed after power fail restart. This problem can be handled by error recovery. See example above.

Avoid fast loops with `SocketCreate ... SocketClose` because the socket is not really closed until a certain time (TCP/IP functionality).

The maximum size of the data that can be received in one call is limited to 1024 bytes.

Syntax

```
SocketReceive
  [ Socket ':=' ] < variable (VAR) of socketdev >
  [ '\' Str' :=' < variable (VAR) of string > ]
  | [ '\' RawData ´:=´ < variable (VAR) of rawbytes > ]
  | [ '\' Data ´:=´ < array {*} (VAR) of byte > ]
  [ '\' ReadNoOfBytes' :=' < expression (IN) of num > ]
  [ '\' NoRecBytes' :=' < variable (VAR) of num > ]
  [ '\' Time ´:=´ < expression (IN) of num > ] ';'
```


Continues on next page

Related information

For information about	See
Socket communication in general	*Application manual - Robot communication and I/O control*, section *Socket Messaging*
Create a new socket	*SocketCreate - Create a new socket on page 460*
Connect to remote computer (only client)	*SocketConnect - Connect to a remote computer on page 457*
Send data to remote computer	*SocketSend - Send data to remote computer on page 469*
Close the socket	*SocketClose - Close a socket on page 455*
Bind a socket (only server)	*SocketBind - Bind a socket to my IP-address and port on page 453*
Listening connections (only server)	*SocketListen - Listen for incoming connections on page 462*
Accept connections (only server)	*SocketAccept - Accept an incoming connection on page 450*
Get current socket state	*SocketGetStatus - Get current socket state on page 973*
Example client socket application	*SocketSend - Send data to remote computer on page 469*

1.167. SocketSend - Send data to remote computer

Usage

`SocketSend` is used to send data to a remote computer. `SocketSend` can be used both for client and server applications.

Basic examples

Basic examples of the instruction `SocketSend` are illustrated below.

See also *More examples on page 470*.

Example 1

```
SocketSend socket1 \Str := "Hello world";
```

Sends the message `"Hello world"` to the remote computer.

Arguments

```
SocketSend Socket [ \Str ] | [ \RawData ] | [ \Data] [ \NoOfBytes ]
```

`Socket`

Data type: `socketdev`

In client application the socket to send from must already be created and connected.

In server application the socket to send to must already be accepted.

`[ \Str ]`

Data type: `string`

The `string` to send to the remote computer.

`[ \RawData ]`

Data type: `rawbytes`

The `rawbytes` data to send to the remote computer.

`[ \Data ]`

Data type: `array of byte`

The data in the `byte` array to send to the remote computer.

Only one of the option parameters `\Str`, `\RawData`, or `\Data` can be used at the same time.

`[ \NoOfBytes ]`

Data type: `num`

If this argument is specified only this number of bytes will be sent to the remote computer. The call to `SocketSend` will fail if `\NoOfBytes` is larger than the actual number of bytes in the data structure to send.

If this argument is not specified then the whole data structure (valid part of `rawbytes`) will be sent to the remote computer.

Continues on next page

Program execution

The specified data is sent to the remote computer. If the connection is broken an error is generated.

The data that is transferred on the cable is always bytes, max. 1024 bytes in one message. No header is added by default to the message. The usage of any header is reserved for the actual application.

Parameter	Input data	Cable data	Output data
`\Str`	1 char	1 byte (8 bits)	1 char
`\RawData`	1 rawbytes	1 byte (8 bits)	1 rawbytes
`\Data`	1 byte	1 byte (8 bits)	1 byte

It's possible to mix the used data type (`string`, `rawbytes`, or `array of byte`) between `SocketSend` and `SocketReceive`.

More examples

More examples of the instruction `SocketSend` are illustrated below.

Example 1

```
VAR socketdev client_socket;
VAR string receive_string;

PROC client_messaging()
  ...
  ! Create and connect the socket in error handlers
  SocketSend client_socket \Str := "Hello server";
  SocketReceive client_socket \Str := receive_string;
  ...
  SocketClose client_socket;
ERROR
  IF ERRNO=ERR_SOCK_TIMEOUT THEN
     RETRY;
  ELSEIF ERRNO=ERR_SOCK_CLOSED THEN
     client_recover;
     RETRY;
  ELSE
     ! No error recovery handling
  ENDIF
ENDPROC

PROC client_recover()
  SocketClose client_socket;
  SocketCreate client_socket;
  SocketConnect client_socket, "192.168.0.2", 1025;
ERROR
  IF ERRNO=ERR_SOCK_TIMEOUT THEN
     RETRY;
```


Continues on next page

```
    ELSEIF ERRNO=ERR_SOCK_CLOSED THEN
      RETURN;
    ELSE
      ! No error recovery handling
    ENDIF
  ENDPROC
```

This is an example of a client program with creation and connection of socket in error handlers. In this way the program can handle power fail restart.

In the procedure `client_recover` the client socket is created and connected to a remote computer server with IP-address `192.168.0.2` on port `1025`.

In the communication procedure `client_messaging` the client sends `"Hello server"` to the server and the server responds with `"Hello client"` to the client, which is stored in the variable `receive_string`.

Example 2

```
VAR socketdev client_socket;
VAR string receive_string;

PROC client_messaging()
  ...
  ! Send cr and lf to the server
  SocketSend client_socket \Str := "\0D\0A";
  ...
ENDPROC
```

This is an example of a client program that sends non printable characters (binary data) in a string. This can be useful if communicating with sensors or other clients that requires such characters.

Error handling

The following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

`ERR_SOCK_CLOSED`	The socket is closed. Broken connection.

Limitations

There is no built-in synchronization mechanism in Socket Messaging to avoid received messages that are compounded of several sent messages. It's up to the programmer to handle the synchronization with "Ack" messages (one sequence of `SocketSend - SocketReceive` in the client or server program must be completed before the next sequence of `SocketSend - SocketReceive`).

All sockets are closed after power fail restart. This problem can be handled by error recovery. See example above.

Avoid fast loops with `SocketCreate ... SocketClose` because the socket is not really closed until a certain time (TCP/IP functionality).

The size of the data to send is limited to 1024 bytes.

Continues on next page

Syntax

```
SocketSend
  [ Socket ´:=´ ] < variable (VAR) of socketdev >
  [ \Str ´:=´ < expression (IN) of string > ]
  | [ \RawData ´:=´ < variable (VAR) of rawdata > ]
  | [ \Data ´:=´ < array {*} (IN) of byte > ]
  [ '\' NoOfBytes ´:=´ < expression (IN) of num > ] ';'
```

Related information

For information about	See
Socket communication in general	*Application manual - Robot communication and I/O control*, section *Socket Messaging*
Create a new socket	*SocketCreate - Create a new socket on page 460*
Connect to remote computer (only client)	*SocketConnect - Connect to a remote computer on page 457*
Receive data from remote computer	*SocketReceive - Receive data from remote computer on page 464*
Close the socket	*SocketClose - Close a socket on page 455*
Bind a socket (only server)	*SocketBind - Bind a socket to my IP-address and port on page 453*
Listening connections (only server)	*SocketListen - Listen for incoming connections on page 462*
Accept connections (only server)	*SocketAccept - Accept an incoming connection on page 450*
Get current socket state	*SocketGetStatus - Get current socket state on page 973*
Example server socket application	*SocketReceive - Receive data from remote computer on page 464*
Use of non printable characters (binary data) in string literals.	*Technical reference manual - RAPID kernel*, section *String literals*

1.168. SoftAct - Activating the soft servo

Usage

`SoftAct` (*Soft Servo Activate*) is used to activate the so called “soft” servo on any axis of the robot or external mechanical unit.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in any motion tasks.

Basic examples

Basic examples of the instruction `SoftAct` are illustrated below.

Example 1

```
SoftAct 3, 20;
```

Activation of soft servo on robot axis `3` with softness value `20%`.

Example 2

```
SoftAct 1, 90 \Ramp:=150;
```

Activation of the soft servo on robot axis `1` with softness value `90%` and ramp factor `150%`.

Example 3

```
SoftAct \MechUnit:=orbit1, 1, 40 \Ramp:=120;
```

Activation of soft servo on axis `1` for the mechanical unit `orbit1` with softness value `40%` and ramp factor `120%`.

Arguments

```
SoftAct[\MechUnit] Axis Softness [\Ramp]
```

`[ \MechUnit ]`

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit. If this argument is omitted then it means activation of the soft servo for specified robot axis in the current program task.

`Axis`

Data type: `num`

Number of the robot or external axis to work with soft servo.

`Softness`

Data type: `num`

Softness value in percent (0 - 100%). 0% denotes min. softness (max. stiffness), and 100% denotes max. softness.

`[ \Ramp ]`

Data type: `num`

Ramp factor in percent (>= 100%). The ramp factor is used to control the engagement of the soft servo. A factor 100% denotes the normal value; with greater values the soft servo is engaged more slowly (longer ramp). The default value for ramp factor is 100 %.

Continues on next page

Program execution

Softness is activated at the value specified for the current axis. The softness value is valid for all movement until a new softness value is programmed for the current axis or until the soft servo is deactivated by the instruction `SoftDeact`.

Limitations

Soft servo for any robot or external axis is always deactivated when there is a power failure. This limitation can be handled in the user program when restarting after a power failure.

The same axis must not be activated twice unless there is a moving instruction in between. Thus, the following program sequence should be avoided. Otherwise there will be a jerk in the robot movement:

```
SoftAct n , x ;
SoftAct n , y ;
```

(n = robot axis n, x, and y softness values)

Syntax

```
SoftAct
  ['\'MechUnit ':=' < variable (VAR) of mecunit>´,´]
  [Axis ':=' ] < expression (IN) of num> ','
  [Softness':=' ] < expression (IN) of num> ´,´
  [ '\'Ramp':=' < expression (IN) of num> ]';'
```

Related information

For information about	See
Deactivate soft servo	*SoftDeact - Deactivating the soft servo on page 475*
Behavior with the soft servo engaged	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution*
Configuration of external axes	*Application manual - Additional axes and stand alone controller*, section *Axes Configuration - Soft servo*

1.169. SoftDeact - Deactivating the soft servo

Usage

`SoftDeact` (*Soft Servo Deactivate*) is used to deactivate the so called “soft” servo.

Basic examples

Basic examples of the instruction `SoftDeact` are illustrated below.

Example 1

```
SoftDeact;
```

Deactivating the soft servo on all axes.

Example 2

```
SoftDeact \Ramp:=150;
```

Deactivating the soft servo on all axes, with ramp factor 150 %.

Arguments

```
SoftDeact  [\Ramp]
```

`[ \Ramp ]`

Data type: `num`

Ramp factor in percent (>= 100 %). The ramp factor is used to control the deactivating of the soft servo. A factor 100% denotes the normal value. With greater values the soft servo is deactivated more slowly (longer ramp). The default value for ramp factor is 100 %.

Program execution

The soft servo is deactivated for the mechanical units that are controlled from current program task. If `SoftDeact` is done from a non-motion task, the soft servo is deactivated for the mechanical unit controlled by the connected motion task. Executing a `SoftDeact` when in synchronized movement mode, soft servo will be deactivated for all mechanical units that are synchronized.

When deactivating soft servo with `SoftDeact` the robot will move to the programmed position even if the robot has moved out of position during soft servo activation.

Syntax

```
SoftDeact
  [ '\'Ramp ':=' < expression (IN) of num> ]';'
```

Related information

For information about	See
Activating the soft servo	*SoftAct - Activating the soft servo on page 473*

1.170. SpeedRefresh - Update speed override for ongoing movement

Usage

`SpeedRefresh` is used to change the movement speed for the ongoing robot movement in current motion program task. With this instruction it is possible to create some type of coarse speed adaptation from some sensor input.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in any Motion tasks.

Basic examples

Basic examples of the instruction `SpeedRefresh` are illustrated below.

Example 1

```
VAR num change_speed:=70;
SpeedRefresh change_speed;
```

This will change the current speed override to 70%.

Arguments

```
SpeedRefresh Override
```

`Override`

Data type: `num`

The speed override value within range 0 ... 100 %.

Program execution

The actual speed override value for the ongoing movements of robot and external units in current motion program task will be updated.

All speed data components for any mechanical units in current motion task will be influenced.

This speed override value generated with this instruction will replace any speed override value generated from FlexPendant for this motion task (no influence on other motion tasks).

If the override speed used for the instruction `SpeedRefresh` exceeds the value set from the FlexPendant, the lowest value will be used. This means, that the speed can not be increased above the speed set from the FlexPendant.

If a PP to main is done or if a new program is loaded, the speed that was set with `SpeedRefresh` will be resetted, and the speed set from the FlexPendant will be applied.

Continues on next page

More examples

More examples of the instruction `SpeedRefresh` are illustrated below.

Example 1

```
VAR intnum time_int;
VAR num override;
...
CONNECT time_int WITH speed_refresh;
ITimer 0.1, time_int;
ISleep time_int;
...
MoveL p1, v100, fine, tool2;
! Read current speed override set from FlexPendant
override := CSpeedOverride (\CTask);
IWatch time_int;
MoveL p2, v100, fine, tool2;
IDelete time_int;
! Reset to FlexPendant old speed override
WaitTime 0.5;
SpeedRefresh override;
...
TRAP speed_refresh
  VAR speed_corr;
  ! Analog input signal value from sensor, value 0 ... 10
  speed_corr := (ai_sensor * 10);
  SpeedRefresh speed_corr;
  ERROR
     IF ERRNO = ERR_SPEED_REFRESH_LIM THEN
        IF speed_corr > 100 speed_corr := 100;
        IF speed_corr < 0 speed_corr := 0;
        RETRY;
     ENDIF
ENDTRAP
```

During the robot movement from position `p1` to `p2`, the speed override value is updated every `0.1` s in the `TRAP speed_refresh`. The analog input signal `ai_sensor` is used for calculation of `Overide` value for the instruction `SpeedRefresh`. There is no `TRAP` execution before and after the robot movement between `p1` and `p2`. The manual speed override from FlexPendant is restored. After that the robot has to reach `p2`.

Error handling

If `Override` has a value outside the range of 0 to 100 % then the `ERRNO` variable will be s et to `ERR_SPEED_REFRESH_LIM`. This error is recoverable and can be handled in the `ERROR` handler.

Continues on next page

Limitations

Note that with `SpeedRefresh` the speed override will not be done momentary. Instead there will be a lag of 0,3 - 0,5 seconds between order and influence on the physical robot.

The user is responsible to reset the speed override value from the RAPID program after the `SpeedRefresh` sequence.

The override speed can not be increased above the speed override set from the FlexPendant.

If `SpeedRefresh` is used in the START or in the RESET event routine, the speed that is set is always the actual FlexPendant speed override.

Syntax

```
SpeedRefresh
  [ Override ':=' ] < expression (IN) of num > ';'
```

Related information

For information about	See
Positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Definition of velocity	*speeddata - Speed data on page 1185*
Read current speed override	*CSpeedOverride - Reads the current override speed on page 810*

1.171. SpyStart - Start recording of execution time data

Usage

`SpyStart` is used to start the recording of instruction and time data during execution.

The execution data will be stored in a file for later analysis.

The stored data is intended for debugging RAPID programs, specifically for multi-tasking systems (only necessary to have `SpyStart - SpyStop` in one program task).

Basic examples

Basic examples of the instruction `SpyStart` are illustrated below.

Example 1

```
SpyStart "HOME:/spy.log";
```

Starts recording the execution time data in the file `spy.log` on the `HOME`: disk.

Arguments

```
SpyStart File
```

File

Data type: `string`

The file path and the file name to the file that will contain the execution data.

Program execution

The specified file is opened for writing and the execution time data begins recording in the file.

Recording of execution time data is active until:

- execution of instruction `SpyStop`
- starting program execution from the beginning
- loading a new program
- next warm start-up

Limitations

Avoid using the floppy disk (option) for recording since writing to the floppy is very time consuming.

Never use the spy function in production programs because the function increases the cycle time and consumes memory on the mass memory device in use.

Error handling

If the file in the `SpyStart` instruction can't be opened then the system variable `ERRNO` is set to `ERR_FILEOPEN` (see "Data types - `errnum`"). This error can then be handled in the error handler.

Continues on next page

File format

TASK	INSTR	IN	CODE	OUT
MAIN	FOR i FROM 1 TO 3 DO	0	READY	0
MAIN	mynum:=mynum+i;	1	READY	1
MAIN	ENDFOR	2	READY	2
MAIN	mynum:=mynum+i;	2	READY	2
MAIN	ENDFOR	2	READY	2
MAIN	mynum:=mynum+i;	2	READY	2
MAIN	ENDFOR	2	READY	3
MAIN	SetDo1,1;	3	READY	3
MAIN	IF di1=0 THEN	3	READY	4
MAIN	MoveL p1, v1000, fine, tool0;	4	WAIT	14
SYSTEM TRAP				
MAIN	MoveL p1, v1000, fine, tool0;	111	READY	111
MAIN	ENDIF	108	READY	108
MAIN	MoveL p2, v1000, fine, tool0;	111	WAIT	118
SYSTEM TRAP				
MAIN	MoveL p2, v1000, fine, tool0;	326	READY	326
MAIN	SpyStop;	326	READY	

TASK column shows executed program task.

INSTR column shows executed instruction in specified program task.

IN column shows the time in ms when entering the executed instruction.

CODE column shows if the instruction is READY or the instruction WAIT for completion at OUT time.

OUT column shows the time in ms upon leaving the executed instruction.

All times are given in ms (relative values).

SYSTEM TRAP means that the system is doing something else than execution of RAPID instructions.

If the procedure calls to some NOSTEPIN procedure (module) then the output list shows only the name of the called procedure. This is repeated for every executed instruction in the NOSTEPIN routine.

Syntax

```
SpyStart
  [File':=']<expression (IN) of string>';'
```

Related information

For information about	See
Stop recording of execution data	*SpyStop - Stop recording of time execution data on page 481*

1.172. SpyStop - Stop recording of time execution data

Usage

`SpyStop` is used to stop the recording of time data during execution.

The data, which can be useful for optimizing the execution cycle time, is stored in a file for later analysis.

Basic examples

Basic examples of the instruction `SpyStop` are illustrated below.

See also *More examples on page 481*.

Example 1

```
SpyStop;
```

Stops recording the execution time data in the file specified by the previous `SpyStart` instruction.

Program execution

The execution data recording is stopped and the file specified by the previous `SpyStart` instruction is closed. If no `SpyStart` instruction has been executed before then the `SpyStop` instruction is ignored.

More examples

More examples of the instruction `SpyStop` are illustrated below.

Example 1

```
IF debug = TRUE SpyStart "HOME:/spy.log";
produce_sheets;
IF debug = TRUE SpyStop;
```

If the debug flag is true then start recording execution data in the file `spy.log` on the `HOME`: disk. Perform actual production; stop recording, and close the file `spy.log`.

Limitations

Avoid using the floppy disk (option) for recording since writing to the floppy is very time consuming.

Never use the spy function in production programs because the function increases the cycle time and consumes memory on the mass memory device in use.

Syntax

```
SpyStop';'
```

Related information

For information about	See
Start recording of execution data	*SpyStart - Start recording of execution time data on page 479*

1.173. StartLoad - Load a program module during execution

Usage

`StartLoad` is used to start the loading of a program module into the program memory during execution.

When loading is in progress other instructions can be executed in parallel. The loaded module must be connected to the program task with the instruction `WaitLoad` before any of its symbols/routines can be used.

The loaded program module will be added to the modules already existing in the program memory.

A program or system module can be loaded in static (default) or dynamic mode. Depending on the used mode, some operations will unload the module or not affect the module at all.

Static mode

The following table shows how two different operations affect a static loaded program or system modules.

	Set PP to main from TP	Open new RAPID program
Program Module	Not affected	Unloaded
System Module	Not affected	Not affected

Dynamic mode

The following table shows how two different operations affect a dynamic loaded program or system modules.

	Set PP to main from TP	Open new RAPID program
Program Module	Unloaded	Unloaded
System Module	Unloaded	Unloaded

Both static and dynamic loaded modules can be unloaded by the instruction `UnLoad`.

Continues on next page

Basic examples

Basic examples of the instruction `StartLoad` are illustrated below.

See also *More examples on page 484*.

Example 1

```
VAR loadsession load1;

! Start loading of new program module PART_B containing routine
    routine_b in dynamic mode
StartLoad \Dynamic, diskhome \File:="PART_B.MOD", load1;

! Executing in parallel in old module PART_A containing routine_a
%"routine_a"%;

! Unload of old program module PART_A
UnLoad diskhome \File:="PART_A.MOD";
! Wait until loading and linking of new program module PART_B is
    ready
WaitLoad load1;

! Execution in new program module PART_B
%"routine_b"%;
```

Starts the loading of program module `PART_B.MOD` from `diskhome` into the program memory with instruction `StartLoad`. In parallel with the loading the program executes `routine_a` in module `PART_A.MOD`. Then instruction `WaitLoad` waits until the loading and linking is finished. The module is loaded in dynamic mode.

Variable `load1` holds the identity of the load session updated by `StartLoad` and referenced by `WaitLoad`.

To save linking time the instruction `UnLoad` and `WaitLoad` can be combined in the instruction `WaitLoad` by using the option argument `\UnLoadPath`.

Arguments

```
StartLoad [\Dynamic] FilePath [\File] LoadNo
```

`[\Dynamic]`

Data type: `switch`

The switch enables loading of a program module in dynamic mode. Otherwise the loading is in static mode.

`FilePath`

Data type: `string`

The file path and the file name to the file that will be loaded into the program memory. The file name shall be excluded when the argument `\File` is used.

`[\File]`

Data type: `string`

When the file name is excluded in the argument `FilePath` it must be defined with this argument.

Continues on next page

`LoadNo`

Data type: `loadsession`

This is a reference to the load session that should be used in the instruction `WaitLoad` to connect the loaded program module to the program task.

Program execution

Execution of `StartLoad` will only order the loading and then proceed directly with the next instruction without waiting for the loading to be completed.

The instruction `WaitLoad` will then wait at first for the loading to be completed if it is not already finished, and then it will be linked and initialized. The initiation of the loaded module sets all variables at module level to their initial values.

Unresolved references will default be accepted for this loading operation `StartLoad - WaitLoad`, but it will be a run time error on execution of an unresolved reference.

To obtain a good program structure that is easy to understand and maintain, all loading and unloading of program modules should be done from the main module, which is always present in the program memory during execution.

For loading of program that contains a `main` procedure to a main program (with another `main` procedure), see instruction `Load`.

More examples

More examples of how to use the instruction `StartLoad` are illustrated below.

Example 1

```
StartLoad \Dynamic, "HOME:/DOORDIR/DOOR1.MOD", load1;
```

Loads the program module `DOOR1.MOD` from the `HOME:` at the directory `DOORDIR` into the program memory. The program module is loaded in dynamic mode.

Example 2

```
StartLoad \Dynamic, "HOME:" \File:="/DOORDIR/DOOR1.MOD", load1;
```

Same as in example 1 but with another syntax.

Example 3

```
StartLoad "HOME:" \File:="/DOORDIR/DOOR1.MOD", load1;
```

Same as in examples 1 and 2 above but the module is loaded in static mode.

Example 4

```
StartLoad \Dynamic, "HOME:" \File:="/DOORDIR/DOOR1.MOD", load1;
WaitLoad load1;
```

is the same as

```
Load \Dynamic, "HOME:" \File:="/DOORDIR/DOOR1.MOD";
```

Error handling

If the file specified in the instruction cannot be found then the system variable `ERRNO` is set to `ERR_FILNOTFND`. This error can then be handled in the error handler.

If the variable specified in argument `LoadNo` is already in use then the system variable `ERRNO` is set to `ERR_LOADNO_INUSE`. This error can then be handled in the error handler.

Continues on next page

Syntax

```
StartLoad
  [´\´Dynamic ´,´]
  [FilePath' :='] <expression (IN) of string>
  ['\'File ':=' <expression (IN) of string> ] ','
  [LoadNo ':='] <variable (VAR) of loadsession>';'
```

Related information

For information about	See
Connect the loaded module to the task	*WaitLoad - Connect the loaded module to the task on page 682*
Load session	*loadsession - Program load session on page 1138*
Load a program module	*Load - Load a program module during execution on page 208*
Unload a program module	*UnLoad - UnLoad a program module during execution on page 655*
Cancel loading of a program module	CancelLoad - Cancel loading of a module on page 35
Procedure call with Late binding	*Technical reference manual - RAPID overview*, section *Basic characteristics - Routines - Procedure call*

1.174. StartMove - Restarts robot movement

Usage

`StartMove` is used to resume robot, external axes movement and belonging process after the movement has been stopped

- by the instruction `StopMove`.
- after execution of `StorePath` ... `RestoPath` sequence.
- after asynchronously raised movements errors, such as `ERR_PATH_STOP` or specific process error after handling in the `ERROR` handler.

For base system it is possible to use this instruction in the following type of program tasks:

- main task `T_ROB1` for restart of the movement in that task.
- any other task for restart of the movements in the main task.

For MultiMove system it is possible to use this instruction in the following type of program tasks:

- motion task, for restart of the movement in that task.
- non motion task, for restart of the movement in the connected motion task. Besides that, if movement is restarted in one connected motion task belonging to a coordinated synchronized task group, the movement is restarted in all the cooperating tasks.

Basic examples

Basic examples of the instruction `StartMove` are illustrated below.

Example 1

```
StopMove;
WaitDI ready_input,1;
StartMove;
```

The robot starts to move again when the input `ready_input` is set.

Example 2

```
...
MoveL p100, v100, z10, tool1;
StorePath;
p:= CRobT(\Tool:=tool1);
! New temporary movement
MoveL p1, v100, fine, tool1;
...
MoveL p, v100, fine, tool1;
RestoPath;
StartMove;
...
```

After moving back to a stopped position `p` (in this example equal to `p100`), the robot starts to move again on the basic path level.

Continues on next page

Arguments

`StartMove [\AllMotionTasks]`

`[\AllMotionTasks]`

Data type: `switch`

Restart the movement of all mechanical units in the system. The switch `[\AllMotionTasks]` can only be used from a non-motion program task.

Program execution

Any processes associated with the stopped movement are restarted at the same time that the motion resumes.

To restart a MultiMove application in synchronized coordinated mode, `StartMove` must be executed in all motion tasks that are involved in coordination.

With the switch `\AllMotionTasks` (only allowed from non-motion program task) the movements for all mechanical units in the system are restarted.

In a base system without the switch `\AllMotionTasks`, the movements for following mechanical units are restarted:

- always the mechanical units in the main task, independent of which task executes the `StartMove` instruction.

In a MultiMove system without the switch `\AllMotionTasks` the movements for the following mechanical units are restarted:

- the mechanical units in the motion task executing `StartMove`.
- the mechanical units in the motion task that are connected to the non motion task executing `StartMove`. Besides that, if mechanical units are restarted in one connected motion task belonging to a coordinated synchronized task group then the mechanical units are restarted in all the cooperated tasks.

Error handling

If the robot is too far from the path (more than 10 mm or 20 degrees) to perform a restart of the interrupted movement then the system variable `ERRNO` is set to `ERR_PATHDIST`.

If the robot is in a hold state at the time `StartMove` is executed then the system variable `ERRNO` is set to `ERR_STARTMOVE`

If the program execution is stopped several times while regaining path movement with `StartMove` then the system variable `ERRNO` is set to `ERR_PROGSTOP`

If the robot is moving at the time `StartMove` is executed then the system variable `ERRNO` is set to `ERR_ALRDY_MOVING`.

These errors can then be handled in the error handler:

- at `ERR_PATHDIST` move the robot closer to the path before attempting `RETRY`.
- at `ERR_STARTMOVE`, `ERR_PROGSTOP`, or `ERR_ALRDY_MOVING` wait some time before attempting `RETRY`.

Continues on next page

Limitations

Only one of several non-motion tasks is allowed at the same time to do `StopMove` - `StartMove` sequence against some motion task.

It is not possible to do any error recovery if `StartMove` is executed in any error handler.

Syntax

```
StartMove
  ['\'AllMotionTasks]';'
```

Related information

For information about	See
Stopping movements	*StopMove - Stops robot movement on page 515*
Continuing a movement	*StartMoveRetry - Restarts robot movement and execution on page 489*
More examples	*StorePath - Stores the path when an interrupt occurs on page 521* *RestoPath - Restores the path after an interrupt on page 362*

1.175. StartMoveRetry - Restarts robot movement and execution

Usage

`StartMoveRetry` is used to resume robot and external axes movements and belonging processes and also retry the execution from an `ERROR` handler.

This instruction can be used in an `ERROR` handler in the following types of program tasks:

- main task `T_ROB1` in a base system
- any motion task in a *MultiMove* system

Basic examples

Basic examples of the instruction `StartMoveRetry` are illustrated below.

Example 1

```
VAR robtarget p_err;
...
MoveL p1\ID:=50, v1000, z30, tool1 \WObj:=stn1;
...
ERROR
  IF ERRNO = ERR_PATH_STOP THEN
    StorePath;
    p_err := CRobT(\Tool:= tool1 \WObj:=wobj0);
    ! Fix the problem
    MoveL p_err, v100, fine, tool1;
    RestoPath;
    StartMoveRetry;
  ENDIF
ENDPROC
```

This is an example from a MultiMove system with coordinated synchronized movements (two robots working on some rotated work object).

During the movement to position `p1`, the other cooperated robot gets some process error so that the coordinated synchronized movements stops. This robots then gets the error `ERR_PATH_STOP`, and the execution is transferred to the `ERROR` handler.

In the `ERROR` handler, do the following:

- `StorePath` stores the original path, goes to a new path level, and sets the MultiMove system in independent mode.
- If there are problems with the robot then initiate movements on the new path level.
- Before `RestoPath` go back to the error position.
- `RestoPath` goes back to the original path level and sets the MultiMove system back to synchronized mode again.
- `StartMoveRetry` restarts the interrupted movement and any process. It also transfers the execution back to resume the normal execution.

Continues on next page

Program execution

`StartMoveRetry` does the following sequence:

- regain to path
- restart any processes associated with the stopped movement
- restart the interrupted movement
- `RETRY` of the program execution

`StartMoveRetry` does the same as `StartMove` and `RETRY` together in one indivisible operation.

Only the mechanical units in the program task that execute `StartMoveRetry` are restarted.

Limitations

Can only be used in an `ERROR` handler in a motion task.

In a MultiMove system executing coordinated synchronized movements the following programming rules must be followed in the `ERROR` handler:

- `StartMoveRetry` must be used in all cooperated program tasks.
- If need movement is needed in any `ERROR` handler then the instructions `StorePath ... RestoPath` must be used in all cooperated program tasks.
- The program must move the robot back to the error position before `RestoPath` is executed if the robot was moved on the `StorePath` level.

Error handling

If the robot is too far from the path (more than 10 mm or 20 degrees) to perform a restart of the interrupted movement then the system variable `ERRNO` is set to `ERR_PATHDIST`.

If the robot is in hold state at the time `StartMoveRetry` is executed then the system variable `ERRNO` is set to `ERR_STARTMOVE`.

If the program execution is stopped several times during the regain to path movement with `StartMoveRetry` then the system variable `ERRNO` is set to `ERR_PROGSTOP`.

If the robot is moving at the time `StartMoveRetry` is executed then the system variable `ERRNO` is set to `ERR_ALRDY_MOVING`.

It is not possible to do any error recovery from these errors because `StartMoveRetry` can only be executed in some error handler.

Syntax

```
StartMoveRetry ';'
```


Continues on next page

Related information

For information about	See
Stopping movements	*StopMove - Stops robot movement on page 515*
Continuing a movement	*StartMove - Restarts robot movement on page 486*
Resume execution after an error	*RETRY - Resume execution after an error on page 364*
Store/restore path	*StorePath - Stores the path when an interrupt occurs on page 521* *RestoPath - Restores the path after an interrupt on page 362*

1.176. STCalib - Calibrate a Servo Tool

Usage

`STCalib` is used to calibrate the distance between the tool tips. This is necessary after tip change or tool change, and it is recommended after performing a tip dress or after using the tool for a while.

Note! The tool performs two close/open movements during the calibration. The first close movement will detect the tip contact position.

Basic examples

Basic examples of the instruction `STCalib` are illustrated below.

Example 1

```
VAR num curr_tip_wear;
VAR num retval;
CONST num max_adjustment := 20;

STCalib gun1 \ToolChg;
```

Calibrate a servo gun after a toolchange. Wait until the gun calibration has finished before continuing with the next Rapid instruction.

Example 2

```
STCalib gun1 \ToolChg \Conc;
```

Calibrate a servo gun after a toolchange. Continue with the next Rapid instruction without waiting for the gun calibration to be finished.

Example 3

```
STCalib gun1 \TipChg;
```

Calibrate a servo gun after a tipchange.

Example 4

```
STCalib gun1 \TipWear \RetTipWear := curr_tip_wear;
```

Calibrate a servo gun after tip wear. Save the tip wear in variable `curr_tip_wear`.

Example 5

```
STCalib gun1 \TipChg \RetPosAdj:=retval;
IF retval > max_adjustment THEN
TPWrite "The tips are lost!";
...
```

Calibrate a servo gun after a tipchange. Check if the tips are missing.

Example 6

```
STCalib gun1 \TipChg \PrePos:=10;
```

Calibrate a servo gun after a tipchange. Move fast to position `10` mm then start to search for contact position with slower speed.

Continues on next page

Example 7

Example of non valid combination:

```
STCalib gun1 \TipWear \RetTipWear := curr_tip_wear \Conc;
```

Perform a tip wear calibration. Continue with the next Rapid instruction without waiting for the gun calibration to be finished. The parameter `curr_tip_wear` will in this case **not** hold any valid value since the `\Conc` switch is used (The next Rapid instruction will start to execute before the calibration process is finished).

Arguments

```
STCalib ToolName [\ToolChg] | [\TipChg] | [\TipWear] [\RetTipWear]
      [\RetPosAdj] [\PrePos] [\Conc]
```

`ToolName`

Data type: `string`

The name of the mechanical unit.

`[\ToolChg]`

Data type: `switch`

Calibration after a tool change.

`[\TipChg]`

Data type: `switch`

Calibration after a tip change.

`[\TipWear]`

Data type: `switch`

Calibration after tip wear.

`[\RetTipWear]`

Data type: `num`

The achieved tip wear [mm].

`[\RetPosAdj]`

Data type: `num`

The positional adjustment since the last calibration [mm].

`[\PrePos]`

Data type: `num`

The position to move with high speed before the search for contact position with slower speed is started [mm].

`[\Conc]`

Data type: `switch`

Subsequent instructions are executed while the gun is moving. The argument can be used to shorten cycle time. This is useful when, for example, two guns are controlled at the same time.

Continues on next page

Program execution

Calibration modes

If the mechanical unit exists then the servo tool is ordered to calibrate. The calibration is done according to the switches, see below. If the `RetTipWear` parameter is used then the tip wear is updated.

Calibration after toolchange:

The tool will close with slow speed waiting for tips in contact to open fast, close fast to a low force, and open again in one sequence. The tip wear will remain unchanged.

Calibration after tipchange:

The tool will close with slow speed waiting for tips in contact to open fast, close fast to a low force, and open again in one sequence. The tip wear will be reset.

Calibration after tipwear:

The tool will close with high speed to the contact position, open fast, close fast to a low force, and open again in one sequence. The tip wear will be updated.

NOTE! If the switch `Conc` is used then the instruction will be considered ready once started and therefore the return value `RetTipWear` will not be available. In this case the `RetTipWear` will be returned by the function `STIsOpen`. For more details, see RobotWare OS functions - `STIsOpen`.

Positional adjustment

The optional argument `RetPosAdj` can be used to detect, for example, if the tips are lost after a tip change. The parameter will hold the value of the positional adjustment since the last calibration. The value can be negative or positive.

Using a pre-position

In order to speed up the calibration it is possible to define a pre-position. When the calibration starts the gun arm will run fast to the pre-position, stop, and then continue slowly*) forward in order to detect the tip contact position. If a pre-position is used then select it carefully! It is important that the tips do not get in contact until *after* the pre-position is reached! Otherwise the accuracy of the calibration will become poor and motion supervision errors may possibly occur. A pre-position will be ignored if it is larger than the current gun position (in order not to slow down the calibration).

*) The second movement will also be fast if the `\TipWear` option is used.

Continues on next page

Error handling

If the specified servo tool name is not a configured servo tool then the system variable `ERRNO` is set to `ERR_NO_SGUN`.

If the gun is not open when `STCalib` is invoked then the system variable `ERRNO` is set to `ERR_SGUN_NOTOPEN`.

If the servo tool mechanical unit is not activated then the system variable `ERRNO` is set to `ERR_SGUN_NOTACT`. Use instruction `ActUnit` to activate the servo tool.

If the servo tool position is not initialized then the system variable `ERRNO` is set to `ERR_SGUN_NOTINIT`. The servo tool position must be initialized the first time the gun is installed or after a fine calibration is made. Use the service routine `ManServiceCalib` or perform a tip change calibration. The tip wear will be reset.

If the servo tool tips are not synchronized then the system variable `ERRNO` is set to `ERR_SGUN_NOTSYNC`. The servo tool tips must be synchronized if the revolution counter has been lost and/or updated. No process data such as tip wear will be lost.

If the instruction is invoked from a background task and there is an emergency stop, the instruction will be finished, and the system variable `ERRNO` is set to `ERR_SGUN_ESTOP`. Note that if the instruction is invoked from the main task then the program pointer will be stopped at the instruction, and the instruction will be restarted from the beginning at program restart.

If the argument `PrePos` is specified with a value less than zero then the system variable `ERRNO` is set to `ERR_SGUN_NEGVAL`.

If the instruction is invoked from a background task and the system is in motors off state then the system variable `ERRNO` will be set to `ERR_SGUN_MOTOFF`.

All above errors can be handled in a RAPID error handler.

Syntax

```
STCalib
  [ 'ToolName' :=' ] < expression (IN) of string > ','
  [ '\'ToolChg] | ['\'TipChg] | [ '\'TipWear]
  [' \'RetTipWear' :=' < variable or persistent(INOUT) of num >
       ]';'
  [ '\'RetPosAdj' :=' < variable or persistent(INOUT) of num > ]';'

  [ '\'PrePos' :=' < expression (IN) of num > ]'
  [ '\'Conc' ];'
```

Related information

For information about	See
Open a servo tool	*STOpen - Open a Servo Tool on page 513*
Close a servo tool	*STClose - Close a Servo Tool on page 496*

1.177. STClose - Close a Servo Tool

Usage

`STClose` is used to close the Servo Tool.

Basic examples

Basic examples of the instruction `STClose` are illustrated below.

Example 1

```
VAR num curr_thickness1;
VAR num curr_thickness2;

STClose gun1, 1000, 5;
```

Close the servo gun with tip force `1000` N and plate thickness `5` mm. Wait until the gun is closed before continuing with the next Rapid instruction.

Example 2

```
STClose gun1, 2000, 3\RetThickness:=curr_thickness;
```

Close the servo gun with tip force `2000` N and plate thickness `3` mm. Get the measured thickness in variable `curr_thickness`.

Example 3

Concurrent mode:

```
STClose gun1, 1000, 5 \Conc;
STClose gun2, 2000, 3 \Conc;
```

Close the servo `gun1` with tip force `1000` N and plate thickness `5` mm. Continue the program execution without waiting for `gun1` to be closed, and close the servo `gun2` with tip force `2000` N and plate thickness `3` mm. Continue the execution of the Rapid program without waiting for `gun2` to be closed.

Example 4

```
IF STIsClosed (gun1)\RetThickness:=curr_thickness1 THEN
  IF curr_thickness1 < 0.2 Set weld_start1;
ENDIF
IF STIsClosed (gun2)\RetThickness:=curr_thickness2 THEN
  IF curr_thickness2 < 0.2 Set weld_start2;
ENDIF
```

Get the measured thickness in the function `STIsClosed` variable `curr_thickness1` and `curr_thickness2`.

Example 5

Example of non valid combination:

```
STClose gun1, 2000, 3\RetThickness:=curr_thickness \Conc;
```

Close the servo gun and continue with the Rapid program execution. The parameter `curr_thickness` will in this case not hold any valid value since the `\Conc` switch is used (The next Rapid instruction will start to execute before the gun is closed).

Continues on next page

Arguments

```
STClose ToolName TipForce Thickness [\RetThickness][\Conc]
```

`ToolName`

Data type: `string`

The name of the mechanical unit.

`TipForce`

Data type: `num`

The desired tip force [N].

`Thickness`

Data type: `num`

The expected contact position for the servo tool [mm].

`[\RetThickness]`

Data type: `num`

The achieved thickness [mm], will only get a value if the `\Conc` switch is not used.

`[\Conc]`

Data type: `switch`

Subsequent instructions are executed while the gun is moving. The argument can be used to shorten cycle time. This is useful when e.g. two guns are controlled at the same time.

Program execution

If the mechanical unit exists then the servo tool is ordered to close to the expected thickness and force.

The closing will start to move the tool arm to the expected contact position (thickness). The movement is stopped in this position, and a switch from position control mode to force control mode is done.

The tool arm is moved with max speed and acceleration as it is defined in the system parameters for corresponding external axis. As for other axes movements, the speed is reduced in manual mode.

When the desired tip force is achieved the instruction is ready and the achieved thickness is returned if the optional argument `RetThickness` is specified.

NOTE! If the switch `Conc` is used then the instruction will be considered to be ready once started and therefore the return value `RetThickness` will not be available. In this case the `RetThickness` will be returned by the function `STIsClosed`. For more details see RobotWare OS functions - `STIsClosed`.

It is possible to close the tool during a programmed robot movement as long as the robot movement does not include a movement of the tool arm.

For more details see Servo tool motion control.

Continues on next page

Error handling

If the specified servo tool name is not a configured servo tool then the system variable ERRNO is set to ERR_NO_SGUN.

If the gun is not open when STClose is invoked then the system variable ERRNO is set to ERR_SGUN_NOTOPEN.

If the servo tool mechanical unit is not activated then the system variable ERRNO is set to ERR_SGUN_NOTACT. Use instruction ActUnit to activate the servo tool.

If the servo tool position is not initialized then the system variable ERRNO is set to ERR_SGUN_NOTINIT. The servo tool position must be initialized the first time the gun is installed or after a fine calibration is made. Use the service routine ManServiceCalib or perform a tip change calibration. The tip wear will be reset.

If the servo tool tips are not synchronized then the system variable ERRNO is set to ERR_SGUN_NOTSYNC. The servo tool tips must be synchronized if the revolution counter has been lost and/or updated. No process data such as tip wear will be lost.

If the instruction is invoked from a background task and if there is an emergency stop then the instruction will be finished and the system variable ERRNO is set to ERR_SGUN_ESTOP. Note that if the instruction is invoked from the main task then the program pointer will be stopped at the instruction, and the instruction will be restarted from the beginning at program restart.

If the instruction is invoked from a background task and if the system is in motors off state then the system variable ERRNO will be set to ERR_SGUN_MOTOFF.

All errors above can be handled in a Rapid error handler.

Syntax

```
STClose
  [ 'ToolName ':=' ] < expression (IN) of string > ','
  [ 'Tipforce' :=' ] < expression (IN) of num > ','
  [ 'Thickness' :=']  < expression (IN) of num > ]
  ['\' 'RetThickness' :=' < variable or persistent (INOUT) of num
       > ]
  ['\'Conc]
```

Related information

For information about	See
Open a servo tool	*STOpen - Open a Servo Tool on page 513*

1.178. StepBwdPath - Move backwards one step on path

Usage

`StepBwdPath` is used to move the TCP backwards on the robot path from a `RESTART` event routine.

It is up to the user to introduce a restart process flag so `StepBwdPath` in the `RESTART` event routine is only executed at process restart and not at all program restarts.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove System, in Motion tasks.

Basic examples

Basic examples of the instruction `StepBwdPath` are illustrated below.

Example 1

```
StepBwdPath 30, 1;
```

Move backwards 30 mm in 1 second.

Arguments

```
StepBwdPath StepLength StepTime
```

`StepLength`

Data type: `num`

Specifies the distance, in millimeters, to move backwards during this step. This argument must be a positive value.

`StepTime`

Data type: `num`

Specifies the time, in seconds, the movement will take. This argument must have a positive value.

Program execution

The robot moves back on its path for the specified distance. The path is exactly the same in the reverse way as it was before the stop occurred. In the case of a quick stop or emergency stop, the `RESTART` event routine is called after the regain phase has completed so the robot will already be back on its path when this instruction is executed.

The actual speed for this movement is the lowest of:

- `StepLength` / `StepTime`
- The programmed speed on the segment
- 250 mm/s

Following properties are valid in MultiMove System - Synchronized Coordinated Movements:

- All involved mechanical units are moved backward simultaneously and coordinated
- Each executed `StepBwdPath` in any involved program task results in one new backward movement step (without need of any `StartMove`)
- To restart and continue the interrupted process movements, instruction `StartMove` must be executed in all involved program tasks

Continues on next page

Limitations

After the program has been stopped it is possible to step backwards on the path with the following limits:

- The 1st `StepBwdPath` movements step will be reduced to the current segment for the robot
- Further `StepBwdPath` movements steps will be limited to the segment before the previous segment (possible to step backward within two segment before the interupted segment).

If an attempt is made to move beyond these limits then the error handler will be called with `ERRNO` set to `ERR_BWDLIMIT`.

Syntax

```
StepBwdPath
  [ StepLength':=' ] < expression (IN) of num >','
  [ StepTime ':=' ] < expression (IN) of num >';'
```

Related information

For information about	See
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principle*
Positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*

1.179. STIndGun - Sets the gun in independent mode

Usage

`STIndGun` (*Servo Tool independent gun*) is used to set the gun in independent mode and thereafter move the gun to a specified independent position. The gun will stay in independent mode until the instruction `STIndGunReset` is executed.

During independent mode the control of the gun is separated from the robot. The gun can be closed, opened, calibrated, or moved to a new independent position, but it will not follow coordinated robot movements.

Independent mode is useful if the gun performs a task that is independent of the robot's task, e.g. tip dressing of a stationary gun.

Basic examples

Basic examples of the instruction `STIndGun` are illustrated below.

Example 1

This procedure could be run from a background task while the robot in the main task can continue with, for example, move instructions.

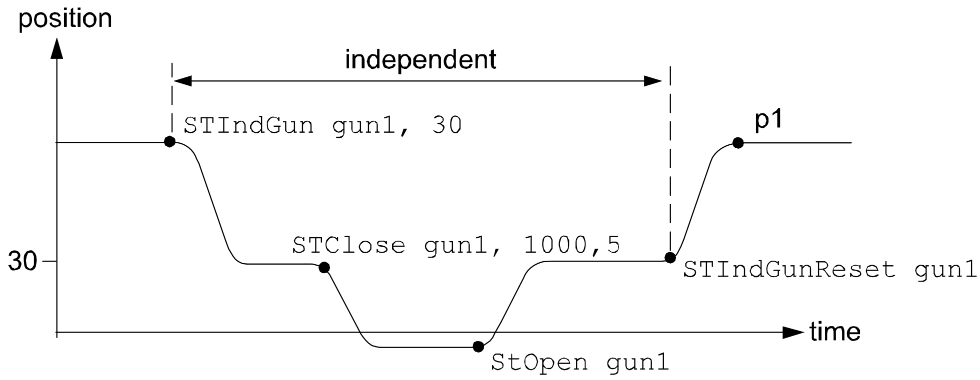
```
PROC tipdress()

  ! Note that the gun will move to current robtarget position, if
  ! already in independent mode.
  STIndGunReset gun1;
  ...
  STIndGun gun1, 30;
  StClose gun1, 1000, 5;
  WaitTime 10;
  STOpen gun1;
  ...
  STIndGunReset gun1;

ENDPROC
```

Independent mode is activated and the gun is moved to an independent position (`30` mm). During independent mode the instructions `StClose`, `WaitTime`, and `STOpen` are executed without interfering with robot motion. The instruction `StIndGunReset` will take the gun out of independent mode and move the gun to current robtarget position.

Continues on next page



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The position p1 depends on the position of the gun given in the robtarget just performed by the robot.

Arguments

`STIndGun ToolName GunPos`

`ToolName`

Data type: `string`

The name of the mechanical unit.

`GunPos`

Data type: `num`

The position (stroke) of the servo gun in mm.

Syntax

```
STIndGun
  [ ToolName ':=' ] < expression (IN) of string > ','
  [ GunPos ':=' < expression (IN) of num > ]';'
```

1.180. STIndGunReset - Resets the gun from independent mode

Usage

`STIndGunReset` (*Servo Tool independent gun reset*) is used to reset the gun from independent mode and thereafter move the gun to current robtarget position.

Basic examples

Basic examples of the instruction `STIndGunReset` are illustrated below.

```
STIndGunReset gun1;
```

Arguments

```
STIndGunReset ToolName
```

`ToolName`

Data type: `string`

The name of the mechanical unit.

Program execution

The instruction will reset the gun from independent mode and move the gun to current robtarget position. During this movement the coordinated speed of the gun must be zero otherwise an error will occur. The coordinated speed will be zero if the robot is standing still or if the current robot movement includes a “zero movement” from the gun.

Syntax

```
STIndGunReset
  [ToolName ´:=´]<expression (IN) of string>´;´
```

1.181. SToolRotCalib - Calibration of TCP and rotation for stationary tool

Usage

`SToolRotCalib` *(Stationary Tool Rotation Calibration)* is used to calibrate the TCP and rotation of a stationary tool.

The position of the robot and its movements are always related to its tool coordinate system, i.e. the TCP and tool orientation. To get the best accuracy it is important to define the tool coordinate system as correctly as possible.

The calibration can also be done with a manual method using the FlexPendant (described in *Operating manual - IRC5 with FlexPendan*t, section *Programming and testing*).

Description

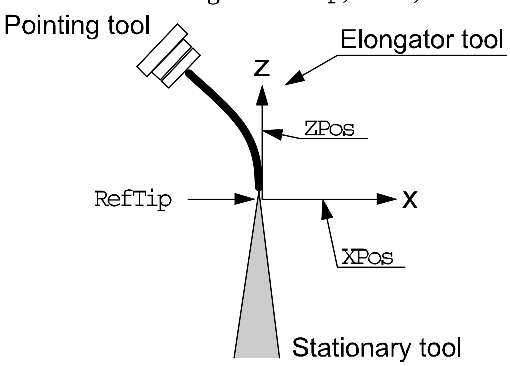
To define the TCP and rotation of a stationary tool, you need a movable pointing tool mounted on the end effector of the robot.

Before using the instruction `SToolRotCalib`, some preconditions must be fulfilled:

- The stationary tool that is to be calibrated must be mounted stationary and defined with the correct component robhold (`FALSE`).
- The pointing tool (`robhold TRUE`) must be defined and calibrated with the correct TCP values.
- If using the robot with absolute accuracy then the load and center of gravity for the pointing tool should be defined. `LoadIdentify` can be used for the load definition.
- The pointing tool, `wobj0`, and `PDispOff` must be activated before jogging the robot.
- Jog the TCP of the pointing tool as close as possible to the TCP of the stationary tool (origin of the tool coordinate system) and define a `robtarget` for the reference point `RefTip`.
- Jog the robot without changing the tool orientation so the TCP of the pointing tool is pointing at some point on the positive z-axis of the tool coordinate system, and define a `robtarget` for point `ZPos`.
- Jog the robot without changing the tool orientation so the TCP of the pointing tool is pointing at some point on the positive x-axis of the tool coordinate system, and define a `robtarget` for point `XPos`.

As a help for pointing out the positive z-axis and x-axis, some type of elongator tool can be used.

Definition of robtargets `RefTip`, `ZPos`, and `XPos`. See figure below.



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NOTE!

It is not recommended to modify the positions `RefTip`, `ZPos`, and `XPos` in the instruction `SToolRotCalib`.

Basic examples

Basic examples of the instruction `SToolRotCalib` are illustrated below.

Example 1

```
! Created with pointing TCP pointing at the stationary tool
! coordinate system
CONST robtarget pos_tip := [...];
CONST robtarget pos_z := [...];
CONST robtarget pos_x := [...];

PERS tooldata tool1:= [ FALSE, [[0, 0, 0], [1, 0, 0 ,0]],  [0, [0,
     0, 0], [1, 0, 0, 0], 0, 0, 0]];

!Instructions for creating or ModPos of pos_tip, pos_z and pos_x
MoveJ pos_tip, v10, fine, point_tool;
MoveJ pos_z, v10, fine, point_tool;
MoveJ pos_x, v10, fine, point_tool;

SToolRotCalib pos_tip, pos_z, pos_x, tool1;
```

The position of the TCP (`tframe.trans`) and the tool orientation (`tframe.rot`) of `tool1` in the world coordinate system is calculated and updated.

Arguments

```
SToolRotCalib RefTip ZPos XPos Tool
```

`RefTip`

Data type: `robtarget`

The point where the TCP of the pointing tool is pointing at the stationary tool TCP to calibrate.

`ZPos`

Data type: `robtarget`

The elongator point that defines the positive z direction.

`XPos`

Data type: `robtarget`

The elongator point that defines the positive x direction.

`Tool`

Data type: `tooldata`

The persistent variable of the tool that is to be calibrated.

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Program execution

The system calculates and updates the TCP (`tframe.trans`) and the tool orientation (`tfame.rot`) in the specified `tooldata`. The calculation is based on the specified 3 `robtarget`. The remaining data in `tooldata` is not changed.

Syntax

```
SToolRotCalib
  [ RefTip ':=' ] < expression (IN) of robtarget > ','
  [ ZPos ':=' ] < expression (IN) of robtarget > ','
  [ XPos ':=' ] < expression (IN) of robtarget > ','
  [ Tool ':=' ] < persistent (PERS) of tooldata > ';'
```

Related information

For information about	See
Calibration of TCP for a moving tool	*MToolTCPCalib - Calibration of TCP for moving tool on page 278*
Calibration of rotation for a moving tool	*MToolRotCalib - Calibration of rotation for moving tool on page 275*
Calibration of TCP for a stationary tool	*MToolTCPCalib - Calibration of TCP for moving tool on page 278*

1.182. SToolTCPCalib - Calibration of TCP for stationary tool

Usage

`SToolTCPCalib` *(Stationary Tool TCP Calibration)* is used to calibrate the Tool Center Point - TCP for a stationary tool.

The position of the robot and its movements are always related to its tool coordinate system, i.e. the TCP and tool orientation. To get the best accuracy it is important to define the tool coordinate system as correctly as possible.

The calibration can also be done with a manual method using the FlexPendant (described in *Operating manual - IRC5 with FlexPendant*, section *Programming and testing*).

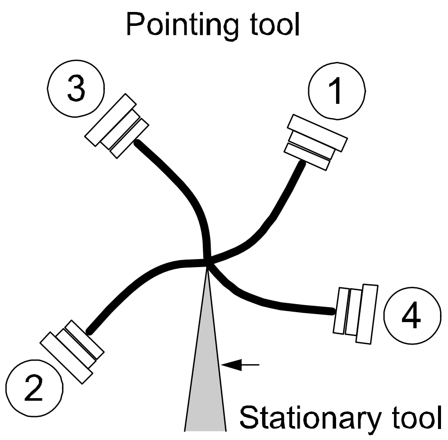
Description

To define the TCP of a stationary tool, you need a movable pointing tool mounted on the end effector of the robot.

Before using the instruction `SToolTCPCalib`, some preconditions must be fulfilled:

- The stationary tool that is to be calibrated must be mounted stationary and defined with the correct component `robhold` (`FALSE`).
- The pointing tool (`robhold TRUE`) must be defined and calibrated with the correct TCP values.
- If using the robot with absolute accuracy then the load and center of gravity for the pointing tool should be defined. `LoadIdentify` can be used for the load definition.
- The pointing tool, `wobj0` and `PDispOff`, must be activated before jogging the robot.
- Jog the TCP of the pointing tool as close as possible to the TCP of the stationary tool and define a `robtarget` for the first point p1.
- Define the further three positions p2, p3, and p4, all with different orientations.
- It is recommended that the TCP is pointed out with different orientations to obtain a reliable statistical result. However, it is not necessary.

Definition of 4 robtargets p1...p4. See figure below.



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NOTE!

It is not recommended to modify the positions `Pos1` to `Pos4` in the instruction `SToolTCPCalib`.

The reorientation between the 4 positions should be as big as possible, putting the robot in different configurations.Its also good practice to check the quality of the TCP after a calibration. Which can be performed by reorientation of the tool to check if the TCP is standing still.

Basic example

Basic examples of the instruction `SToolTCPCalib` are illustrated below.

Example 1

```
! Created with pointing TCP pointing at the stationary TCP
CONST robtarget p1 := [...];
CONST robtarget p2 := [...];
CONST robtarget p3 := [...];
CONST robtarget p4 := [...];

PERS tooldata tool1:= [ FALSE, [[0, 0, 0], [1, 0, 0 ,0]], [0,001,
     [0, 0, 0.001], [1, 0, 0, 0], 0, 0, 0]];
VAR num max_err;
VAR num mean_err;
! Instructions for creating or ModPos of p1 - p4
MoveJ p1, v10, fine, point_tool;
MoveJ p2, v10, fine, point_tool;
MoveJ p3, v10, fine, point_tool;
MoveJ p4, v10, fine, point_tool;

SToolTCPCalib p1, p2, p3, p4, tool1, max_err, mean_err;
```

The TCP value (`tframe.trans`) of `tool1` will be calibrated and updated. `max_err` and `mean_err` will hold the max error in mm from the calculated TCP and the mean error in mm from the calculated TCP, respectively.

Arguments

```
SToolTCPCalib Pos1 Pos2 Pos3 Pos4 Tool MaxErr MeanErr
```

`Pos1`

Data type: `robtarget`

The first approach point.

`Pos2`

Data type: `robtarget`

The second approach point.

`Pos3`

Data type: `robtarget`

The third approach point.

Continues on next page

`Pos4`

Data type: `robtarget`

The fourth approach point.

`Tool`

Data type: `tooldata`

The persistent variable of the tool that is to be calibrated.

`MaxErr`

Data type: `num`

The maximum error in mm for one approach point.

`MeanErr`

Data type: `num`

The average distance that the approach points are from the calculated TCP, i.e. how accurately the robot was positioned relative to the stationary TCP.

Program execution

The system calculates and updates the TCP value in the world coordinate system (`tfame.trans`) in the specified `tooldata`. The calculation is based on the specified 4 `robtarget`. The remaining data in tooldata, such as tool orientation (`tframe.rot`), is not changed.

Syntax

```
SToolTCPCalib
  [ Pos1 ':=' ] < expression (IN) of robtarget > ','
  [ Pos2 ':=' ] < expression (IN) of robtarget > ','
  [ Pos3 ':=' ] < expression (IN) of robtarget > ','
  [ Pos4 ':=' ] < expression (IN) of robtarget > ','
  [ Tool ':=' ] < persistent (PERS) of tooldata > ','
  [ MaxErr ':=' ] < variable (VAR) of num > ','
  [ MeanErr' :=' ] < variable (VAR) of num > ';'
```

Related information

For information about	See
Calibration of TCP for a moving tool	*SToolTCPCalib - Calibration of TCP for stationary tool on page 507*
Calibration of rotation for a moving tool	*MToolRotCalib - Calibration of rotation for moving tool on page 275*
Calibration of TCP and rotation for a stationary tool	*SToolRotCalib - Calibration of TCP and rotation for stationary tool on page 504*

1.183. Stop - Stops program execution

Usage

`Stop` is used to stop the program execution. Any movement performed at the time will be finished before the `Stop` instruction is ready.

Basic examples

Basic examples of the instruction `Stop` are illustrated below.

See also *More examples on page 512*.

Example 1

```
TPWrite "The line to the host computer is broken";
Stop;
```

Program execution stops after a message has been written on the FlexPendant.

Arguments

```
Stop [ \NoRegain ] | [ \AllMoveTasks ]
```

`[ \NoRegain ]`

Data type: `switch`

Specifies for the next program start, whether or not the affected mechanical unit should return to the stop position.

If the argument `\NoRegain` is set then the robot and external axes will not return to the stop position (if they have been jogged away from it).

If the argument is omitted and if the robot or external axes have been jogged away from the stop position then the robot displays a question on the FlexPendant. The user can then answer whether or not the robot should return to the stop position.

`[ \AllMoveTasks ]`

Data type: `switch`

Specifies that programs in all running normal tasks besides the actual task should be stopped.

If the argument is omitted then only the program in the task that executes the instruction will be stopped.

Continues on next page

Program execution

The instruction stops program execution when the affected mechanical units in the actual motion task have reached zero speed for the movement it is performing at the time, and stands still. Program execution can then be restarted from the next instruction.

If the instruction is used without any switches then only the program in that task will be affected.

If the `AllMoveTasks` switch is used in a task (Normal, Static, or Semistatic) then the program in that task and all normal tasks will stop. See more about declaration of tasks in documentation for System Parameters

The `NoRegain` switch is only possible to use in motion tasks since it only concerns the motion path.

If there is a `Stop` instruction in some event routine then the execution of the routine will be stopped, and the execution continue as described in TABLE 1.

If there is a `Stop\AllMoveTasks` instruction in some event routine in a `MultiMove` system, then the task containing the instruction continue as described in TABLE 1 and all other motion tasks executing an event routine continues as described in TABLE 2 (same affect as for normal program stop during execution of the event routine).

TABLE 1	
Event routines	**Affect by Stop instruction**
`POWER ON`	The execution is stopped. `STOP` event routines are executed. The execution does not continue in the event routine at the next start order..
`START`	The execution is stopped. `STOP` event routines are executed. The execution does not continue in the event routine at the next start order.
`RESTART`	The execution is stopped. `STOP` event routines are executed. The execution does not continue in the event routine at the next start order.
`STOP`	The execution is stopped. No other event routines are executed. The execution does not continue in the event routine at the next start order.
`QSTOP`	The execution is stopped. `STOP` event routines are executed. The execution does not continue in the event routine at the next start order.
`RESET`	The execution is stopped. `STOP` event routines are executed. The execution does not continue in the event routine at the next start order.

Continues on next page

TABLE 2	
Event routines	**Affect by Stop \AllMoveTasks**
`POWER ON`	The `POWER ON` event routine completes its execution. No `STOP` event routines are executed.
`START`	The execution is stopped, and continues at the next ordered start. No `STOP` event routines are executed.
`RESTART`	The execution is stopped, and continues at the next ordered start. No `STOP` event routines are executed.
`STOP`	The `STOP` event routine completes its execution.
`QSTOP`	The `QSTOP` event routine completes its execution.
`RESET`	The execution is stopped, and continues at the next ordered start. No `STOP` event routines are executed.

More examples

More examples of how to use the instruction `Stop` are illustrated below.

Example 1

```
MoveL p1, v500, fine, tool1;
TPWrite "Jog the robot to the position for pallet corner 1";
Stop \NoRegain;
p1_read := CRobT(\Tool:=tool1 \WObj:=wobj0);
MoveL p2, v500, z50, tool1;
```

Program execution stops with the robot at `p1`. The operator jogs the robot to `p1_read`. For the next program start the robot does not regain to `p1`, so the position `p1_read` can be stored in the program.

Syntax

```
Stop
  [ '\' NoRegain ]'|'
  [ '\' AllMoveTasks ]';'
```

Related information

For information about	See
Terminating program execution	*EXIT - Terminates program execution on page 105*
Only stopping robot movements	*StopMove - Stops robot movement on page 515*
Stop program for debugging	*Break - Break program execution on page 32*

1.184. STOpen - Open a Servo Tool

Usage

`STOpen` is used to open the Servo Tool.

Basic examples

Basic examples of the instruction `STOpen` are illustrated below.

Example 1

```
STOpen gun1;
```

Open the servo tool `gun1`. Wait until the gun is opened before continuing with the next Rapid instruction.

Example 2

```
STOpen gun1 \Conc;
```

Open the servo tool `gun1`. Continue with the next Rapid instruction without waiting for the gun to be opened.

Example 3

```
STOpen "SERVOGUN"\WaitZeroSpeed;
```

Stop the servo tool `SERVOGUN`, wait until any coordinated movement has finished, and then open the servo tool `SERVOGUN`.

Arguments

```
STOpen ToolName
```

`ToolName`

Data type: `string`

The name of the mechanical unit.

`[\WaitZeroSpeed]`

Data type: `switch`

Stop the servo tool, wait until any coordinated movement has finished, and then open the servo tool.

`[\Conc]`

Data type: `switch`

Subsequent instructions are executed while the gun is moving. The argument can be used to shorten cycle time. This is useful when, for example, two guns are controlled at the same time.

Continues on next page

Program execution

If the mechanical unit exists then the servo tool is ordered to open. The tip force is reduced to zero and the tool arm is moved back to the pre_close position.

The tool arm is moved with max speed and acceleration as it is defined in the system parameters for the corresponding external axis. As for other axes movements, the speed is reduced in manual mode.

It is possible to open the tool during a programmed robot movement as long as the robot movement does not include a movement of the tool arm. If the tool is opened during such movement then an error `50251 Tool opening failed` will be displayed. The switch `WaitZeroSpeed` can be used to reduce the risk for this error.

If the switch Conc is used then the instruction will be considered to be ready before the servo tool is opened. It is recommended that the function `STIsOpen` is used after `STOpen` to avoid any problems in concurrent mode.

For more details, see Servo tool motion control.

Error handling

If the specified servo tool name is not a configured servo tool then the system variable `ERRNO` is set to `ERR_NO_SGUN`.

If the servo tool mechanical unit is not activated then the system variable `ERRNO` is set to `ERR_SGUN_NOTACT`. Use instruction `ActUnit` to activate the servo tool.

If the servo tool position is not initialized then the system variable `ERRNO` is set to `ERR_SGUN_NOTINIT`. The servo tool position must be initialized the first time the gun is installed or after a fine calibration is made. Use the service routine `ManServiceCalib`, or perform a tip change calibration. The tip wear will be reset.

If the servo tool tips are not synchronized then the system variable `ERRNO` is set to `ERR_SGUN_NOTSYNC`. The servo tool tips must be synchronized if the revolution counter has been lost and/or updated. No process data such as tip wear will be lost.

All above errors can be handled in a RAPID error handler.

NOTE!

If the instruction is invoked from a background task and there is an emergency stop then the instruction will be finished without an error.

Syntax

```
STOpen
[ 'ToolName ':=' ] < expression (IN) of string > ','
[ '\'WaitZeroSpeed]' ','
['\'Conc]'
```

Related information

For information about	See
Close a servo tool	*STClose - Close a Servo Tool on page 496*

1.185. StopMove - Stops robot movement

Usage

`StopMove` is used to stop robot and external axes movements and any belonging process temporarily. If the instruction `StartMove` is given then the movement and process resumes.

This instruction can, for example, be used in a trap routine to stop the robot temporarily when an interrupt occurs.

For base system it is possible to use this instruction in the following type of program tasks:

- main task `T_ROB1` for stopping the movement in that task.
- any other task for stopping the movements in the main task.

For MultiMove systems it is possible to use this instruction in following type of program tasks:

- motion task for stopping the movement in that task.
- non-motion task for stopping the movement in the connected motion task. Besides that, if movement is stopped in one motion task belonging to a coordinated synchronized task group then the movement is stopped in all the cooperated tasks.

Basic examples

Basic examples of the instruction `StopMove` are illustrated below.

See also *More examples on page 517*.

Example 1

```
StopMove;
WaitDI ready_input, 1;
StartMove;
```

The robot movement is stopped until the input, `ready_input` is set.

Arguments

```
StopMove [\Quick] [\AllMotionTasks]
```

`[\Quick]`

Data type: `switch`

Stops the robot on the path as fast as possible.

Without the optional parameter `\Quick`, the robot stops on the path, but the braking distance is longer (same as for normal Program Stop).

`[\AllMotionTasks]`

Data type: `switch`

Stop the movement of all mechanical units in the system. The switch `[\AllMotionTasks]` can only be used from a non-motion program task.

Continues on next page

Program execution

The movements of the robot and external axes stop without the brakes being engaged. Any processes associated with the movement in progress are stopped at the same time as the movement is stopped.

Program execution continues after waiting for the robot and external axes to stop (standing still).

With the switch `\AllMotionTasks` (only allowed from non-motion program task) the movements for all mechanical units in the system are stopped.

In a base system without the switch `\AllMotionTasks`, the movements for the following mechanical units are stopped:

- always the mechanical units in the main task, independent of which task executes the `StopMove` instruction.

In a MultiMove system without the switch `\AllMotionTasks`, the movements for the following mechanical units are stopped:

- the mechanical units in the motion task executing `StopMove`.
- the mechanical units in the motion task that are connected to the non-motion task executing `StopMove`. Besides that, if mechanical units are stopped in one connected motion task belonging to a coordinated synchronized task group then the mechanical units are stopped in all the cooperated tasks.

The `StopMove` state in the motion task generated from the motion task itself will automatically be reset when starting that task from the beginning.

The `StopMove` state in connected motion task, generated from the some non-motion task, will automatically be reset:

- if normal non-motion task, at the start of that task from the beginning.
- if semi-static non-motion task, at power fail restart when the task is starting from the beginning.
- if static non-motion task, at installation start when the task is starting from the beginning.

Continues on next page

More examples

More examples of the instruction `StopMove` are illustrated below.

Example 1

```
VAR intnum intno1;
...
CONNECT intno1 WITH go_to_home_pos;
ISignalDI di1,1,intno1;

TRAP go_to_home_pos
  VAR robtarget p10;
  StopMove;
  StorePath;
  p10:=CRobT(\Tool:=tool1 \WObj:=wobj0);
  MoveL home,v500,fine,tool1;
  WaitDI di1,0;
  Move L p10,v500,fine,tool1;
  RestoPath;
  StartMove;
ENDTRAP
```

When the input `di1` is set to 1 an interrupt is activated which in turn activates the interrupt routine `go_to_home_pos`. The current movement is stopped, and the robot moves instead to the `home` position. When `di1` is set to 0 the robot returns to the position at which the interrupt occurred and continues to move along the programmed path.

Example 2

```
VAR intnum intno1;
...
CONNECT intno1 WITH go_to_home_pos;
ISignalDI di1,1,intno1;

TRAP go_to_home_pos ()
  VAR robtarget p10;
  StorePath;
  p10:=CRobT(\Tool:=tool1 \WObj:=wobj0);
  MoveL home,v500,fine,tool1;
  WaitDI di1,0;
  MoveL p10,v500,fine,tool1;
  RestoPath;
  StartMove;
ENDTRAP
```

Similar to the previous example but the robot does not move to the home position until the current movement instruction is finished.

Limitations

Only one of several non-motion tasks is allowed at the same time to do `StopMove` - `StartMove` sequence against some motion task.

Continues on next page

Syntax

```
StopMove
  ['\'Quick]
  ['\'AllMotionTasks]';'
```

Related information

For information about	See
Continuing a movement	*StartMove - Restarts robot movement on page 486* *StartMoveRetry - Restarts robot movement and execution on page 489*
Store - restore path	*StorePath - Stores the path when an interrupt occurs on page 521* *RestoPath - Restores the path after an interrupt on page 362*

1.186. StopMoveReset - Reset the system stop move state

Usage

`StopMoveReset` is used to reset the system stop move state without starting any movements.

Asynchronously raised movements errors, such as `ERR_PATH_STOP` or specific process error during the movements, can be handled in the `ERROR` handler. When such an error occurs the movements are stopped at once, and the system stop move flag is set for actual program tasks. This means that the movement is not restarted if doing any program start while program pointer is inside the `ERROR` handler.

Restart of the movements after such movement error will be done after one of these action:

- Execute `StartMove` or `StartMoveRetry`.
- Execute `StopMoveReset` and the movement will restart at the next program start.

Basic examples

Basic examples of the instruction `StopMoveReset` are illustrated below.

Example 1

```
...
ArcL p101, v100, seam1, weld1, weave1, z10, gun1;
...
ERROR
  IF ERRNO=AW_WELD_ERR OR ERRNO=ERR_PATH_STOP THEN
    ! Execute something but without any restart of the movement
    ! ProgStop - ProgStart must be allowed
    ...
    ! No idea to try to recover from this error, so let the error
    ! stop the program
    ...
    ! Reset the move stop flag, so it's possible to manual restart
    ! the program and the movement after that the program has
    ! stopped
    StopMoveReset;
  ENDIF
ENDPROC
```

After that above `ERROR` handler has executed the `ENDPROC`, the program execution stops and the pointer is at the beginning of the `ArcL` instruction. Next program start restarts the program and movement from the position where the original movement error occurred.

Arguments

```
StopMoveReset [\AllMotionTasks]
```

`[\AllMotionTasks]`

Data type: `switch`

Reset the system stop move state for all mechanical units in the system. The switch `[\AllMotionTasks]` can only be used from a non-motion program task.

Continues on next page

Program execution

To reset a MultiMove application in synchronized coordinated mode, `StopMoveReset` must be executed in all motion tasks that are involved in coordination.

With the switch `\AllMotionTasks` (only allowed from non-motion program task) the reset is done for all all mechanical units in the system.

In a base system without the switch `\AllMotionTasks`, the reset is always done for the main task, independent of which task that executes the `StopMoveReset` instruction.

For base system it is possible to use `StopMoveReset` in the following type of program tasks:

- main task `T_ROB1` to reset the stop move state in that task.
- any other task to reset the stop move state in the main task.

For MultiMove system it is possible to use this instruction in the following type of program tasks:

- motion task, to reset the stop move state in that task.
- non motion task, to reset the stop move state in the connected motion task. Besides that, if the reset of the stop move state in one connected motion task belonging to a coordinated synchronized task group, the stop move state is reset in all the cooperating tasks.

Syntax

```
StopMoveReset
  ['\'AllMotionTasks]';'
```

Related information

For information about	See
Stop the movement	*StopMove - Stops robot movement on page 515*
Continuing a movement	*StartMove - Restarts robot movement on page 486* *StartMoveRetry - Restarts robot movement and execution on page 489*
Store - restore path	*StorePath - Stores the path when an interrupt occurs on page 521* *RestoPath - Restores the path after an interrupt on page 362*

1.187. StorePath - Stores the path when an interrupt occurs

Usage

`StorePath` is used to store the movement path being executed, e.g. when an error or interrupt occurs. The error handler or a trap routine can then start a new temporary movement and finally restart the original movement that was stored earlier.

For example, this instruction can be used to go to a service position or to clean the gun when an error occurs.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Basic examples

Basic examples of the instruction `StorePath` are illustrated below.

See also *More examples on page 522*.

Example 1

```
StorePath;
```

The current movement path is stored for later use. Set the system to independent movement mode.

Example 2

```
StorePath \KeepSync;
```

The current movement path is stored for later use. Keep synchronized movement mode.

Arguments

```
StorePath [\KeepSync]
```

`[\KeepSync]`

Keep Synchronization

Data type: `switch`

Keeps synchronized movement mode after the `StorePath \KeepSync`. The `KeepSync` switch can only be used if the system is in synchronized movement mode before the `StorePath \KeepSync` call.

Without the optional parameter `\KeepSync`, in a MultiMove coordinated synchronized system, the system is set to independent-semicoordinated movement mode. After execution of `StorePath` in all involved tasks, the system is in semicoordinated mode if further on use of coordinated work object. Otherwise it is in independent mode. If in semicoordinated mode it is recommended to always start with a movement in the mechanical unit that controls the user frame before `WaitSyncTask` in all involved tasks.

Program execution

The current movement path of the robot and external axes are saved. After this, another movement can be started in a trap routine or in an error handler. When the reason for the error or interrupt has been rectified then the saved movement path can be restarted.

Continues on next page

More examples

More examples of how to use the instruction `StorePath` are illustrated below.

Example 1

```
TRAP machine_ready
VAR robtarget p1;
StorePath;
p1 := CRobT();
MoveL p100, v100, fine, tool1;
...
MoveL p1, v100, fine, tool1;
RestoPath;
StartMove;
ENDTRAP
```

When an interrupt occurs that activates the trap routine `machine_ready`, the movement path which the robot is executing at the time is stopped at the end of the instruction (ToPoint) and stored. After this the robot remedies the interrupt by, for example, replacing a part in the machine. Then the normal movement is restarted.

Limitations

Only the movement path data is stored with the instruction `StorePath`.

If the user wants to order movements on the new path level then the actual stop position must be stored directly after `StorePath` and before `RestoPath` makes a movement to the stored stop position on the path.

Only one movement path can be stored at a time.

Syntax

```
StorePath
  ['\'KeepSync]';'
```

Related information

For information about	See
Restoring a path	*RestoPath - Restores the path after an interrupt on page 362*
More examples	*RestoPath - Restores the path after an interrupt on page 362* *PathRecStart - Start the path recorder on page 308* *SyncMoveResume - Set synchronized coordinated movements on page 541* *SyncMoveSuspend - Set independent-semicoordinated movements on page 543*

1.188. STTune - Tuning Servo Tool

Usage

`STTune` is used to tune/change a servo tool parameter. The parameter is changed temporarily from the original value, which is set up in the system parameters. The new tune value will be active immediately after executing the instruction.

`STTune` is useful in tuning procedures. A tuning procedure is typically used to find an optimal value for a parameter. An experiment (i.e. a program execution with a servo tool movement) is repeated when using different parameter tune values.

`STTune` shall not be used during calibration or tool closure.

Basic examples

Basic examples of the instruction `STTune` are illustrated below.

Example 1

```
STTune SEOLO_RG, 0.050, CloseTimeAdjust;
```

The servo tool parameter `CloseTimeAdjust` is temporarily set to `0.050` seconds.

Arguments

```
STTune MecUnit TuneValue Type
```

`MecUnit`

Data type: `mecunit`

The name of the mechanical unit.

`TuneValue`

Data type: `num`

New tuning value.

`Type`

Data type: `tunegtype`

Parameter type. Servo tool parameters available for tuning are `RampTorqRefOpen`, `RampTorqRefClose`, `KV`, `SpeedLimit`, `CollAlarmTorq`, `CollContactPos`, `CollisionSpeed`, `CloseTimeAdjust`, `ForceReadyDelayT`, `PostSyncTime`, `CalibTime`, `CalibForceLow`, `CalibForceHigh`. These types are predefined in the system parameters and defines the original values.

Description

`RampTorqRefOpen`

Tunes the system parameter `Ramp when decrease force`, which decides how fast force is released while opening the tool. The unit is Nm/s and a typical value 200.

Corresponding system parameter: topic *Motion*, type *Force master*, parameter `ramp_torque_ref_opening`.

Continues on next page

`RampTorqRefClose`

Tunes the system parameter `Ramp when increase force`, which decides how fast force is built up while opening the tool. The unit is Nm/s and a typical value 80.

Corresponding system parameter: topic *Motion*, type *Force master*, parameter `ramp_torque_ref_closing`.

`KV`

Tunes the system parameter `KV`, which is used for speed limitation. The unit is Nms/rad and a typical value 1. For more details, see the external axis documentation.

Corresponding system parameter: topic *Motion*, type *Force master*, parameter `Kv`.

`SpeedLimit`

Tunes the system parameter `Speed limit`, which is used for speed limitation. The unit is rad/s (motor speed) and a typical value 60. For more details, see the external axis documentation.

Corresponding system parameter: topic *Motion*, type *Force master*, parameter `speed_limit`.

`CollAlarmTorq`

Tunes the system parameter `Collision alarm torque`, which is used for the automatic calibration of new tips. The unit is Nm (motor torque) and a typical value 1. For more details, see the external axis documentation.

Corresponding system parameter: topic *Motion*, type *Force master*, parameter `alarm_torque`.

`CollContactPos`

Tunes the system parameter `Collision delta pos`, which is used for automatic calibration of new tips. The unit is m and a typical value 0,002. For more details, see the external axis documentation.

Corresponding system parameter: topic *Motion*, type *Force master*, parameter `distance_to_contact_position`.

`CollisionSpeed`

Tunes the system parameter `Collision speed`, which is used for automatic calibration of new tips. The unit is m/s and a typical value 0,02. For more details, see the external axis documentation.

Corresponding system parameter: topic *Motion*, type *Force master*, parameter `col_speed`.

`CloseTimeAdjust`

Constant time adjustment (s), positive or negative, of the moment when the tool tips reaches contact during a tool closure. May be used to delay the closing slightly when the synchronized pre-closing is used for welding.

Corresponding system parameter: topic *Motion*, type *SG process*, parameter `min_close_time_adjust`.

Continues on next page

`ForceReadyDelayT`

Constant time delay (s) before sending the weld ready signal after reaching the programmed force.

Corresponding system parameter: topic *Motion*, type *SG process*, parameter `pre_sync_delay_time`.

`PostSyncTime`

Release time anticipation (s) of the next robot movement after a weld. This tune type can be tuned to synchronize the gun opening with the next robot movement. The synchronization may fail if the parameters is set too high.

Corresponding system parameter: topic *Motion*, type *SG process*, parameter `post_sync_time`.

`CalibTime`

The wait time (s) during a calibration before the positional tool tip correction is done. For best results do not use too low a value like 0.5 s.

Corresponding system parameter: topic *Motion*, type *SG process*, parameter `calib_time`.

`CalibForceLow`

The minimum tip force (N) used during a TipWear calibration. For best result of the thickness detection it is recommended to use the minimum programmed weld force.

Corresponding system parameter: topic *Motion*, type *SG process*, parameter `calib_force_low`.

`CalibForceHigh`

The maximum tip force (N) used during a TipWear calibration. For best result of the thickness detection it is recommended to use the max programmed weld force.

Corresponding system parameter: topic *Motion*, type *SG process*, parameter `calib_force_high`.

Program execution

The specified tuning type and tuning value are activated for the specified mechanical unit. This value is applicable for all movements until a new value is programmed for the current mechanical unit or until the tuning types and values are reset using the instruction `STTuneReset`.

The original tune values may be permanently changed in the system parameters.

The default servo tool tuning values are automatically set

- by executing instruction `STTuneReset`.
- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

Error handling

If the specified servo tool name is not a configured servo tool then the system variable `ERRNO` is set to `ERR_NO_SGUN`.

The error can be handled in a Rapid error handler.

Continues on next page

Syntax

```
STTune
  [ MecUnit ':=' ] < variable (VAR) of mecunit > ','
  [ TuneValue' :=' ] < expression (IN) of num > ','
  [ 'Type ':='] < expression (IN) of tunegtype > ]';'
```

Related information

For information about	See
Restore of servo tool parameters	*TuneReset - Resetting servo tuning on page 637*
Tuning of servo tool	*Application manual - Additional axes and stand alone controller*

1.189. STTuneReset - Resetting Servo tool tuning

Usage

`STTuneReset` is used to restore original values of servo tool parameters if they have been changed by the `STTune` instruction.

Basic examples

Basic examples of the instruction `STTuneReset` are illustrated below.

Example 1

```
STTuneReset SEOLO_RG;
```

Restore *original values of servo tool parameters* for the mechanical unit `SEOLO_RG`.

Arguments

```
STTuneReset MecUnit
```

`MecUnit`

Data type: `mecunit`

The name of the mechanical unit.

Program execution

The original servo tool parameters are restored.

This is also achieved

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

Error handling

If the specified servo tool name is not a configured servo tool then the system variable `ERRNO` is set to `ERR_NO_SGUN`.

The error can be handled in a Rapid error handler.

Syntax

```
STTuneReset
  [ MecUnit ':=' ] < variable (VAR) of mecunit > ','
```

Related information

For information about	See
Tuning of servo tool parameters	*STTune - Tuning Servo Tool on page 523*
Tuning of servo tool parameters	*Application manual - Additional axes and stand alone controller*

1.190. SyncMoveOff - End coordinated synchronized movements

Usage

`SyncMoveOff` is used to end a sequence of synchronized movements and, in most cases, coordinated movements. First, all involved program tasks will wait to synchronize in a stop point, and then the motion planners for the involved program tasks are set to independent mode.

The instruction `SyncMoveOff` can only be used in a *MultiMove* system with option *Coordinated Robots* and only in program tasks defined as `Motion Task`.

WARNING!

To reach safe synchronization functionality every meeting point (parameter `SyncID`) must have a unique name. The name of the meeting point must also be the same for all the program tasks that should meet.

Basic examples

Basic examples of the instruction `SyncMoveOff` are illustrated below.

See also *More examples on page 530*.

Example 1

```
!Program example in task T_ROB1

PERS tasks task_list{2} := [ ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;
VAR syncident sync2;

...
SyncMoveOn sync1, task_list;
...
SyncMoveOff sync2;
...

!Program example in task T_ROB2

PERS tasks task_list{2} := [ ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;
VAR syncident sync2;

...
SyncMoveOn sync1, task_list;
...
SyncMoveOff sync2;
...
```

The program task that first reaches `SyncMoveOff` with identity `sync2` waits until the other tasks reach `SyncMoveOff` with the same identity `sync2`. At that synchronization point `sync2`, the motion planners for the involved program tasks are set to independent mode. After that, both task `T_ROB1` and `T_ROB2` continue their execution.

Continues on next page

Arguments

```
SyncMoveOff SyncID [\TimeOut]
```

`SyncID`

Synchronization Identity

Data type: `syncident`

Variables that specify the name of the unsynchronization (meeting) point. Data type `syncident` is a non-value type. It is only used as an identifier for naming the unsynchronization point.

The variable must be defined and have an equal name in all cooperated program tasks. It is recommended to always define the variable global in each task (`VAR syncident ...`).

`[\TimeOut]`

Data type: `num`

The max. time to wait for the other program tasks to reach the unsynchronization point. The time-out is defined in seconds (resolution 0,001s).

If this time runs out before all program tasks have reached the unsynchronization point then the error handler will be called, if there is one, with the error code `ERR_SYNCMOVEOFF`. If there is no error handler then the execution will be stopped.

If this argument is omitted then the program task will wait forever.

Program execution

The program task that first reaches `SyncMoveOff` waits until all other specified tasks reach `SyncMoveOff` with the same `SyncID` identity. At that `SyncID` unsynchronization point the motion planner for the involved program tasks is set to independent mode. After that, involved program tasks continue their execution.

The motion planner for the involved program tasks are set to unsynchronized mode. This means the following:

- All RAPID program tasks and all movements from these tasks are working independently of each other again.
- Any move instruction must **not** be marked with any ID number. See instruction `MoveL`.

It is possible to exclude program tasks for testing purpose from FlexPendant - Task Selection Panel. The instructions `SyncMoveOn` and `SyncMoveOff` will still work with the reduced number of program tasks, even for only one program task.

Continues on next page

More examples

More examples of how to use the instruction `SyncMoveOff` are illustrated below.

Example 1

```
!Program example in task T_ROB1
PERS tasks task_list{2} := [ ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;
VAR syncident sync2;
VAR syncident sync3;

PROC main()
  ...
  MoveL p_zone, vmax, z50, tcp1;
  WaitSyncTask sync1, task_list;
  MoveL p_fine, v1000, fine, tcp1;
  syncmove;
  ...
ENDPROC

PROC syncmove()
  SyncMoveOn sync2, task_list;
  MoveL * \ID:=10, v100, z10, tcp1 \WOBJ:= rob2_obj;
  MoveL * \ID:=20, v100, fine, tcp1 \WOBJ:= rob2_obj;
  SyncMoveOff sync3;
  UNDO
     SyncMoveUndo;
ENDPROC

!Program example in task T_ROB2
PERS tasks task_list{2} := [ ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;
VAR syncident sync2;
VAR syncident sync3;

PROC main()
  ...
  MoveL p_zone, vmax, z50, obj2;
  WaitSyncTask sync1, task_list;
  MoveL p_fine, v1000, fine, obj2;
  syncmove;
  ...
ENDPROC
```


Continues on next page

```
PROC syncmove()
  SyncMoveOn sync2, task_list;
  MoveL * \ID:=10, v100, z10, obj2;
  MoveL * \ID:=20, v100, fine, obj2 ;
  SyncMoveOff sync3;
  UNDO
    SyncMoveUndo;
ENDPROC
```

First program tasks `T_ROB1` and `T_ROB2` are waiting at `WaitSyncTask` with identity `sync1` for each other, programmed with corner path for the preceding movements for saving cycle time.

Then the program tasks are waiting at `SyncMoveOn` with identity `sync2` for each other, programmed with a necessary stop point for the preceding movements. After that, the motion planner for the involved program tasks is set to synchronized mode.

After that, `T_ROB2` is moving the `obj2` to `ID` point `10` and `20` in world coordinate system while `T_ROB1` is moving the `tcp1` to `ID` point `10` and `20` on the moving object `obj2`.

Then the program tasks are waiting at `SyncMoveOff` with identity `sync3` for each other, programmed with a necessary stop point for the preceding movements. After that, the motion planner for the involved program tasks is set to independent mode.

Example 2

```
!Program example with use of time-out function
VAR syncident sync3;

...
SyncMoveOff sync3 \TimeOut := 60;
...
ERROR
  IF ERRNO = ERR_SYNCMOVEOFF THEN
    RETRY;
  ENDIF
```

The program task waits for an instruction `SyncMoveOff` and for some other program task to reach the same synchronization point `sync3`. After waiting 60 seconds, the error handler is called with `ERRNO` equal to `ERR_SYNCMOVEOFF`. Then the instruction `SyncMoveOff` is called again for an additional wait of 60 seconds.

Continues on next page

Example 3

```
!Example with with semicoordinated and syncronized movement
!Program example in task T_ROB1
PERS tasks task_list{2} := [ ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;
VAR syncident sync2;
..

PROC main()
  ...
  MoveL p1_90, v100, fine, tcp1 \WOBJ:= rob2_obj;
  WaitSyncTask sync1, task_list;
  SyncMoveOn sync2, task_list;
  MoveL p1_100 \ID:=10, v100, fine, tcp1 \WOBJ:= rob2_obj;
  SyncMoveOff sync3;
  WaitSyncTask sync3, task_list;
  MoveL p1_120, v100, z10, tcp1 \WOBJ:= rob2_obj;
  MoveL p1_130, v100, fine, tcp1 \WOBJ:= rob2_obj;
  WaitSyncTask sync4, task_list;
  ...
ENDPROC

!Program example in task T_ROB2
PERS tasks task_list{2} := [ ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;
VAR syncident sync2;
..

PROC main()
  ...
  MoveL p_fine, v1000, fine, tcp2;
  WaitSyncTask sync1, task_list;
  SyncMoveOn sync2, task_list;
  MoveL p2_100 \ID:=10, v100, fine, tcp2;
  SyncMoveOff sync3;
  MoveL p2_100, v100, fine, tcp2;
  WaitSyncTask sync3, task_list;
  WaitSyncTask sync4, task_list;
  MoveL p2_110, v100, z10, tcp2;
  ...
ENDPROC
```

When switching between semicoordinated to syncronized movement, a `WaitSyncTask` is needed (when using identity `sync1`).

When switching between syncronized to semicoordinated movement, the task that move the work object (`rob2_obj`) needs to move to the desired position. After that a `WaitSyncTask` is needed (identity `sync3`) before the semicoordinated movement.

Continues on next page

Error handling

If time-out is reached because `SyncMoveOff` is not ready in time then the system variable `ERRNO` is set to `ERR_SYNCMOVEOFF`.

This error can be handled in the `ERROR` handler.

Limitations

The `SyncMoveOff` instruction can only be executed if all involved robots stand still in a stop point.

If this instruction is preceded by a move instruction then that move instruction must be programmed with a stop point (zonedata `fine`), not a fly-by point. Otherwise restart after power failure will not be possible.

`SyncMoveOff` cannot be executed in a RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart, Reset, or Step.

Syntax

```
SyncMoveOff
  [ SyncID ':=' ] < variable (VAR) of syncident>
  [ '\'TimeOut' :=' < expression (IN) of num> ] ';'
```

Related information

For information about	See
Specify cooperated program tasks	*tasks - RAPID program tasks on page 1204*
Identity for synchronization point	*syncident - Identity for synchronization point on page 1200*
Start coordinated synchronized movements	*SyncMoveOn - Start coordinated synchronized movements on page 534*
Set independent movements	*SyncMoveUndo - Set independent movements on page 545*
Test if in synchronized mode	*IsSyncMoveOn - Test if in synchronized movement mode on page 888*
MultiMove system with option Coordinated robots	*Application manual - MultiMove*

1.191. SyncMoveOn - Start coordinated synchronized movements

Usage

`SyncMoveOn` is used to start a sequence of synchronized movements and in most cases, coordinated movements. First, all involved program tasks will wait to synchronize in a stop point and then the motion planner for the involved program tasks is set to synchronized mode.

The instruction `SyncMoveOn` can only be used in a *MultiMove* system with option *Coordinated Robots* and only in program tasks defined as `Motion Task`.

WARNING!

To reach safe synchronization functionality every meeting point (parameter `SyncID`) must have a unique name. The name of the meeting point must also be the same for all the program tasks that should meet in the meeting point.

Basic examples

Basic examples of the instruction `SyncMoveOn` are illustrated below.

See also *More examples on page 536*.

Example 1

```
!Program example in task T_ROB1

PERS tasks task_list{2} := [ ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;
VAR syncident sync2;

...
SyncMoveOn sync1, task_list;
...
SyncMoveOff sync2;
...

!Program example in task T_ROB2

PERS tasks task_list{2} := [ ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;
VAR syncident sync2;

...
SyncMoveOn sync1, task_list;
...
SyncMoveOff sync2;
...
```

The program task that first reaches `SyncMoveOn` with identity `sync1` waits until the other task reaches its `SyncMoveOn` with the same identity `sync1`. At that synchronization point, `sync1`, the motion planner for the involved program tasks is set to synchronized mode. After that, both task `T_ROB1` and `T_ROB2` continue their execution, synchronized until they reach `SyncMoveOff` with the same identity `sync2`.

Continues on next page

Arguments

`SyncMoveOn SyncID TaskList [\TimeOut]`

`SyncID`

Synchronization Identity

Data type: `syncident`

Variable that specifies the name of the synchronization (meeting) point. Data type `syncident` is a non-value type that is only used as an identifier for naming the synchronization point.

The variable must be defined and have an equal name in all cooperated program tasks. It is recommended to always define the variable global in each task (`VAR syncident ...`).

`TaskList`

Data type: `tasks`

Persistent variable that in a task list (array) specifies the name (`string`) of the program tasks that should meet in the synchronization point with name according argument `SyncID`.

The persistent variable must be defined and have equal name and equal contents in all cooperated program tasks. It is recommended to always define the variable global in the system (`PERS tasks ...`).

`[\TimeOut]`

Data type: `num`

The max. time to wait for the other program tasks to reach the synchronization point. The time-out is defined in seconds (resolution 0.001s).

If this time runs out before all program tasks have reached the synchronization point then the error handler will be called, if there is one, with the error code `ERR_SYNCMOVEON`. If there is no error handler then the execution will be stopped.

If this argument is omitted then the program task will wait for ever.

Program execution

The program task that first reaches `SyncMoveOn` waits until all other specified tasks reach their `SyncMoveOn` with the same `SyncID` identity. At that `SyncID` synchronization point the motion planner for the involved program tasks is set to synchronized mode. After that, involved program tasks continue their execution.

The motion planner for the involved program tasks is set to synchronized mode. This means the following:

- Each movement instruction in any program task in the `TaskList` is working synchronous with movement instructions in other program tasks in the `TaskList`.
- All cooperated movement instructions are planned and interpolated in the same Motion Planner.
- All movements start and end at the same time. The movement that takes the longest time will be the speed master with reduced speed in relation to the work object for the other movements.
- All cooperated move instruction must be marked with the same ID number. See instruction `MoveL`.

Continues on next page

It is possible to exclude program tasks for testing purpose from FlexPendant - Task Selection Panel. The instruction `SyncMoveOn` will still work with the reduced number of program tasks even for only one program task.

More examples

More examples of how to use the instruction `SyncMoveOn` are illustrated below.

Example 1

```
!Program example in task T_ROB1
PERS tasks task_list{2} := [["T_ROB1"], ["T_ROB2"]];
VAR syncident sync1;
VAR syncident sync2;
VAR syncident sync3;

PROC main()
  ...
  MoveL p_zone, vmax, z50, tcp1;
  WaitSyncTask sync1, task_list;
  MoveL p_fine, v1000, fine, tcp1;
  syncmove;
  ...
ENDPROC

PROC syncmove()
  SyncMoveOn sync2, task_list;
  MoveL * \ID:=10, v100, z10, tcp1 \WOBJ:= rob2_obj;
  MoveL * \ID:=20, v100, fine, tcp1 \WOBJ:= rob2_obj;
  SyncMoveOff sync3;
  UNDO
    SyncMoveUndo;
ENDPROC

!Program example in task T_ROB2
PERS tasks task_list{2} := [["T_ROB1"], ["T_ROB2"]];
VAR syncident sync1;
VAR syncident sync2;
VAR syncident sync3;

PROC main()
  ...
  MoveL p_zone, vmax, z50, obj2;
  WaitSyncTask sync1, task_list;
  MoveL p_fine, v1000, fine, obj2;
  syncmove;
  ...
ENDPROC
```


Continues on next page

```
PROC syncmove()
  SyncMoveOn sync2, task_list;
  MoveL * \ID:=10, v100, z10, obj2;
  MoveL * \ID:=20, v100, fine, obj2;
  SyncMoveOff sync3;
  UNDO
     SyncMoveUndo;
ENDPROC
```

First, program tasks `T_ROB1` and `T_ROB2` are waiting at `WaitSyncTask` with identity `sync1` for each other. They are programmed with corner path for the preceding movements for saving cycle time.

Then the program tasks are waiting at `SyncMoveOn` with identity `sync2` for each other. They are programmed with a necessary stop point for the preceding movements. After that the motion planner for the involved program tasks is set to synchronized mode.

After that, `T_ROB2` is moving the `obj2` to `ID` point `10` and `20` in world coordinate system while `T_ROB1` is moving the `tcp1` to `ID` point `10` and `20` on the moving object `obj2`.

Example 2

```
!Program example with use of time-out function
VAR syncident sync3;

...
SyncMoveOn sync3, task_list \TimeOut :=60;
...
ERROR
  IF ERRNO = ERR_SYNCMOVEON THEN
     RETRY;
  ENDIF
```

The program task waits for instruction `SyncMoveOn` for the program task `T_ROB2` to reach the same synchronization point `sync3`. After waiting `60` seconds, the error handler is called with `ERRNO` equal to `ERR_SYNCMOVEON`. Then the instruction `SyncMoveOn` is called again for an additional wait of 60 seconds.

Continues on next page

Example 3- Program example with three tasks

```
!Program example in task T_ROB1
PERS tasks task_list1 {2} :=[["T_ROB1"], ["T_ROB2"]];
PERS tasks task_list2 {3} :=[["T_ROB1"], ["T_ROB2"], ["T_ROB3"]];
VAR syncident sync1;
...
VAR syncident sync5;

...
  SyncMoveOn sync1, task_list1;
  ...
  SyncMoveOff sync2;
  WaitSyncTask sync3, task_list2;
  SyncMoveOn sync4, task_list2;
  ...
  SyncMoveOff sync5;
...

!Program example in task T_ROB2

PERS tasks task_list1 {2} := [["T_ROB1"], ["T_ROB2"]];
PERS tasks task_list2 {3} := [["T_ROB1"], ["T_ROB2"], ["T_ROB3"]];
VAR syncident sync1;
...
VAR syncident sync5;

...
  SyncMoveOn sync1, task_list1;
  ...
  SyncMoveOff sync2;
  WaitSyncTask sync3, task_list2;
  SyncMoveOn sync4, task_list2;
  ...
  SyncMoveOff sync5;
...

!Program example in task T_ROB3

PERS tasks task_list2 {3} := [["T_ROB1"], ["T_ROB2"], ["T_ROB3"]];
VAR syncident sync3;
VAR syncident sync4;
VAR syncident sync5;
```


Continues on next page

```
...
  WaitSyncTask sync3, task_list2;
  SyncMoveOn sync4, task_list2;
  ...
  SyncMoveOff sync5;
...
```

In this example, at first, program task `T_ROB1` and `T_ROB2` are moving synchronized and `T_ROB3` is moving independent. Further on in the program all three tasks are moving synchronized. To prevent the instruction of `SyncMoveOn` to be executed in `T_ROB3` before the first synchronization of `T_ROB1` and `T_ROB2` have ended, the instruction `WaitSyncTask` is used.

Error handling

If time-out is reached because `SyncMoveOn` is not ready in time then the system variable `ERRNO` is set to `ERR_SYNCMOVEON`.

This error can be handled in the `ERROR` handler.

Limitations

The `SyncMoveOn` instruction can only be executed if all involved robots stand still in a stop point.

Only one coordinated synchronized movement group can be active at the same time.

If this instruction is preceded by a move instruction then that move instruction must be programmed with a stop point (zonedata `fine`), not a fly-by point. Otherwise restart after power failure will not be possible.

`SyncMoveOn` cannot be executed in a RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart, Reset, or Step.

Syntax

```
SyncMoveOn
  [ SyncID ´:=’ ] < variable (VAR) of syncident> ´,’
  [ TaskList ‘:=’ ] < persistent array {*} (PERS) of tasks> ´,’
  [ ´\’TimeOut ´:=’ < expression (IN) of num > ]’;’
```

Related information

For information about	See
Specify cooperated program tasks	*tasks - RAPID program tasks on page 1204*
Identity for synchronization point	*syncident - Identity for synchronization point on page 1200*
End coordinated synchronized movements	*SyncMoveOff - End coordinated synchronized movements on page 528*
Set independent movements	*SyncMoveUndo - Set independent movements on page 545*
Test if in synchronized mode	*IsSyncMoveOn - Test if in synchronized movement mode on page 888*
MultiMove system with option Coordinated Robots	*Application manual - MultiMove*

Continues on next page

For information about	See
Wait for synchronized tasks	*WaitSyncTask - Wait at synchronization point for other program tasks on page 688*

1.192. SyncMoveResume - Set synchronized coordinated movements

Usage

`SyncMoveResume` is used to go back to synchronized movements from independent movement mode. The instruction can only be used on `StorePath` level, e.g. after a `StorePath \KeepSync` has been executed and the system is in independent motion mode after `SyncMoveSuspend` has been executed. To be able to use the instruction the system must have been in synchronized motion mode before executing the `StorePath` and `SyncMoveSuspend` instruction.

The instruction `SyncMoveResume` can only be used in a *MultiMove* system with options *Coordinated Robots* and *Path Recovery* and only in program tasks defined as *Motion Task*.

Basic examples

Basic examples of the instruction `SyncMoveResume` are illustrated below.

Example 1

```
ERROR
  StorePath \KeepSync;
  ! Save position
  p11 := CRobT(\Tool:=tool2);
  ! Move in syncronized motion mode
  MoveL p12\ID:=111, v50, fine, tool2;
  SyncMoveSuspend;
  ! Move in independent mode somewhere, e.g. to a cleaning station
  p13 := CRobT();
  MoveL p14, v100, fine, tool2;
  ! Do something at cleaning station
  MoveL p13, v100, fine, tool2;
  SyncMoveResume;
  ! Move in syncronized motion mode back to start position p11
  MoveL p11\ID:=111, fine, z20, tool2;
  RestoPath;
  StartMove;
  RETRY;
```

Some kind of recoverable error occurs. The system is kept in synchronized mode, and a synchronized movement is done to a point, e.g. moving backwards on path. After that, an independent movement is done to a cleaning station. Then the robot is moved back to the point where the error occurred and the program continues where it was interrupted by the error.

Continues on next page

Program execution

`SyncMoveResume` forces resume of synchronized mode when system is in independent movement mode on `StorePath` level.

`SyncMoveResume` is required in all tasks that were executing in synchronized movement before entering independent movement mode. If one Motion task executes a `SyncMoveResume` then that task will wait until all tasks that earlier were in synchronized movement mode execute a `SyncMoveResume` instruction. After that, involved program tasks continue their execution.

Limitations

The `SyncMoveResume` can only be used to go back to synchronized movement mode and can only be used on `StorePath` level.

If this instruction is preceded by a move instruction then that move instruction must be programmed with a stop point (zonedata `fine`), not a fly-by point. Otherwise restart after power failure will not be possible.

`SyncMoveResume` cannot be executed in a RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart, Reset, or Step.

Syntax

```
SyncMoveResume ';'
```

Related information

For information about	See
Specify cooperated program tasks	*tasks - RAPID program tasks on page 1204*
Start coordinated synchronized movements	*SyncMoveOn - Start coordinated synchronized movements on page 534*
End coordinated synchronized movements	*SyncMoveOff - End coordinated synchronized movements on page 528*
Test if in synchronized mode	*SyncMoveOn - Start coordinated synchronized movements on page 534*
Stores the path	*StorePath - Stores the path when an interrupt occurs on page 521*
Restores the path	*RestoPath - Restores the path after an interrupt on page 362*
Suspends synchronized movements	*SyncMoveSuspend - Set independent-semicoordinated movements on page 543*

1.193. SyncMoveSuspend - Set independent-semicoordinated movements

Usage

`SyncMoveSuspend` is used to suspend synchronized movements mode and set the system to independent-semicoordinated movement mode. The instruction can only be used on `StorePath` level, e.g. after a `StorePath` or `StorePath \KeepSync` has been executed and the system is in synchronized movement mode.

The instruction `SyncMoveSuspend` can only be used in a *MultiMove System* with options *Coordinated Robots* and *Path Recovery* and only in program tasks defined as *Motion Task*.

Basic examples

Basic examples of the instruction `SyncMoveSuspend` are illustrated below.

Example 1

```
ERROR
  StorePath \KeepSync;
  ! Save position
  p11 := CRobT(\Tool:=tool2);
  ! Move in syncronized motion mode
  MoveL p12\ID:=111, v50, fine, tool2;
  SyncMoveSuspend;
  ! Move in independent mode somewhere, e.g. to a cleaning station
  p13 := CRobT();
  MoveL p14, v100, fine, tool2;
   ! Do something at cleaning station
  MoveL p13, v100, fine, tool2;
  SyncMoveResume;
  ! Move in syncronized motion mode back to start position p11
  MoveL p11\ID:=111, fine, z20, tool2;
  RestoPath;
  StartMove;
  RETRY;
```

Some kind of recoverable error occurs. The system is kept in synchronized mode, and a synchronized movement is done to a point, e.g. moving backwards on path. After that, an independent movement is done to a cleaning station. Then the robot is moved back to the point where the error occurred and the program continues where it was interrupted by the error.

Continues on next page

Program execution

`SyncMoveSuspend` forces reset of synchronized movements and sets the system to independent-semicoordinated movement mode.

`SyncMoveSuspend` is required in all synchronized Motion tasks to set the system in independent-semicoordinated movement mode. If one Motion tasks executes a `SyncMoveSuspend` then that task waits until the other tasks have executed a `SyncMoveSuspend` instruction.

After execution of `SyncMoveSuspend` in all involved tasks, the system is in semicoordinated mode if it further uses a coordinated work object. Otherwise, it is in independent mode. If in semicoordinated mode, it is recommended to always start with a movement in the mechanical unit that controls the user frame before `WaitSyncTask` in all involved tasks.

Limitations

The `SyncMoveSuspend` instruction suspends synchronized mode only on `StorePath` level. After returning from `StorePath` level, the system is set to the mode that it was in before the `StorePath`.

If this instruction is preceded by a move instruction then that move instruction must be programmed with a stop point (zonedata `fine`), not a fly-by point. Otherwise restart after power failure will not be possible.

`SyncMoveSuspend` cannot be executed in a RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart, Reset, or Step.

Syntax

```
SyncMoveSuspend' ;'
```

Related information

For information about	See
Specify cooperated program tasks	*tasks - RAPID program tasks on page 1204*
Start coordinated synchronized movements	*SyncMoveOn - Start coordinated synchronized movements on page 534*
End coordinated synchronized movements	*SyncMoveOff - End coordinated synchronized movements on page 528*
Test if in synchronized mode	*IsSyncMoveOn - Test if in synchronized movement mode on page 888*
Stores the path	*StorePath - Stores the path when an interrupt occurs on page 521*
Restores the path	*RestoPath - Restores the path after an interrupt on page 362*
Resume synchronized movements	*SyncMoveResume - Set synchronized coordinated movements on page 541*

1.194. SyncMoveUndo - Set independent movements

Usage

`SyncMoveUndo` is used to force a reset of synchronized coordinated movements and set the system to independent movement mode.

The instruction `SyncMoveUndo` can only be used in a *MultiMove* system with option *Coordinated Robots* and only in program tasks defined as `Motion Task`.

Basic examples

Basic examples of the instruction `SyncMoveUndo` are illustrated below.

Example 1

Program example in task `T_ROB1`

```
PERS tasks task_list{2} := [ ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;
VAR syncident sync2;
VAR syncident sync3;

PROC main()

...
  MoveL p_zone, vmax, z50, tcp1;
  WaitSyncTask sync1, task_list;
  MoveL p_fine, v1000, fine, tcp1;
  syncmove;
  ...
ENDPROC

PROC syncmove()
  SyncMoveOn sync2, task_list;
  MoveL * \ID:=10, v100, z10, tcp1 \WOBJ:= rob2_obj;
  MoveL * \ID:=20, v100, fine, tcp1 \WOBJ:= rob2_obj;
  SyncMoveOff sync3;
UNDO
  SyncMoveUndo;
ENDPROC
```

If the program is stopped while the execution is inside the procedure `syncmove` and the program pointer is moved out of the procedure `syncmove` then all instruction inside the `UNDO` handler is executed. In this example, the instruction `SyncMoveUndo` is executed and the system is set to independent movement mode.

Continues on next page

Program execution

Force reset of synchronized coordinated movements and set the system to independent movement mode.

It is enough to execute `SyncMoveUndo` in one program task to set the whole system to the independent movement mode. The instruction can be executed several times without any error if the system is already in independent movement mode.

The system is set to the default independent movement mode also

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.
- when moving program pointer to the beginning.

Syntax

```
SyncMoveUndo ';'
```

Related information

For information about	See
Specify cooperated program tasks	*tasks - RAPID program tasks on page 1204*
Identity for synchronization point	*syncident - Identity for synchronization point on page 1200*
Start coordinated synchronized movements	*SyncMoveOn - Start coordinated synchronized movements on page 534*
End coordinated synchronized movements	*SyncMoveOff - End coordinated synchronized movements on page 528*
Test if in synchronized mode	*IsSyncMoveOn - Test if in synchronized movement mode on page 888*

1.195. SystemStopAction - Stop the robot system

Usage

`SystemStopAction` can be used to stop the robot system in different ways depending how serious the error or problem is.

Basic examples

Basic examples of the instruction `SystemStopAction` are illustrated below.

Example 1

```
SystemStopAction \Stop;
```

This will stop program execution and robot movements in all motion tasks. No specific action is needed to be done before restarting the program execution.

Example 2

```
SystemStopAction \StopBlock;
```

This will stop program execution and robot movements in all motion tasks. All program pointers must be moved before the program execution can be restarted.

Example 3

```
SystemStopAction \Halt;
```

This will result in motors off, stop program execution, and robot movements in all motion tasks. Motors on must be done before the program execution can be restarted.

Arguments

```
SystemStopAction [\Stop] [\StopBlock] [\Halt]
```

`[\Stop]`

Data type: `switch`

`\Stop` is used to stop program execution and robot movements in all motion tasks. No specific action is needed to be done before restart of the program execution.

`[\StopBlock]`

Data type: `switch`

`\StopBlock` is used stop program execution and robot movements in all motion tasks. All program pointers must be moved before the program execution can be restarted.

`[\Halt]`

Data type: `switch`

`\Halt` will result in motors off state, stop of program execution and robot movements in all motion tasks. Motors on must be done before the program execution can be restarted.

Limitations

If the robot is performing a circular movement during a `SystemStopAction \StopBlock` then the program pointer and the robot have to be moved to the beginning of the circular movement before the program execution is restarted.

Continues on next page

Syntax

```
SystemStopAction
  [ '\'Stop ]
  | [ '\'StopBlock ]
  | [ '\'Halt ]';'
```

Related information

For information about	See
Stop program execution	*Stop - Stops program execution on page 510*
Terminate program execution	*EXIT - Terminates program execution on page 105*
Only stop robot movements	*StopMove - Stops robot movement on page 515*
Write some error message	*ErrLog - Write an error message on page 94*

1.196. TEST - Depending on the value of an expression ...

Usage

`TEST` is used when different instructions are to be executed depending on the value of an expression or data.

If there are not too many alternatives then the `IF..ELSE` instruction can also be used.

Basic examples

Basic examples of the instruction `TEST` are illustrated below.

Example 1

```
TEST reg1
CASE 1,2,3 :
  routine1;
CASE 4 :
  routine2;
DEFAULT :
  TPWrite "Illegal choice";
  Stop;
ENDTEST
```

Different instructions are executed depending on the value of `reg1`. If the value is 1-3 `routine1` is executed. If the value is 4, `routine2` is executed. Otherwise, an error message is printed and execution stops.

Arguments

```
TEST Test data {CASE Test value {, Test value} : ...}  [ DEFAULT:
     ...] ENDTEST
```

`Test data`

Data type: All

The data or expression with which the test value will be compared.

`Test value`

Data type: Same as `test data`

The value which the test data must have for the associated instructions to be executed.

Program execution

The test data is compared with the test values in the first `CASE` condition. If the comparison is true then the associated instructions are executed. After that, program execution continues with the instruction following `ENDTEST`.

If the first CASE condition is not satisfied then other `CASE` conditions are tested and so on. If none of the conditions are satisfied then the instructions associated with `DEFAULT` are executed (if this is present).

Continues on next page

Syntax

```
(EBNF)
TEST <expressio
{( CASE<test value> { ',' <test value> } ':'
  <instruction list> ) | <CSE> }
[ DEFAULT ':' <instruction list> ]
ENDTEST

<test value> ::= <expression>
```

Related information

For information about	See
Expressions	*Technical reference manual - RAPID Instructions, Functions and Data types*, section *Basic characteristics - Expressions*

1.197. TestSignDefine - Define test signal

Usage

`TestSignDefine` is used to define one test signal for the robot motion system.

A test signal continuously mirrors some specified motion data stream. For example, torque reference for some specified axis. The actual value at a certain time can be read in RAPID with the function `TestSignRead`.

Only test signals for external axes can be reached. Test signals are also available on request for the robot axes and for not predefined test signals for external axes.

Basic examples

Basic examples of the instruction `TestSignDefine` are illustrated below.

Example 1

```
TestSignDefine 1, resolver_angle, Orbit, 2, 0.1;
```

Test signal `resolver_angle` connected to channel `1` will give the value of the resolver angle for external axis `2` on the `orbit` manipulator, sampled at 100 ms rate.

Arguments

```
TestSignDefine Channel SignalId MechUnit Axis SampleTime
```

`Channel`

Data type: `num`

The channel numbers 1-12 to be used for the test signal. The same number must be used in the function `TestSignRead` for reading the actual value of the test signal.

`SignalId`

Data type: `testsignal`

The name or number of the test signal. Refer to predefined constants described in data type `testsignal`.

`MechUnit`

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit.

`Axis`

Data type: `num`

The axis number within the mechanical unit.

Continues on next page

`SampleTime`

Data type: `num`

Sample time in seconds.

For sample time < 0.004 s, the function `TestSignRead` returns the mean value of the latest available internal samples as shown in the table below.

Sample Time in seconds	Result from TestSignRead
0	Mean value of the latest 8 samples generated each 0.5 ms
0.001	Mean value of the latest 4 samples generated each 1 ms
0.002	Mean value of the latest 2 samples generated each 2 ms
Greater or equal to 0.004	Momentary value generated at specified sample time
0.1	Momentary value generated at specified sample time 100 ms

Program execution

The definition of test signal is activated and the robot system starts the sampling of the test signal.

The sampling of the test signal is active until:

- A new `TestSignDefine` instruction for the actual channel is executed.
- All test signals are deactivated with execution of instruction `TestSignReset`.
- All test signals are deactivated with a warm start of the system.

Error handling

If there is an error in the parameter `MechUnit` then the variable `ERRNO` is set to `ERR_UNIT_PAR`. If there is an error in the parameter `Axis` then `ERRNO` is set to `ERR_AXIS_PAR`.

Syntax

```
TestSignDefine
  [ Channel ':=' ] < expression (IN) of num>' ,'
  [ SignalId' :=' ] < expression (IN) of testsignal> ','
  [ MechUnit' :=' ] < variable (VAR) of mecunit> ','
  [ Axis ':=' ] < expression (IN) of num> ','
  [ SampleTime' :=' ] < expression (IN) of num > ';'
```

Related information

For information about	See
Test signal	*testsignal - Test signal on page 1206*
Read test signal	*TestSignRead - Read test signal value on page 1020*
Reset test signals	*TestSignReset - Reset all test signal definitions on page 553*

1.198. TestSignReset - Reset all test signal definitions

Usage

`TestSignReset` is used to deactivate all previously defined test signals.

Basic examples

Basic examples of the instruction `TestSignReset` are illustrated below.

Example 1

```
TestSignReset;
```

Deactivate all previously defined test signals.

Program execution

The definitions of all test signals are deactivated, and the robot system stops the sampling of any test signals.

The sampling of defined test signals is active until:

- A warm start of the system
- Execution of this instruction `TestSignReset`

Syntax

```
TestSignReset';'
```

Related information

For information about	See
Define test signal	*TestSignDefine - Define test signal on page 551*
Read test signal	*TestSignRead - Read test signal value on page 1020*

1.199. TextTabInstall - Installing a text table

Usage

`TextTabInstall` is used to install a text table in the system.

Basic examples

Basic examples of the instruction `TextTabInstall` are illustrated below.

Example 1

```
! System Module with Event Routine to be executed at event
! POWER ON, RESET or START

PROC install_text()
  IF TextTabFreeToUse("text_table_name") THEN
    TextTabInstall "HOME:/text_file.eng";
  ENDIF
ENDPROC
```

The first time the event routine `install_text` is executed the function `TextTabFreeToUse` returns TRUE, and the text file `text_file.eng` is installed in the system. After that, the installed text strings can be fetched from the system to RAPID by the functions `TextTabGet` and `TextGet`.

The next time the event routine `install_text` is executed, the function `TextTabFreeToUse` returns FALSE, and the installation is **not** repeated.

Arguments

```
TextTabInstall File
```

`File`

Data type: `string`

The file path and the file name to the file that contains text strings to be installed in the system.

Limitations

Limitations for installation of text tables (text resources) in the system:

- It is not possible to install the same text table more than once in the system.
- It is not possible to uninstall (free) a single text table from the system. The only way to uninstall text tables from the system is to cold start the system. All text tables (both system and user defined) will then be uninstalled.

Error handling

If the file in the `TextTabInstall` instruction cannot be opened then the system variable `ERRNO` is set to `ERR_FILEOPEN`. This error can then be handled in the error handler.

Syntax

```
TextTabInstall
  [ File ':=' ] < expression (IN) of string >';'
```


Continues on next page

Related information

For information about	See
Test whether text table is free	*TextTabFreeToUse - Test whether text table is free on page 1024*
Format of text files	*Technical reference manual - RAPID kernel*, section *Text files*
Get text table number	*TextTabGet - Get text table number on page 1026*
Get text from system text tables	*TextGet - Get text from system text tables on page 1022*
String functions	*Technical reference manual - RAPID overview*, section *Basic RAPID summary - String Functions*
Definition of string	*string - Strings on page 1195*

1.200. TPErase - Erases text printed on the FlexPendant

Usage

`TPErase` (*FlexPendant Erase*) is used to clear the display of the FlexPendant.

Basic examples

Basic examples of the instruction `TPErase` are illustrated below.

Example 1

```
TPErase;
TPWrite "Execution started";
```

The FlexPendant display is cleared before `Execution started` is written.

Program execution

The FlexPendant display is completely cleared of all text. The next time text is written it will be entered on the uppermost line of the display.

Syntax

```
TPErase;
```

Related information

For information about	See
Writing on the FlexPendant	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*

1.201. TPReadDnum - Reads a number from the FlexPendant

Usage

`TPReadDnum` (*FlexPendant Read Numerical*) is used to read a number from the FlexPendant

Basic examples

Basic examples of the instruction `TPReadDnum` are illustrated below.

Example 1

```
VAR dnum value;

TPReadDnum value, "How many units should be produced?";
```

The text `How many units should be produced?` is written on the FlexPendant display. Program execution waits until a number has been input from the numeric keyboard on the FlexPendant. That number is stored in `value`.

Arguments

```
TPReadDnum TPAnswer TPText [\MaxTime] [\DIBreak] [\DOBreak]
      [\BreakFlag]
```

`TPAnswer`

Data type: `dnum`

The variable for which the number input via the FlexPendant is returned.

`TPText`

Data type: `string`

The information text to be written on the FlexPendant (a maximum of 80 characters with 40 characters row).

`[\MaxTime]`

Data type: `num`

The maximum amount of time that program execution waits. If no number is input within this time, the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_MAXTIME` can be used to test whether or not the maximum time has elapsed.

`[\DIBreak]`

Digital Input Break

Data type: `signaldi`

The digital signal that may interrupt the operator dialog. If no number is input when the signal is set to 1 (or is already 1), the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_DIBREAK` can be used to test whether or not this has occurred.

Continues on next page

`[\DOBreak]`

Digital Output Break

Data type: `signaldo`

The digital signal that support termination request from other tasks. If no button is selected when the signal is set to 1 (or is already 1), the program continues to execute in the error handler, unless the `BreakFlag` is used (see below). The constant `ERR_TP_DOBREAK` can be used to test whether or not this has occurred.

`[\BreakFlag]`

Data type: `errnum`

A variable that will hold the error code if `MaxTime`, `DIBreak` or `DOBreak` is used. If this optional variable is omitted, the error handler will be executed. The constants `ERR_TP_MAXTIME`, `ERR_TP_DIBREAK` and `ERR_TP_DOBREAK` can be used to select the reason.

Program execution

The information text is always written on a new line. If the display is full of text, this body of text is moved up one line first. There can be up to 7 lines above the new text written.

Program execution waits until a number is typed on the numeric keyboard (followed by Enter or OK) or the instruction is interrupted by a time out or signal action..

Reference to `TPReadFK` about description of concurrent `TPReadFK` or `TPReadDnum` request on FlexPendant from same or other program tasks.

Error handling

If time out (parameter `\MaxTime`) before input from the operator, the system variable `ERRNO` is set to `ERR_TP_MAXTIME` and the execution continues in the error handler.

If digital input set (parameter `\DIBreak`) before input from the operator, the system variable `ERRNO` is set to `ERR_TP_DIBREAK` and the execution continues in the error handler.

If a digital output occurred (parameter `\DOBreak`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_DOBREAK` and the execution continues in the error handler.

If there is no client, e.g. a Flex Pendant, to take care of the instruction, the system variable `ERRNO` is set to `ERR_TP_NO_CLIENT` and the execution continues in the error handler.

These situations can then be dealt with by the error handler.

Syntax

```
TPReadDnum
  [TPAnswer':='] <var or pers (INOUT) of dnum>','
  [TPText':='] <expression (IN) of string>
  ['\'MaxTime':=' <expression (IN) of num>]
  ['\'DIBreak':=' <variable (VAR) of signaldi>]
  ['\'DOBreak':=' <variable (VAR) of signaldo>]
  ['\'BreakFlag':=' <var or pers (INOUT) of errnum>] ';'
```

Continues on next page

Related information

For information about	See
Writing to and reading from the FlexPendant	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*
Entering a number on the FlexPendant	*Operating manual - IRC5 with FlexPendant*, section *Running in production*
Examples of how to use the arguments MaxTime, DIBreak and BreakFlag	*TPReadFK - Reads function keys on page 560*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

1.202. TPReadFK - Reads function keys

Usage

`TPReadFK` (*FlexPendant Read Function Key*) is used to write text on the functions keys and to find out which key is depressed.

Basic examples

Basic examples of the instruction `TPReadFK` are illustrated below.

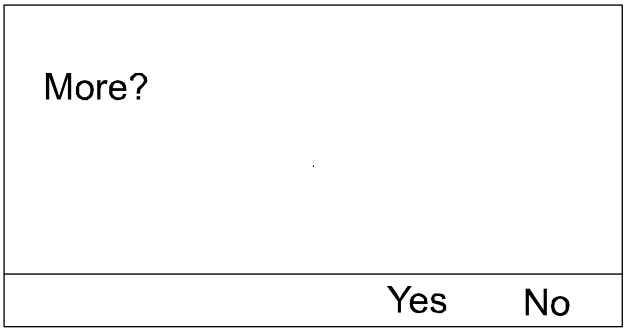
See also *More examples on page 562*.

Example 1

```
TPReadFK reg1, "More?", stEmpty, stEmpty, stEmpty, "Yes", "No";
```

The text `More?` is written on the FlexPendant display and the function keys 4 and 5 are activated by means of the text strings `Yes` and `No` respectively (see figure below). Program execution waits until one of the function keys 4 or 5 is pressed. In other words, `reg1` will be assigned 4 or 5 depending on which of the keys are pressed.

The figure shows that the operator can put in information via the function keys.



xx0500002345

Arguments

```
TPReadFK TPAnswer TPText TPFK1 TPFK2 TPFK3 TPFK4 TPFK5 [\MaxTime]
      [\DIBreak] [\DOBreak] [\BreakFlag]
```

`TPAnswer`

Data type: `num`

The variable for which, depending on which key is pressed, the numeric value 1..5 is returned. If the function key 1 is pressed then 1 is returned, and so on.

`TPText`

Data type: `string`

The information text to be written on the display (a maximum of 80 characters, with 40 characters/row).

Continues on next page

`TPFKx`

Function key text

Data type: `string`

The text to be written on the appropriate function key (a maximum of 45 characters). `TPFK1` is the left-most key.

Function keys without text are specified by the predefined string constant `stEmpty` with value empty string (“”).

`[\MaxTime]`

Data type: `num`

The maximum amount of time in seconds that program execution waits. If no function key is pressed within this time then the program continues to execute in the error handler unless the BreakFlag is used (see below). The constant `ERR_TP_MAXTIME` can be used to test whether or not the maximum time has elapsed.

`[\DIBreak]`

Digital Input Break

Data type: `signaldi`

The digital signal that may interrupt the operator dialog. If no function key is pressed when the signal is set to 1 (or is already 1) then the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_DIBREAK` can be used to test whether or not this has occurred.

`[\DOBreak]`

Digital Output Break

Data type: `signaldo`

The digital signal that supports termination request from other tasks. If no button is selected when the signal is set to 1 (or is already 1) then the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_DOBREAK` can be used to test whether or not this has occurred.

`[\BreakFlag]`

Data type: `errnum`

A variable that will hold the error code if `MaxTime`, `DIBreak`, or `DOBreak` is used. If this optional variable is omitted then the error handler will be executed. The constants `ERR_TP_MAXTIME, ERR_TP_DIBREAK`, and `ERR_TP_DOBREAK` can be used to select the reason.

Continues on next page

Program execution

The information text is always written on a new line. If the display is full of text then this body of text is moved up one line first. There can be up to 7 lines above the new written text.

Text is written on the appropriate function keys.

Program execution waits until one of the activated function keys are pressed.

Description of concurrent `TPReadFK` or `TPReadNum` request on FlexPendant (TP request) from the same or other program tasks:

- New TP request from other program tasks will not take focus (new put in queue)
- New TP request from TRAP in the same program task will take focus (old put in queue)
- Program stop take focus (old put in queue)
- New TP request in program stop state takes focus (old put in queue)

More examples

More examples of how to use the instruction `TPReadFK` are illustrated below.

Example 1

```
VAR errnum errvar;
...
TPReadFK reg1, "Go to service position?", stEmpty, stEmpty,
     stEmpty, "Yes","No"
\MaxTime:= 600
  \DIBreak:= di5\BreakFlag:= errvar;
IF reg1 = 4 OR errvar = ERR_TP_DIBREAK THEN
  MoveL service, v500, fine, tool1;
  Stop;
ENDIF
IF errvar = ERR_TP_MAXTIME EXIT;
```

The robot is moved to the service position if the forth function key (`"Yes"`) is pressed or if the input 5 is activated. If no answer is given within 10 minutes then the execution is terminated.

Error handling

If there is a timeout (parameter `\MaxTime`) before an input from the operator then the system variable `ERRNO` is set to `ERR_TP_MAXTIME`, and the execution continues in the error handler.

If digital input is set (parameter `\DIBreak`) before an input from the operator then the system variable `ERRNO` is set to `ERR_TP_DIBREAK`, and the execution continues in the error handler.

If a digital output occurred (parameter `\DOBreak`) before an input from the operator then the system variable `ERRNO` is set to `ERR_TP_DOBREAK` and the execution continues in the error handler.

If there is no client, e.g. a FlexPendant, to take care of the instruction then the system variable `ERRNO` is set to `ERR_TP_NO_CLIENT`, and the execution continues in the error handler.

These situations can then be dealt with by the error handler.

Continues on next page

Limitations

Avoid using too small of a value for the timeout parameter `\MaxTime` when `TPReadFK` is frequently executed, for example in a loop. It can result in an unpredictable behavior of the system performance, like slowing the FlexPendant response.

Predefined data

```
CONST string stEmpty := "";
```

The predefined constant `stEmpty` should be used for Function Keys without text. Using `stEmpty` instead of `""` saves about 80 bytes for every Function Key without text.

Syntax

```
TPReadFK
  [TPAnswer ':='] <var or pers (INOUT) of num>','
  [TPText ':='] <expression (IN) of string>','
  [TPFK1 ':='] <expression (IN) of string>','
  [TPFK2 ':='] <expression (IN) of string>','
  [TPFK3 ':='] <expression (IN) of string>','
  [TPFK4 ':='] <expression (IN) of string>','
  [TPFK5 ':='] <expression (IN) of string>
  ['\'MaxTime':=' <expression (IN) of num>]
  ['\'DIBreak':=' <variable (VAR) of signaldi>]
  ['\'DOBreak':=' <variable (VAR) of signaldo>]
  ['\'BreakFlag':=' <var or pers (INOUT) of errnum>]';'
```

Related information

For information about	See
Writing to and reading from the FlexPendant	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*
Replying via the FlexPendant	*Operating manual - IRC5 with FlexPendant*, section *Running in production*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

1.203. TPReadNum - Reads a number from the FlexPendant

Usage

`TPReadNum` (*FlexPendant Read Numerical*) is used to read a number from the FlexPendant.

Basic examples

Basic examples of the instruction `TPReadNum` are illustrated below.

See also *More examples on page 565*.

Example 1

```
TPReadNum reg1, "How many units should be produced?";
```

The text `How many units should be produced?` is written on the FlexPendant display. Program execution waits until a number has been input from the numeric keyboard on the FlexPendant. That number is stored in `reg1`.

Arguments

```
TPReadNum TPAnswer TPText [\MaxTime] [\DIBreak] [\DOBreak]
      [\BreakFlag]
```

`TPAnswer`

Data type: `num`

The variable for which the number input via the FlexPendant is returned.

`TPText`

Data type: `string`

The information text to be written on the FlexPendant (a maximum of 80 characters with 40 characters per row).

`[\MaxTime]`

Data type: `num`

The maximum amount of time that program execution waits. If no number is input within this time, the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_MAXTIME` can be used to test whether or not the maximum time has elapsed.

`[\DIBreak]`

Digital Input Break

Data type: `signaldi`

The digital signal that may interrupt the operator dialog. If no number is input when the signal is set to 1 (or is already 1), the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_DIBREAK` can be used to test whether or not this has occurred.

Continues on next page

`[\DOBreak]`

Digital Output Break

Data type: `signaldo`

The digital signal that supports termination request from other tasks. If no button is selected when the signal is set to 1 (or is already 1), the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_DOBREAK` can be used to test whether or not this has occurred.

`[\BreakFlag]`

Data type: `errnum`

A variable that will hold the error code if `MaxTime`, `DIBreak` or `DOBreak` is used. If this optional variable is omitted, the error handler will be executed. The constants `ERR_TP_MAXTIME`, `ERR_TP_DIBREAK` and `ERR_TP_DOBREAK` can be used to select the reason.

Program execution

The information text is always written on a new line. If the display is full of text, this body of text is moved up one line first. There can be up to 7 lines above the new text written.

Program execution waits until a number is typed on the numeric keyboard (followed by Enter or OK) or the instruction is interrupted by a time out or signal action.

Reference to `TPReadFK` about description of concurrent `TPReadFK` or `TPReadNum` request on FlexPendant from same or other program tasks.

More examples

More examples of how to use the instruction `TPReadNum` are illustrated below.

Example 1

```
TPReadNum reg1, "How many units should be produced?";
FOR i FROM 1 TO reg1 DO
  produce_part;
ENDFOR
```

The text `How many units should be produced?` is written on the FlexPendant display. The routine `produce_part` is then repeated the number of times that is input via the FlexPendant.

Error handling

If timeout occurs (parameter `\MaxTime`) before input from the operator, the system variable `ERRNO` is set to `ERR_TP_MAXTIME` and the execution continues in the error handler.

If the digital input (parameter `\DIBreak`) is set before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_DIBREAK` and the execution continues in the error handler.

If the digital output (parameter `\DOBreak`) is set before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_DOBREAK` and the execution continues in the error handler.

If there is no client, e.g. a FlexPendant, to take care of the instruction, the system variable `ERRNO` is set to `ERR_TP_NO_CLIENT` and the execution continues in the error handler.

These situations can then be dealt with by the error handler.

Continues on next page

Syntax

```
TPReadNum
  [TPAnswer':='] <var or pers (INOUT) of num>','
  [TPText':='] <expression (IN) of string>
  ['\'MaxTime':=' <expression (IN) of num>]
  ['\'DIBreak':=' <variable (VAR) of signaldi>]
  ['\'DOBreak':=' <variable (VAR) of signaldo>]
  ['\'BreakFlag':=' <var or pers (INOUT) of errnum>] ';'
```

Related information

For information about	See
Writing to and reading from the FlexPendant	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*
Entering a number on the FlexPendant	*Operating manual - IRC5 with FlexPendant*, section *Running in production*
Examples of how to use the arguments MaxTime, DIBreak and BreakFlag	*TPReadFK - Reads function keys on page 560*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

1.204. TPShow - Switch window on the FlexPendant

Usage

`TPShow` (*FlexPendant Show*) is used to select FlexPendant window from RAPID.

Basic examples

Basic examples of the instruction `TPShow` are illustrated below.

Example 1

```
TPShow TP_LATEST;
```

The latest used FlexPendant Window before the current FlexPendant window will be active after execution of this instruction.

Arguments

```
TPShow Window
```

`Window`

Data type: `tpnum`

The window TP_LATEST will show the latest used FlexPendant window before current FlexPendant window.

Predefined data

```
CONST tpnum TP_LATEST := 2;
```

Program execution

The selected FlexPendant window will be activated.

Syntax

```
TPShow
  [Window':='] <expression (IN) of tpnum> ´;'
```

Related information

For information about	See
Communicating using the FlexPendant	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*
FlexPendant Window number	*tpnum - FlexPendant window number on page 1211*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

1.205. TPWrite - Writes on the FlexPendant

Usage

`TPWrite` (*FlexPendant Write*) is used to write text on the FlexPendant. The value of certain data can be written as well as text.

Basic examples

Basic examples of the instruction `TPWrite` are illustrated below.

Example 1

```
TPWrite "Execution started";
```

The text `Execution started` is written on the FlexPendant.

Example 2

```
TPWrite "No of produced parts="\Num:=reg1;
```

If, for example, `reg1` holds the value 5 then the text `No of produced parts=5` is written on the FlexPendant.

Arguments

```
TPWrite String [\Num] | [\Bool] | [\Pos] | [\Orient] | [\Dnum]
```

`String`

Data type: `string`

The text string to be written (a maximum of 80 characters, with 40 characters/row).

`[\Num]`

Numeric

Data type: `num`

The data whose numeric value is to be written after the text string.

`[\Bool]`

Boolean

Data type: `bool`

The data whose logical value is to be written after the text string.

`[\Pos]`

Position

Data type: `pos`

The data whose position is to be written after the text string.

`[\Orient]`

Orientation

Data type: `orient`

The data whose orientation is to be written after the text string.

`[\Dnum]`

Numeric

Data type: `dnum`

The data whose numeric value is to be written after the text string.

Continues on next page

Program execution

Text written on the FlexPendant always begins on a new line. When the display is full of text (11 lines) then this text is moved up one line first.

If one of the arguments `\Num`, `\Dnum`, `\Bool`, `\Pos`, or `\Orient` is used then its value is first converted to a text string before it is added to the first string. The conversion from value to text string takes place as follows:

Argument	Value	Text string
`\Num`	23	"23"
`\Num`	1.141367	"1.14137"
`\Bool`	TRUE	"TRUE"
`\Pos`	[1817.3,905.17,879.11]	"[1817.3,905.17,879.11]"
`\Orient`	[0.96593,0,0.25882,0]	"[0.96593,0,0.25882,0]"
`\Dnum`	4294967295	"4294967295"

The value is converted to a string with standard RAPID format. This means, in principle, 6 significant digits. If the decimal part is less than 0.000005 or greater than 0.999995 then the number is rounded to an integer.

Limitations

The arguments `\Num`, `\Dnum`, `\Bool`, `\Pos`, and `\Orient` are mutually exclusive and thus cannot be used simultaneously in the same instruction.

Syntax

```
TPWrite
  [TPText':='] <expression (IN) of string>
  ['\'Num':=' <expression (IN) of num> ]
  | ['\'Bool':=' <expression (IN) of bool> ]
  | ['\'Pos':=' <expression (IN) of pos> ]
  | ['\'Orient':=' <expression (IN) of orient> ]
  | ['\'Dnum':=' <expression (IN) of dnum> ]';'
```

Related information

For information about	See
Clearing and reading the FlexPendant	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

1.206. TriggC - Circular robot movement with events

Usage

`TriggC` (*Trigg Circular*) is used to set output signals and/or run interrupt routines at fixed positions at the same time that the robot is moving on a circular path.

One or more (max. 8) events can be defined using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO` and afterwards these definitions are referred to in the instruction `TriggC`.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `TriggC` are illustrated below.

See also *More examples on page 574*.

Example 1

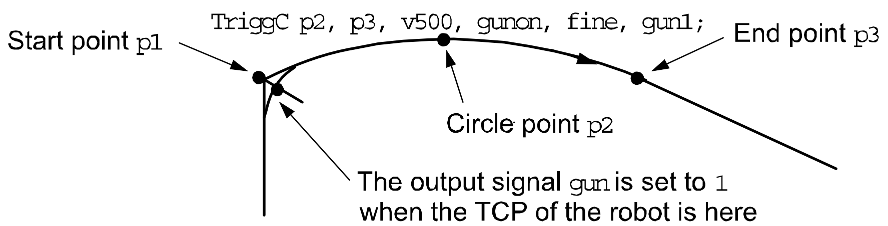
```
VAR triggdata gunon;

TriggIO gunon, 0 \Start \DOp:=gun, 1;

MoveL p1, v500, z50, gun1;
TriggC p2, p3, v500, gunon, fine, gun1;
```

The digital output signal `gun` is set when the robot's TCP passes the midpoint of the corner path of the point `p1`.

The figure shows an example of fixed position I/O event.



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Arguments

```
TriggC [\Conc] CirPoint ToPoint [\ID] Speed [\T] Trigg_1 [\T2]
      [\T3] [\T4] [\T5] [\T6] [\T7] [\T8] Zone [\Inpos] Tool
      [\WObj] [ \Corr ]
```

`[ \Conc ]`

Concurrent

Data type: `switch`

Subsequent instructions are executed while the robot is moving. The argument is usually not used but can be used to avoid unwanted stops caused by overloaded CPU when using fly-by points. This is useful when the programmed points are very close together at high speeds. The argument is also useful when, for example, communicating with external equipment and

Continues on next page

synchronization between the external equipment and robot movement is not required. It can also be used to tune the execution of the robot path, to avoid warning 50024 Corner path failure, or error 40082 Deceleration limit.

When using the argument `\Conc`, the number of movement instructions in succession is limited to 5. In a program section that includes `StorePath-RestoPath`, movement instructions with the argument `\Conc` are not permitted.

If this argument is omitted and the `ToPoint` is not a stop point then the subsequent instruction is executed some time before the robot has reached the programmed zone.

This argument can not be used in coordinated synchronized movement in a MultiMove system.

`CirPoint`

Data type: `robtarget`

The circle point of the robot. See the instruction `MoveC` for a more detailed description of circular movement. The circle point is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove System, if coordinated synchronized movement, and is not allowed in any other cases.

The specified ID number must be the same in all cooperating program tasks. The ID number gives a guarantee that the movements are not mixed up at runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the tool center point, the tool reorientation, and the external axes.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

`Trigg_1`

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

Continues on next page

`[ \T2 ]`

Trigg 2

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \T3 ]`

Trigg 3

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \T4 ]`

Trigg 4

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \T5 ]`

Trigg 5

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheck`, `TriggSpeed`, or `TriggRampAO`.

`[ \T6 ]`

Trigg 6

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO` ,`TriggSpeed`, or `TriggRampAO`.

`[ \T7 ]`

Trigg 7

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

Continues on next page

`[ \T8 ]`

Trigg 8

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`[ \Inpos ]`

In position

Data type: `stoppointdata`

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the `Zone` parameter.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point that is moved to the specified destination position.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used then this argument must be specified for a linear movement relative to the work object to be performed.

`[ \Corr ]`

Correction

Data type: `switch`

Correction data written to a corrections entry by the instruction `CorrWrite` will be added to the path and destination position if this argument is present.

Program execution

See the instruction `MoveC` for information about circular movement.

As the trigger conditions are fulfilled when the robot is positioned closer and closer to the end point, the defined trigger activities are carried out. The trigger conditions are fulfilled either at a certain distance before the end point of the instruction, or at a certain distance after the start point of the instruction, or at a certain point in time (limited to a short time) before the end point of the instruction.

During stepping the execution forward, the I/O activities are carried out but the interrupt routines are not run. During stepping the execution backward, no trigger activities at all are carried out.

Continues on next page

More examples

More examples of how to use the instruction `TriggC` are illustrated below.

Example 1

```
VAR intnum intno1;
VAR triggdata trigg1;
...
CONNECT intno1 WITH trap1;
TriggInt trigg1, 0.1 \Time, intno1;
...
TriggC p1, p2, v500, trigg1, fine, gun1;
TriggC p3, p4, v500, trigg1, fine, gun1;
...
IDelete intno1;
```

The interrupt routine `trap1` is run when the work point is at a position `0.1` s before the point `p2` or `p4` respectively.

Error handling

If the programmed `ScaleValue` argument for the specified analog output signal `AOp` in some of the connected `TriggSpeed` instructions result in out of limit for the analog signal together with the programmed `Speed` in this instruction, then the system variable ERRNO is set to ERR_AO_LIM.

If the programmed `DipLag` argument in some of the connected `TriggSpeed` instructions is too big in relation to the used Event Preset Time in System Parameters then the system variable ERRNO is set to ERR_DIPLAG_LIM.

The system variable ERRNO can be set to ERR_NORUNUNIT if there is no contact with the I/O unit when entering instruction and the used triggdata depends on a running I/O unit, i.e. a signal is used in the triggdata.

These errors can be handled in the error handler.

Limitations

General limitations according to instruction `MoveC`.

If the current start point deviates from the usual point so that the total positioning length of the instruction `TriggC` is shorter than usual then it may happen that several or all of the trigger conditions are fulfilled immediately and at the same position. In such cases, the sequence in which the trigger activities are carried out will be undefined. The program logic in the user program may not be based on a normal sequence of trigger activities for an "incomplete movement".

WARNING!

The instruction `TriggC` should never be started from the beginning with the robot in position after the circle point. Otherwise, the robot will not take the programmed path (positioning around the circular path in another direction compared to that which is programmed).

Continues on next page

Syntax

```
TriggC
  [ '\' Conc ',']
  [ CirPoint' :=' ] < expression (IN) of robtarget > ','
  [ ToPoint' :=' ] < expression (IN) of robtarget > ','
  [ '\' ID ':=' < expression (IN) of identno >] ','
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' T ':=' < expression (IN) of num > ] ','
  [Trigg_1 ':=' ] < variable (VAR) of triggdata >
  [ '\' T2 ':=' < variable (VAR) of triggdata > ]
  [ '\' T3 ':=' < variable (VAR) of triggdata > ]
  [ '\' T4 ':=' < variable (VAR) of triggdata > ]
  [ '\' T5 ':=' < variable (VAR) of triggdata > ]
  [ '\' T6 ':=' < variable (VAR) of triggdata > ]
  [ '\' T7 ':=' < variable (VAR) of triggdata > ]
  [ '\' T8 ':=' < variable (VAR) of triggdata > ] ´,'
  [Zone ':=' ] < expression (IN) of zonedata >
  [ '\' Inpos' :=' < expression (IN) of stoppointdata > ]´,'
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\' WObj' :=' < persistent (PERS) of wobjdata > ]
  [ '\' Corr ]';'
```

Related information

For information about	See
Linear movement with triggers	*TriggL - Linear robot movements with events on page 603*
Joint movement with triggers	*TriggJ - Axis-wise robot movements with events on page 597*
Move the robot circularly	*MoveC - Moves the robot circularly on page 236*
Definition of triggers	*TriggIO - Define a fixed position or time I/O event near a stop point on page 592* *TriggEquip - Define a fixed position and time I/O event on the path on page 582* *TriggInt - Defines a position related interrupt on page 588* *TriggCheckIO - Defines IO check at a fixed position on page 577* *TriggRampAO - Define a fixed position ramp AO event on the path on page 616* *TriggSpeed - Defines TCP speed proportional analog output with fixed position-time scale event on page 622*
Writes to a corrections entry	*CorrWrite - Writes to a correction generator on page 77*
Circular movement	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*

Continues on next page

For information about	See
Definition of stop point data	*stoppointdata - Stop point data on page 1189*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*

1.207. TriggCheckIO - Defines IO check at a fixed position

Usage

`TriggCheckIO` is used to define conditions for testing the value of a digital, a group of digital, or an analog input or output signal at a fixed position along the robot's movement path. If the condition is fulfilled then there will be no specific action. But if it is not then an interrupt routine will be run after the robot has optionally stopped on path as fast as possible.

To obtain a fixed position I/O check, `TriggCheckIO` compensates for the lag in the control system (lag between servo and robot).

The data defined is used for implementation in one or more subsequent `TriggL`, `TriggC`, or `TriggJ` instructions.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `TriggCheckIO` are illustrated below.

See also *More examples on page 580*.

Example 1

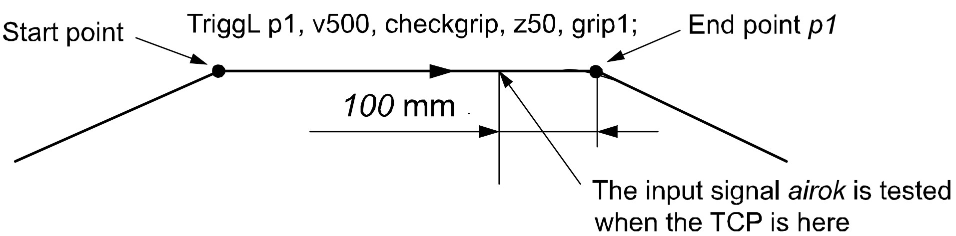
```
VAR triggdata checkgrip;
VAR intnum intno1;

CONNECT intno1 WITH trap1;
TriggCheckIO checkgrip, 100, airok, EQ, 1, intno1;

TriggL p1, v500, checkgrip, z50, grip1;
```

The digital input signal `airok` is checked to have the value `1` when the TCP is `100` mm before the point `p1`. If it is set then normal execution of the program continues. If it is not set then the interrupt routine `trap1` is run.

The figure shows an example of fixed position I/O check.



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Arguments

```
TriggCheckIO TriggData Distance [\Start] | [\Time] Signal Relation
     CheckValue |CheckDvalue [\StopMove] Interrupt
```

`TriggData`

Data type: `triggdata`

Variable for storing the `triggdata` returned from this instruction. These `triggdata` are then used in the subsequent `TriggL`, `TriggC`, or `TriggJ` instructions.

Continues on next page

`Distance`

Data type: `num`

Defines the position on the path where the I/O check shall occur.

Specified as the distance in mm (positive value) from the end point of the movement path (applicable if the argument `\Start` or `\Time` is not set).

See the section *Program execution* for further details.

`[ \Start ]`

Data type: `switch`

Used when the distance for the argument `Distance` starts at the movement start point instead of the end point.

`[ \Time ]`

Data type: `switch`

Used when the value specified for the argument `Distance` is in fact a time in seconds (positive value) instead of a distance.

Fixed position I/O in time can only be used for short times (< 0.5 s) before the robot reaches the end point of the instruction. See the section *Limitations* for more details.

`Signal`

Data type: `signalxx`

The name of the signal that will be tested. May be any type of IO signal.

`Relation`

Data type: `opnum`

Defines how to compare the actual value of the signal with the one defined by the argument `CheckValue`. Refer to the `opnum` data type for the list of the predefined constants to be used.

`CheckValue`

Data type: `num`

Value to which the actual value of the input or output signal is to be compared (within the allowed range for the current signal). If the signal is a digital signal, it must be an integer value.

If the signal is a digital group signal, the permitted value is dependent on the number of signals in the group. Max value that can be used in the `CheckValue` argument is 8388608, and that is the value a 23 bit digital group signal can have as maximum value (see ranges for `num`).

`CheckDvalue`

Data type: `dnum`

Value to which the actual value of the input or output signal is to be compared (within the allowed range for the current signal). If the signal is a digital signal, it must be an integer value.

If the signal is a digital group signal, the permitted value is dependent on the number of signals in the group. The maximal amout of signal bits a digital group signal can have is 32. With a `dnum` variable it is possible to cover the value range 0-4294967295, which is the value range a 32 bits digital signal can have.

Continues on next page

`[ \StopMove ]`

Data type: `switch`

Specifies that if the condition is not fulfilled then the robot will stop on path as quickly as possible before the interrupt routine is run.

`Interrupt`

Data type: `intnum`

Variable used to identify the interrupt routine to run.

Program execution

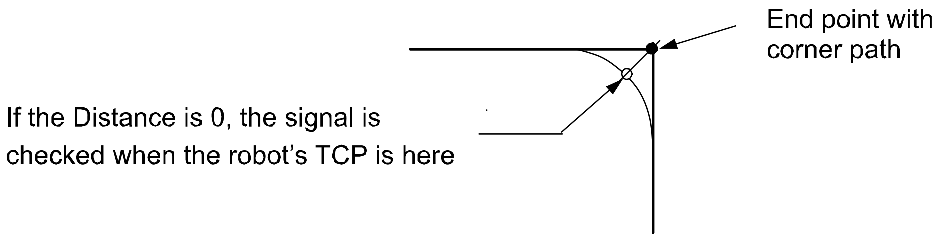
When running the instruction `TriggCheckIO`, the trigger condition is stored in a specified variable for the argument `TriggData`.

Afterwards, when one of the instructions `TriggL`, `TriggC`, or `TriggJ` is executed, the following are applicable with regard to the definitions in `TriggCheckIO`:

The table describes distance specified in the argument `Distance`:

Linear movement	The straight line distance
Circular movement	The circle arc length
Non-linear movement	The approximate arc length along the path (to obtain adequate accuracy, the distance should not exceed one half of the arc length).

The figure shows fixed position I/O check on a corner path.



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The fixed position I/O check will be done when the start point (end point) is passed if the specified distance from the end point (start point) is not within the length of movement of the current instruction (`TriggL...`).

When the TCP of the robot is at specified place on the path, the following I/O check will be done by the system:

- Read the value of the I/O signal.
- Compare the read value with `CheckValue` according specified `Relation`.
- If the comparison is TRUE then nothing more is done.
- If the comparison is FALSE then following is done:
- If optional parameter `\StopMove` is present then the robot is stopped on the path as quickly as possible.
- Generate and execute the specified TRAP routine.

Continues on next page

More examples

More examples of how to use the instruction `TriggCheckIO` are illustrated below.

Example 1

```
VAR triggdata checkgate;
VAR intnum gateclosed;

CONNECT gateclosed WITH waitgate;
TriggCheckIO checkgate, 150, gatedi, EQ, 1 \StopMove, gateclosed;
TriggL p1, v600, checkgate, z50, grip1;
  ...
TRAP waitgate
  ! log some information
  ...
  WaitDI gatedi,1;
  StartMove;
ENDTRAP
```

The gate for the next workpiece operation is checked to be open (digital input signal `gatedi` is checked to have the value `1`) when the TCP is `150` mm before the point `p1`. If it is open then the robot will move on to `p1` and continue. If it is not open then the robot is stopped on path and the interrupt routine `waitgate` is run. This interrupt routine logs some information and typically waits for the conditions to be OK to execute a `StartMove` instruction in order to restart the interrupted path.

Error handling

The following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_GO_LIM`

if the programmed `CheckValue` or `CheckDvalue` argument for the specified digital group output signal `Signal` is outside limits.

`ERR_AO_LIM`

if the programmed `CheckValue` or `CheckDvalue` argument for the specified analog output signal `Signal` is outside limits.

Limitations

I/O checks with distance (without the argument `\Time`) is intended for flying points (corner path). I/O checks with distance, using stop points, results in worse accuracy than specified below.

I/O checks with time (with the argument `\Time`) is intended for stop points. I/O checks with time, using flying points, results in worse accuracy than specified below.

I/O checks with time can only be specified from the end point of the movement. This time cannot exceed the current braking time of the robot, which is max. approx. 0.5 s (typical values at speed 500 mm/s for IRB2400 150 ms and for IRB6400 250 ms). If the specified time is greater that the current braking time then the I/O check will be generated anyway but not until braking is started (later than specified). However, the whole of the movement time for the current movement can be utilized during small and fast movements.

Continues on next page

Typical absolute accuracy values for testing of digital inputs +/- 5 ms. Typical repeat accuracy values for testing of digital inputs +/- 2 ms.

Syntax

```
TriggCheckIO
  [ TriggData ':=' ] < variable (VAR) of triggdata> ´,'
  [ Distance' :=' ] < expression (IN) of num>
  [ '\' Start ] | [ '\' Time ] ´,'
  [ Signal ':=' ] < variable (VAR) of anytype> ´,'
  [ Relation' :=' ] < expression (IN) of opnum> ´,'
  [ CheckValue' :=' ] < expression (IN) of num>
  | [ CheckDvalue' :=' ] < expression (IN) of dnum>
  [ '\' StopMove] ´,'
  [ Interrupt' :=' ] < variable(VAR) of intnum> ´;'
```

Related information

For information about	See
Use of triggers	*TriggL - Linear robot movements with events on page 603* *TriggC - Circular robot movement with events on page 570* *TriggJ - Axis-wise robot movements with events on page 597*
Definition of position-time I/O event	*TriggIO - Define a fixed position or time I/O event near a stop point on page 592* *TriggEquip - Define a fixed position and time I/O event on the path on page 582*
Definition of position related interrupts	*TriggInt - Defines a position related interrupt on page 588*
Storage of trigg data	*triggdata - Positioning events, trigg on page 1213*
Definition of comparison operators	*opnum - Comparison operator on page 1149*

1.208. TriggEquip - Define a fixed position and time I/O event on the path

Usage

`TriggEquip` (*Trigg Equipment*) is used to define conditions and actions for setting a digital, a group of digital, or an analog output signal at a fixed position along the robot's movement path with possibility to do time compensation for the lag in the external equipment.

`TriggIO` (not `TriggEquip`) should always be used if there is need for good accuracy of the I/O settings near a stop point.

The data defined is used for implementation in one or more subsequent `TriggL`, `TriggC`, or `TriggJ` instructions.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `TriggEquip` are illustrated below.

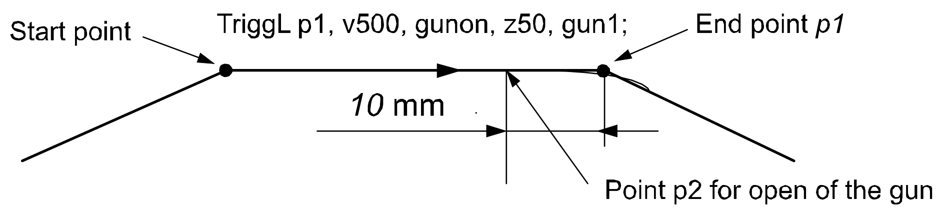
See also *More examples on page 585*.

Example 1

```
VAR triggdata gunon;
...
TriggEquip gunon, 10, 0.1 \DOp:=gun, 1;
TriggL p1, v500, gunon, z50, gun1;
```

The tool `gun1` starts to open when its TCP is `0,1` s before the fictitious point `p2` (`10` mm before point `p1`). The gun is full open when TCP reach point `p2`.

The figure shows an example of a fixed position time I/O event.



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Arguments

```
TriggEquip TriggData Distance [\Start] EquipLag [\DOp] | [\GOp]|
    [\AOp] | [\ProcID] SetValue | SetDvalue [\Inhib]
```

`TriggData`

Data type: `triggdata`

Variable for storing the `triggdata` returned from this instruction. These `triggdata` are then used in the subsequent `TriggL`, `TriggC`, or `TriggJ` instructions.

Continues on next page

`Distance`

Data type: `num`

Defines the position on the path where the I/O equipment event shall occur.

Specified as the distance in mm (positive value) from the end point of the movement path (applicable if the argument `\Start` is not set).

See the section *Program execution* for further details.

`[ \Start ]`

Data type: `switch`

Used when the distance for the argument `Distance` starts at the movement start point instead of the end point.

`EquipLag`

Equipment Lag

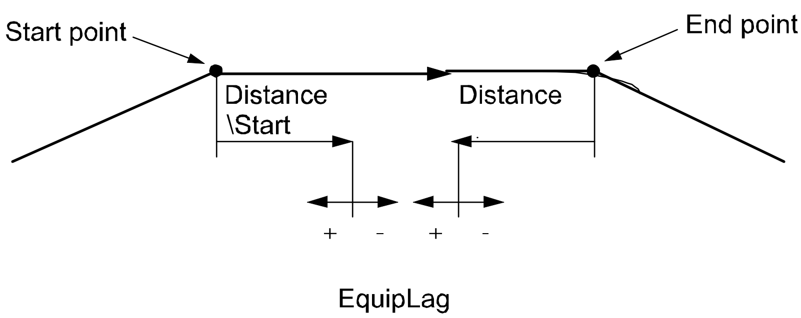
Data type: `num`

Specify the lag for the external equipment in s.

For compensation of external equipment lag, use a positive argument value. Positive argument value means that the I/O signal is set by the robot system at a specified time before the TCP physically reaches the specified distance in relation to the movement start or end point.

Negative argument value means that the I/O signal is set by the robot system at a specified time after that the TCP has physically passed the specified distance in relation to the movement start or end point.

The figure shows use of argument `EquipLag`.



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`[ \DOp ]`

Digital Output

Data type: `signaldo`

The name of the signal when a digital output signal shall be changed.

`[ \GOp ]`

Group Output

Data type: `signalgo`

The name of the signal when a group of digital output signals shall be changed.

Continues on next page

`[ \AOp ]`

Analog Output

Data type: `signalao`

The name of the signal when a analog output signal shall be changed.

`[ \ProcID ]`

Process Identity

Data type: `num`

Not implemented for customer use.

(The identity of the IPM process to receive the event. The selector is specified in the argument `SetValue`.)

`SetValue`

Data type: `num`

The desired value of the signal (within the allowed range for the current signal). If the signal is a digital signal, it must be an integer value. If the signal is a digital group signal, the permitted value is dependent on the number of signals in the group. Max value that can be used in the `SetValue` argument is 8388608, and that is the value a 23 bit digital group signal can have as maximum value (see ranges for `num`).

`SetDvalue`

Data type: `dnum`

The desired value of the signal (within the allowed range for the current signal). If the signal is a digital signal, it must be an integer value. If the signal is a digital group signal, the permitted value is dependent on the number of signals in the group. The maximal amout of signal bits a digital group signal can have is 32. With a `dnum` variable it is possible to cover the value range 0-4294967295, which is the value range a 32 bits digital signal can have.

`[ \Inhib ]`

Inhibit

Data type: `bool`

The name of a persistent variable flag for inhibiting the setting of the signal at runtime.

If this optional argument is used and the actual value of the specified flag is TRUE at the position-time for setting of the signal then the specified signal (`DOp`, `GOp` or `AOp`) will be set to 0 instead of a specified value.

Program execution

When running the instruction `TriggEquip`, the trigger condition is stored in the specified variable for the argument `TriggData`.

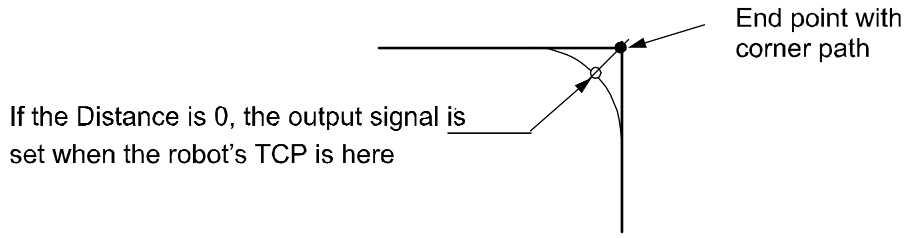
Afterwards, when one of the instructions `TriggL`, `TriggC`, or `TriggJ` is executed then the following are applicable with regard to the definitions in `TriggEquip`:

The table describes the distance specified in the argument `Distance`:

Linear movement	The straight line distance
Circular movement	The circle arc length
Non-linear movement	The approximate arc length along the path (to obtain adequate accuracy, the distance should not exceed one half of the arc length).

Continues on next page

The figure shows fixed position time I/O on a corner path.



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The position-time related event will be generated when the start point (end point) is passed if the specified distance from the end point (start point) is not within the length of movement of the current instruction (`TriggL...`). With use of argument `EquipLag` with negative time (delay), the I/O signal can be set after the end point.

More examples

More examples of how to use the instruction `TriggEquip` are illustrated below.

Example 1

```
VAR triggdata glueflow;
...
TriggEquip glueflow, 1 \Start, 0.05 \AOp:=glue, 5.3;
MoveJ p1, v1000, z50, tool1;
TriggL p2, v500, glueflow, z50, tool1;
```

The analog output signal `glue` is set to the value `5.3` when the TCP passes a point located `1` mm after the start point `p1` with compensation for equipment lag `0.05` s.

Example 2

```
...
TriggL p3, v500, glueflow, z50, tool1;
```

The analog output signal `glue` is set once more to the value `5.3` when the TCP passes a point located `1` mm after the start point `p2`.

Error handling

If the programmed `SetValue` argument for the specified analog output signal `AOp` is out of limit then the system variable ERRNO is set to ERR_AO_LIM. This error can be handled in the error handler.

If the programmed `SetValue` or `SetDvalue` argument for the specified digital group output signal `GOp` is out of limit then the system variable ERRNO is set to ERR_GO_LIM. This error can be handled in the error handler.

Continues on next page

Limitations

I/O events with distance is intended for flying points (corner path). I/O events with distance, using stop points, results in worse accuracy than specified below.

Regarding the accuracy for I/O events with distance and using flying points, the following is applicable when setting a digital output at a specified distance from the start point or end point in the instruction `TriggL` or `TriggC`:

- Accuracy specified below is valid for positive `EquipLag` parameter < 40 ms, equivalent to the lag in the robot servo (without changing the system parameter `Event Preset Time`). The lag can vary between different robot types. For example it is lower for IRB140.
- Accuracy specified below is valid for positive `EquipLag` parameter < configured `Event Preset Time` (system parameter).
- Accuracy specified below is not valid for positive `EquipLag` parameter > configured `Event Preset Time` (system parameter). In this case, an approximate method is used in which the dynamic limitations of the robot are not taken into consideration. `SingArea \Wrist` must be used in order to achieve an acceptable accuracy.
- Accuracy specified below is valid for negative `EquipLag`.

Typical absolute accuracy values for set of digital outputs +/- 5 ms.

Typical repeat accuracy values for set of digital outputs +/- 2 ms.

Syntax

```
TriggEquip
  [ TriggData ':=' ] < variable (VAR) of triggdata> ´,'
  [ Distance' :=' ] < expression (IN) of num>
  [ '\' Start ] ´,'
  [ EquipLag' :=' ] < expression (IN) of num>
  [ '\' DOp' :=' < variable (VAR) of signaldo> ]
  | [ '\' GOp' :=' < variable (VAR) of signalgo> ]
  | [ '\' AOp' :=' < variable (VAR) of signalao> ]
  | [ '\' ProcID' :=' < expression (IN) of num> ] ´,'
  [ SetValue' :=' ] < expression (IN) of num>
  | [ SetDvalue' :=' ] < expression (IN) of dnum>
  [ '\' Inhib' :=' < persistent (PERS) of bool> ] ´,'
```

Related information

For information about	See
Use of triggers	*TriggL - Linear robot movements with events on page 603* *TriggC - Circular robot movement with events on page 570* *TriggJ - Axis-wise robot movements with events on page 597*

Continues on next page

For information about	See
Definition of other triggs	*TriggIO - Define a fixed position or time I/O event near a stop point on page 592* *TriggInt - Defines a position related interrupt on page 588*
Define I/O check at a fixed position	*TriggCheckIO - Defines IO check at a fixed position on page 577*
Storage of trigg data	*triggdata - Positioning events, trigg on page 1213*
Set of I/O	*SetDO - Changes the value of a digital output signal on page 440* *SetGO - Changes the value of a group of digital output signals on page 442* *SetAO - Changes the value of an analog output signal on page 431*
Configuration of Event preset time	*Technical reference manual - System parameters*, section *Motion*

1.209. TriggInt - Defines a position related interrupt

Usage

`TriggInt` is used to define conditions and actions for running an interrupt routine at a specified position on the robot's movement path.

The data defined is used for implementation in one or more subsequent `TriggL`, `TriggC`, or `TriggJ` instructions.

This instruction can only be used in the main task `T_ROB1` or, if in a MultiMove System, in Motion tasks.

Basic examples

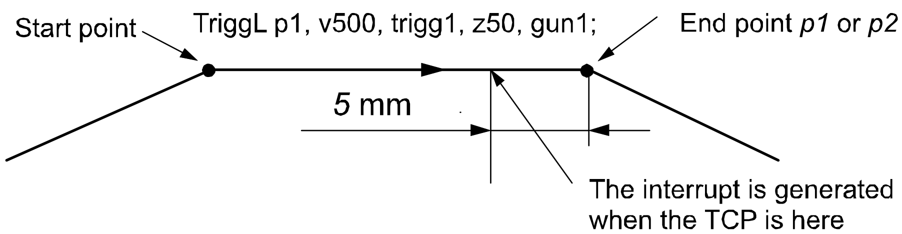
Basic examples of the instruction `TriggInt` are illustrated below.

Example 1

```
VAR intnum intno1;
VAR triggdata trigg1;
...
CONNECT intno1 WITH trap1;
TriggInt trigg1, 5, intno1;
...
TriggL p1, v500, trigg1, z50, gun1;
TriggL p2, v500, trigg1, z50, gun1;
...
IDelete intno1;
```

The interrupt routine `trap1` is run when the TCP is at a position `5` mm before the point `p1` or `p2` respectively.

The figure shows an example of position related interrupt.



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Arguments

```
TriggInt TriggData Distance [\Start] | [\Time] Interrupt
```

`TriggData`

Data type: `triggdata`

Variable for storing the `triggdata` returned from this instruction. These `triggdata` are then used in the subsequent `TriggL`, `TriggC`, or `TriggJ` instructions.

Continues on next page

`Distance`

Data type: `num`

Defines the position on the path where the interrupt shall be generated.

Specified as the distance in mm (positive value) from the end point of the movement path (applicable if the argument `\Start` or `\Time` is not set).

See the section entitled Program execution for further details.

`[ \Start ]`

Data type: `switch`

Used when the distance for the argument `Distance` starts at the movement's start point instead of the end point.

`[ \Time ]`

Data type: `switch`

Used when the value specified for the argument `Distance` is in fact a time in seconds (positive value) instead of a distance.

Position related interrupts in time can only be used for short times (< 0.5 s) before the robot reaches the end point of the instruction. See the section *Limitations* for more details.

`Interrupt`

Data type: `intnum`

Variable used to identify an interrupt.

Program execution

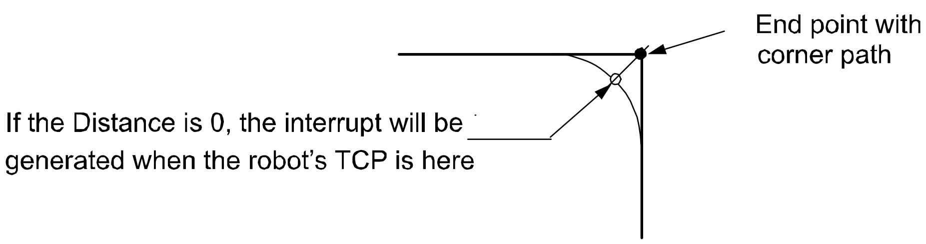
When running the instruction `TriggInt`, data is stored in a specified variable for the argument `TriggData` and the interrupt that is specified in the variable for the argument `Interrupt` is activated.

Afterwards, when one of the instructions `TriggL`, `TriggC`, or `TriggJ` is executed, the following are applicable with regard to the definitions in `TriggInt`:

The table describes the distance specified in the argument `Distance`:

Linear movement	The straight line distance
Circular movement	The circle arc length
Non-linear movement	The approximate arc length along the path (to obtain adequate accuracy, the distance should not exceed one half of the arc length).

The figure shows position related interrupt on a corner path.



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The position related interrupt will be generated when the start point (end point) is passed if the specified distance from the end point (start point) is not within the length of movement of the current instruction (`TriggL...`).

The interrupt is considered to be a safe interrupt. A safe interrupt can not be put in sleep with instruction `ISleep`. The safe interrupt event will be queued at program stop and stepwise execution, and when starting in continious mode again, the interrupt will be executed. The only time a safe interrupt will be thrown is when the interrupt queue is full. Then an error will be reported. The interrupt will not survive program reset, e.g. PP to main.

More examples

More examples of how to use the instruction `TriggInt` are illustrated below.

Example 1

This example describes programming of the instructions that interact to generate position related interrupts:

```
VAR intnum intno2;
VAR triggdata trigg2;
```

- Declaration of the variables `intno2` and `trigg2` (shall not be initiated).

```
CONNECT intno2 WITH trap2;
```

- Allocation of interrupt numbers that are stored in the variable `intno2`.
- The interrupt number is coupled to the interrupt routine `trap2`.

```
TriggInt trigg2, 0, intno2;
```

- The interrupt number in the variable `intno2` is flagged as used.
- The interrupt is activated.
- Defined trigger conditions and interrupt numbers are stored in the variable `trigg2`

```
TriggL p1, v500, trigg2, z50, gun1;
```

- The robot is moved to the point `p1`.
- When the TCP reaches the point `p1` an interrupt is generated, and the interrupt routine `trap2` is run.

```
TriggL p2, v500, trigg2, z50, gun1;
```

- The robot is moved to the point `p2`.
- When the TCP reaches the point `p2`, an interrupt is generated and the interrupt routine `trap2` is run once more.

```
IDelete intno2;
```

- The interrupt number in the variable `intno2` is de-allocated.

Limitations

Interrupt events with distance (without the argument `\Time`) are intended for flying points (corner path). Interrupt events with distance, using stop points results in worse accuracy than specified below.

Interrupt events with time (with the argument `\Time`) are intended for stop points. Interrupt events with time, using flying points, result in worse accuracy than specified below. I/O events with time can only be specified from the end point of the movement. This time cannot exceed the current braking time of the robot, which is max. approx. 0.5 s (typical values at speed 500 mm/s for IRB2400 150 ms and for IRB6400 250 ms). If the specified time is

Continues on next page

greater that the current braking time then the event will be generated anyhow but not until braking is started (later than specified). However, the whole of the movement time for the current movement can be utilized during small and fast movements.

Typical absolute accuracy values for generation of interrupts +/- 5 ms. Typical repeat accuracy values for generation of interrupts +/- 2 ms. Normally there is a delay of 2 to 30 ms between interrupt generation and response depending on the type of movement being performed at the time of the interrupt. (Ref. to *RAPID reference manual - RAPID overview*, section *Basic characteristics - Interrupts*).

To obtain the best accuracy when setting an output at a fixed position along the robot's path, use the instructions `TriggIO` or `TriggEquip` in preference to the instructions `TriggInt` with `SetDO/SetGO/SetAO` in an interrupt routine.

Syntax

```
TriggInt
  [ TriggData ':=' ] < variable (VAR) of triggdata> ´,'
  [ Distance' :=' ] < expression (IN) of num>
  [ '\' Start ] | [ '\' Time ] ','
  [ Interrupt' :=' ] < variable (VAR) ofintnum> ';'
```

Related information

For information about	See
Use of triggers	*TriggL - Linear robot movements with events on page 603* *TriggC - Circular robot movement with events on page 570* *TriggJ - Axis-wise robot movements with events on page 597*
Definition of position fix I/O	*TriggIO - Define a fixed position or time I/O event near a stop point on page 592* *TriggEquip - Define a fixed position and time I/O event on the path on page 582*
Define I/O check at a fixed position	*TriggCheckIO - Defines IO check at a fixed position on page 577*
Storage of trigg data	*triggdata - Positioning events, trigg on page 1213*
Interrupts	*Technical reference manual - RAPID overview*, section *Basic characteristics - Interrupts*

1.210. TriggIO - Define a fixed position or time I/O event near a stop point

Usage

`TriggIO` is used to define conditions and actions for setting a digital, a group of digital, or an analog output signal at a fixed position along the robot's movement path.

`TriggIO` (not `TriggEquip`) should always be used if needed for good accuracy of the I/O settings near a stop point.

To obtain a fixed position I/O event, `TriggIO` compensates for the lag in the control system (lag between robot and servo) but not for any lag in the external equipment. For compensation of both lags use `TriggEquip`.

The data defined is used for implementation in one or more subsequent `TriggL`, `TriggC`, or `TriggJ` instructions.

This instruction can only be used in the main `T_ROB1` task or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic example of the instruction `TriggIO` are illustrated below.

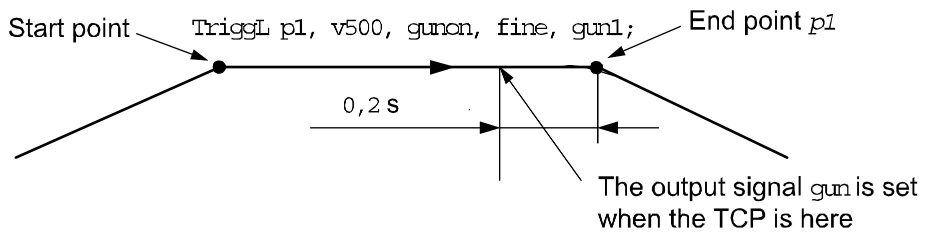
See also *More examples on page 595*.

Example 1

```
VAR triggdata gunon;
...
TriggIO gunon, 0.2\Time\DOp:=gun, 1;
TriggL p1, v500, gunon, fine, gun1;
```

The digital output signal `gun` is set to the value `1` when the TCP is `0,2` seconds before the point `p1`.

The figure shows an example of fixed position I/O event.



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Arguments

```
TriggIO TriggData Distance [\Start] | [\Time] [\DOp] | [\GOp]|
    [\AOp] | [\ProcID] SetValue | SetDvalue [\DODelay]
```

`TriggData`

Data type: `triggdata`

Variable for storing the `triggdata` returned from this instruction. These `triggdata` are then used in the subsequent `TriggL`, `TriggC`, or `TriggJ` instructions.

Continues on next page

`Distance`

Data type: `num`

Defines the position on the path where the I/O event shall occur.

Specified as the distance in mm (positive value) from the end point of the movement path (applicable if the argument `\Start` or `\Time` is not set).

See the sections *Program execution on page 594*, and *Limitations on page 595* for further details.

`[ \Start ]`

Data type: `switch`

Used when the distance for the argument `Distance` starts at the movement start point instead of the end point.

`[ \Time ]`

Data type: `switch`

Used when the value specified for the argument `Distance` is in fact a time in seconds (positive value) instead of a distance.

Fixed position I/O in time can only be used for short times (< 0.5 s) before the robot reaches the end point of the instruction. See the section Limitations for more details.

`[ \DOp ]`

Digital Output

Data type: `signaldo`

The name of the signal when a digital output signal shall be changed.

`[ \GOp ]`

Group Output

Data type: `signalgo`

The name of the signal when a group of digital output signals shall be changed.

`[ \AOp ]`

Analog Output

Data type: `signalao`

The name of the signal when a analog output signal shall be changed.

`[ \ProcID ]`

Process Identity

Data type: `num`

Not implemented for customer use.

(The identity of the IPM process to receive the event. The selector is specified in the argument `SetValue`.)

Continues on next page

`SetValue`

Data type: `num`

The desired value of the signal (within the allowed range for the current signal). If the signal is a digital signal, it must be an integer value. If the signal is a digital group signal, the permitted value is dependent on the number of signals in the group. Max value that can be used in the `SetValue` argument is 8388608, and that is the value a 23 bit digital group signal can have as maximum value (see ranges for `num`).

`SetDvalue`

Data type: d`num`

The desired value of the signal (within the allowed range for the current signal). If the signal is a digital signal, it must be an integer value. If the signal is a digital group signal, the permitted value is dependent on the number of signals in the group. The maximal amout of signal bits a digital group signal can have is 32. With a `dnum` variable it is possible to cover the value range 0-4294967295, which is the value range a 32 bits digital signal can have.

`[ \DODelay ]`

Digital Output Delay

Data type: `num`

Time delay in seconds (positive value) for a digital, group, or analog output signal.

Only used to delay setting of output signals after the robot has reached the specified position. There will be no delay if the argument is omitted.

The delay is not synchronized with the movement.

Program execution

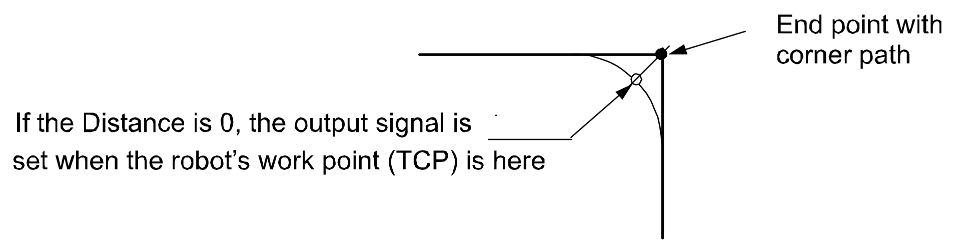
When running the instruction `TriggIO`, the trigger condition is stored in a specified variable in the argument `TriggData`.

Afterwards, when one of the instructions `TriggL`, `TriggC`, or `TriggJ` is executed, the following are applicable with regard to the definitions in `TriggIO`:

The following table describes the distance specified in the argument `Distance`:

Linear movement	The straight line distance
Circular movement	The circle arc length
Non-linear movement	The approximate arc length along the path (to obtain adequate accuracy, the distance should not exceed one half of the arc length).

The figure shows fixed position I/O on a corner path.



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The fixed position I/O will be generated when the start point (end point) is passed if the specified distance from the end point (start point) is not within the length of movement of the current instruction (`Trigg...`).

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More examples

More examples of how to use the instruction `TriggIO` are illustrated below.

Example 1

```
VAR triggdata glueflow;

TriggIO glueflow, 1 \Start \AOp:=glue, 5.3;

MoveJ p1, v1000, z50, tool1;
TriggL p2, v500, glueflow, z50, tool1;
```

The analog output signal `glue` is set to the value `5.3` when the work point (TCP) passes a point located `1` mm after the start point `p1`.

Example 2

```
...
TriggL p3, v500, glueflow, z50, tool1;
```

The analog output signal `glue` is set once more to the value `5.3` when the work point (TCP) passes a point located `1` mm after the start point `p2`.

Error handling

If the programmed `SetValue` argument for the specified analog output signal `AOp` is out of limit then the system variable ERRNO is set to ERR_AO_LIM. This error can be handled in the error handler.

If the programmed `SetValue` or `SetDvalue` argument for the specified digital group output signal `GOp` is out of limit then the system variable ERRNO is set to ERR_GO_LIM. This error can be handled in the error handler.

Limitations

I/O events with distance (without the argument `\Time`) is intended for flying points (corner path). I/O events with distance=0, using stop points, will delay the trigg until the robot has reached the point with accuracy +/-24 ms.

I/O events with time (with the argument `\Time`) are intended for stop points. I/O events with time, using flying points result in worse accuracy than specified below. I/O events with time can only be specified from the end point of the movement. This time cannot exceed the current braking time of the robot, which is max. approx. 0.5 s (typical values at speed 500 mm/s for IRB2400 150 ms and for IRB6400 250 ms). If the specified time is greater than the current braking time then the event will be generated anyway but not until braking is started (later than specified). However, the whole of the movement time for the current movement can be utilized during small and fast movements.

Typical absolute accuracy values for set of digital outputs +/- 5 ms. Typical repeat accuracy values for set of digital outputs +/- 2 ms.

Continues on next page

Syntax

```
TriggIO
  [ TriggData ':=' ] < variable (VAR) of triggdata> ´,'
  [ Distance' :=' ] < expression (IN) of num>
  [ '\' Start ] | [ '\' Time ]
  [ '\' DOp' :=' < variable (VAR) of signaldo> ]
  | [ '\' GOp' :=' < variable (VAR) of signalgo> ]
  | [ '\' AOp' :=' < variable (VAR) of signalao> ]
  | [ '\' ProcID' :=' < expression (IN) of num> ] ´,'
  [ SetValue' :=' ] < expression (IN) of num>
  | [ SetDvalue' :=' ] < expression (IN) of dnum>
  [ '\' DODelay' :=' < expression (IN) of num> ] ´;'
```

Related information

For information about	See
Use of triggers	*TriggL - Linear robot movements with events on page 603* *TriggC - Circular robot movement with events on page 570* *TriggJ - Axis-wise robot movements with events on page 597*
Definition of position-time I/O event	*TriggEquip - Define a fixed position and time I/O event on the path on page 582*
Definition of position related interrupts	*TriggInt - Defines a position related interrupt on page 588*
Storage of trigg data	*triggdata - Positioning events, trigg on page 1213*
Define I/O check at a fixed position	*TriggCheckIO - Defines IO check at a fixed position on page 577*
Set of I/O	*SetDO - Changes the value of a digital output signal on page 440* *SetGO - Changes the value of a group of digital output signals on page 442* *SetAO - Changes the value of an analog output signal on page 431*

1.211. TriggJ - Axis-wise robot movements with events

Usage

`TriggJ` (*TriggJoint*) is used to set output signals and/or run interrupt routines at roughly fixed positions at the same time that the robot is moving quickly from one point to another when that movement does not have be in a straight line.

One or more (max. 8) events can be defined using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO` , `TriggSpeed`, or `TriggRampAO` and afterwards these definitions are referred to in the instruction `TriggJ`.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `TriggJ` are illustrated below.

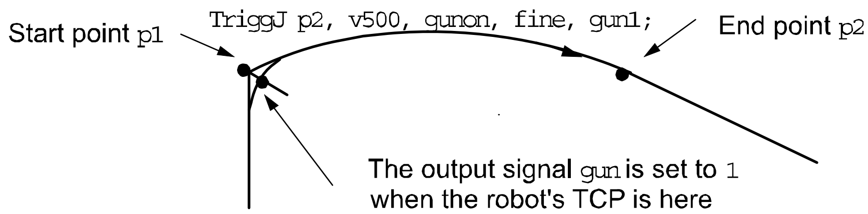
See also *More examples on page 600*.

Example 1

```
VAR triggdata gunon;
...
TriggIO gunon, 0 \Start \DOp:=gun, 1;
MoveL p1, v500, z50, gun1;
TriggJ p2, v500, gunon, fine, gun1;
```

The digital output signal `gun` is set when the robot’s TCP passes the midpoint of the corner path of the point `p1`.

The figure shows an example of fixed position I/O event.



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Arguments

```
TriggJ [\Conc] ToPoint [\ID] Speed [\T] Trigg_1 [ \T2 ] [ \T3 ]
      [\T4] [\T5] [\T6] [\T7] [\T8] Zone [\Inpos] Tool [\WObj]
```

`[ \Conc ]`

Concurrent

Data type: `switch`

Subsequent instructions are executed while the robot is moving. The argument can be used to avoid unwanted stops caused by overloaded CPU when using fly-by points. This is useful when the programmed points are very close together at high speeds.

The argument is also useful when, for example, communicating with external equipment and synchronization between the external equipment and robot movement is not required. It can also be used to tune the execution of the robot path to avoid warning 50024 Corner path failure or error 40082 Deceleration limit.

Continues on next page

Using the argument `\Conc`, the number of movement instructions in succession is limited to 5. In a program section that includes `StorePath-RestoPath`, movement instructions with the argument `\Conc` are not permitted.

If this argument is omitted then the subsequent instruction is executed after the robot has reached the specified stop point or 100 ms before the specified zone.

This argument can not be used in coordinated synchronized movement in a MultiMove System.

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove System, if it is a coordinated synchronized movement, and is not allowed in any other cases.

The specified ID number must be the same in all cooperating program tasks. The ID number gives a guarantee that the movements are not mixed up at runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the tool center point, the tool reorientation, and the external axes.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

`Trigg_1`

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO` , `TriggSpeed`, or `TriggRampAO`.

`[ \T2 ]`

Trigg 2

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO` , `TriggSpeed`, or `TriggRampAO`.

Continues on next page

`[ \T3 ]`

Trigg 3

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO` , `TriggSpeed`, or `TriggRampAO`.

`[ \T4 ]`

Trigg 4

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO` , `TriggSpeed`, or `TriggRampAO`.

`[ \T5 ]`

Trigg 5

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \T6 ]`

Trigg 6

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \T7 ]`

Trigg 7

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \T8 ]`

Trigg 8

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

Continues on next page

`[ \Inpos ]`

In position

Data type: `stoppointdata`

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the `Zone` parameter.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point that is moved to the specified destination position.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used then this argument must be specified for a joint movement relative to the work object to be performed.

Program execution

See the instruction `MoveJ` for information about joint movement.

As the trigger conditions are fulfilled when the robot is positioned closer and closer to the end point, the defined trigger activities are carried out. The trigger conditions are fulfilled either at a certain distance before the end point of the instruction, or at a certain distance after the start point of the instruction, or at a certain point in time (limited to a short time) before the end point of the instruction.

During the stepping execution forward, the I/O activities are carried out but the interrupt routines are not run. During stepping the execution backwards, no trigger activities at all are carried out.

More examples

More examples of how to use the instruction `TriggJ` are illustrated below.

Example 1

```
VAR intnum intno1;
VAR triggdata trigg1;
...
CONNECT intno1 WITH trap1;
TriggInt trigg1, 0.1 \Time, intno1;
...
TriggJ p1, v500, trigg1, fine, gun1;
TriggJ p2, v500, trigg1, fine, gun1;
...
IDelete intno1;
```

The interrupt routine `trap1` is run when the work point is at a position `0.1` s before the stop point `p1` or `p2` respectively.

Continues on next page

Error handling

If the programmed `ScaleValue` argument for the specified analog output signal `AOp` in some of the connected `TriggSpeed` instructions results in out of limit for the analog signal together with the programmed `Speed` in this instruction, then the system variable ERRNO is set to ERR_AO_LIM.

If the programmed `DipLag` argument in some of the connected `TriggSpeed` instructions is too big in relation to the Event Preset Time used in System Parameters then the system variable ERRNO is set to ERR_DIPLAG_LIM.

The system variable ERRNO can be set to ERR_NORUNUNIT if there is no contact with the I/O unit when entering instruction and the used triggdata depends on a running I/O unit, i.e. a signal is used in the triggdata.

These errors can be handled in the error handler.

Limitations

If the current start point deviates from the usual so that the total positioning length of the instruction `TriggJ` is shorter than usual (e.g. at the start of `TriggJ` with the robot position at the end point), it may happen that several or all of the trigger conditions are fulfilled immediately and at the same position. In such cases, the sequence in which the trigger activities are carried will be undefined. The program logic in the user program may not be based on a normal sequence of trigger activities for an “incomplete movement”.

Syntax

```
TriggJ
  [ '\' Conc ',']
  [ ToPoint' :=' ] < expression (IN) of robtarget >
  [ '\' ID ':=' < expression (IN) of identno >]','
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' T ':=' < expression (IN) of num > ]','
  [Trigg_1 ':=' ] < variable (VAR) of triggdata >
  [ '\' T2 ':=' < variable (VAR) of triggdata > ]
  [ '\' T3 ':=' < variable (VAR) of triggdata > ]
  [ '\' T4 ':=' < variable (VAR) of triggdata > ]
  [ '\' T5 ':=' < variable (VAR) of triggdata > ]
  [ '\' T6 ':=' < variable (VAR) of triggdata > ]
  [ '\' T7 ':=' < variable (VAR) of triggdata > ]
  [ '\' T8 ':=' < variable (VAR) of triggdata > ] ´,'
  [Zone ':=' ] < expression (IN) of zonedata >
  [ '\' Inpos ':=' < expression (IN) of stoppointdata > ]´,'
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\' WObj' :='< persistent (PERS) of wobjdata > ] ';'
```


Continues on next page

Related information

For information about	See
Linear movement with triggers	*TriggL - Linear robot movements with events on page 603*
Circular movement with triggers	*TriggC - Circular robot movement with events on page 570*
Definition of triggers	*TriggIO - Define a fixed position or time I/O event near a stop point on page 592* *TriggEquip - Define a fixed position and time I/O event on the path on page 582* *TriggRampAO - Define a fixed position ramp AO event on the path on page 616* *TriggInt - Defines a position related interrupt on page 588* *TriggCheckIO - Defines IO check at a fixed position on page 577*
Moves the robot by joint movement	*MoveJ - Moves the robot by joint movement on page 253*
Joint movement	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*
Definition of stop point data	*stoppointdata - Stop point data on page 1189*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work object	*wobjdata - Work object data on page 1224*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*

1.212. TriggL - Linear robot movements with events

Usage

`TriggL` (*Trigg Linear*) is used to set output signals and/or run interrupt routines at fixed positions at the same time that the robot is making a linear movement.

One or more (max. 8) events can be defined using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggSpeed`, `TriggCheckIO`, or `TriggRampAO`. Afterwards these definitions are referred to in the instruction `TriggL`.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `TriggL` are illustrated below.

See also *More examples on page 607*.

Example 1

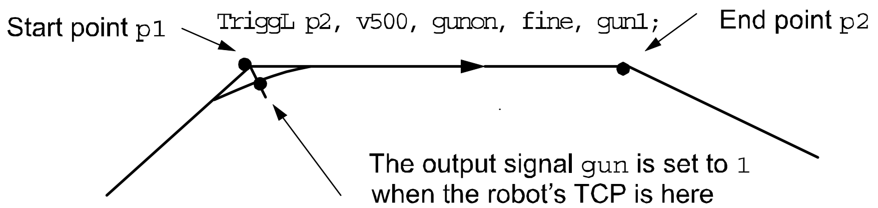
```
VAR triggdata gunon;

TriggIO gunon, 0 \Start \DOp:=gun, 1;

MoveJ p1, v500, z50, gun1;
TriggL p2, v500, gunon, fine, gun1;
```

The digital output signal `gun` is set when the robot's TCP passes the midpoint of the corner path of the point `p1`.

The figure shows an example of fixed position I/O event.



xx0500002291

Arguments

```
TriggL [\Conc] ToPoint [\ID] Speed [\T] Trigg_1 [\T2] [\T3] [\T4]
      [\T5] [\T6] [\T7] [\T8] Zone [\Inpos] Tool [\WObj] [\Corr]
```

`[ \Conc ]`

Concurrent

Data type: `switch`

Subsequent instructions are executed while the robot is moving. The argument can be used to avoid unwanted stops, caused by overloaded CPU, when using fly-by points. This is useful when the programmed points are very close together at high speeds.

The argument is also useful when, for example, communicating with external equipment and synchronization between the external equipment and robot movement is not required. It can also be used to tune the execution of the robot path, to avoid warning 50024 Corner path failure or error 40082 Deceleration limit.

Continues on next page

Using the argument `\Conc`, the number of movement instructions in succession is limited to 5. In a program section that includes `StorePath-RestoPath`, movement instructions with the argument `\Conc` are not permitted.

If this argument is omitted and the `ToPoint` is not a stop point then the subsequent instruction is executed some time before the robot has reached the programmed zone.

This argument cannot be used in a coordinated synchronized movement in a MultiMove System.

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove system, if it is a coordinated synchronized movement, and is not allowed in any other cases.

The specified ID number must be the same in all cooperating program tasks. The ID number gives a guarantee that the movements are not mixed up at runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the tool center point, the external axes, and of the tool reorientation.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

`Trigg_1`

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggSpeed`, `TriggCheckIO` or `TriggRampAO`.

`[ \T2 ]`

Trigg 2

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggSpeed`, `TriggCheckIO`, or `TriggRampAO`.

Continues on next page

`[ \T3 ]`

Trigg 3

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggSpeed`, `TriggCheckIO`, or `TriggRampAO`.

`[ \T4 ]`

Trigg 4

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggSpeed`, `TriggCheckIO`, or `TriggRampAO`.

`[ \T5 ]`

Trigg 5

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggSpeed`, `TriggCheckIO`, or `TriggRampAO`.

`[ \T6 ]`

Trigg 6

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggSpeed`, `TriggCheckIO`, or `TriggRampAO`.

`[ \T7 ]`

Trigg 7

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggSpeed`, `TriggCheckIO`, or `TriggRampAO`.

`[ \T8 ]`

Trigg 8

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggSpeed`, `TriggCheckIO`, or `TriggRampAO`.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

Continues on next page

`[ \Inpos ]`

In position

Data type: `stoppointdata`

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the `Zone` parameter.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point that is moved to the specified destination position.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used then this argument must be specified for a linear movement relative to the work object to be performed.

`[ \Corr ]`

Correction

Data type: `switch`

Correction data written to a corrections entry by the instruction `CorrWrite` will be added to the path and destination position if this argument is present.

Program execution

See the instruction `MoveL` for information about linear movement.

As the trigger conditions are fulfilled when the robot is positioned closer and closer to the end point, the defined trigger activities are carried out. The trigger conditions are fulfilled either at a certain distance before the end point of the instruction, or at a certain distance after the start point of the instruction, or at a certain point in time (limited to a short time) before the end point of the instruction.

During stepping the execution forward, the I/O activities are carried out but the interrupt routines are not run. During stepping the execution backwards, no trigger activities at all are carried out.

Continues on next page

More examples

More examples of how to use the instruction `TriggL` are illustrated below.

Example 1

```
VAR intnum intno1;
VAR triggdata trigg1;
...
CONNECT intno1 WITH trap1;
TriggInt trigg1, 0.1 \Time, intno1;
...
TriggL p1, v500, trigg1, fine, gun1;
TriggL p2, v500, trigg1, fine, gun1;
...
IDelete intno1;
```

The interrupt routine `trap1` is run when the work point is at a position `0.1` s before the point `p1` or `p2` respectively.

Error handling

If the programmed `ScaleValue` argument for the specified analog output signal `AOp` in some of the connected `TriggSpeed` instructions results in out of limit for the analog signal together with the programmed `Speed` in this instruction, then the system variable `ERRNO` is set to `ERR_AO_LIM`.

If the programmed `DipLag` argument in some of the connected `TriggSpeed` instructions is too big in relation to the Event Preset Time used in System Parameters, then the system variable `ERRNO` is set to `ERR_DIPLAG_LIM`.

The system variable ERRNO can be set to ERR_NORUNUNIT if there is no contact with the I/O unit when entering instruction and the used triggdata depends on a running I/O unit, i.e. a signal is used in the triggdata.

These errors can be handled in the error handler.

Limitations

If the current start point deviates from the usual so that the total positioning length of the instruction `TriggL` is shorter than usual (e.g. at the start of `TriggL` with the robot position at the end point) it may happen that several or all of the trigger conditions are fulfilled immediately and at the same position. In such cases, the sequence in which the trigger activities are carried out will be undefined. The program logic in the user program may not be based on a normal sequence of trigger activities for an “incomplete movement”.

Continues on next page

Syntax

```
TriggL
  ['\' Conc ',']
  [ ToPoint' :=' ] < expression (IN) of robtarget >
  [ '\' ID ':=' < expression (IN) of identno >] ','
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' T ':=' < expression (IN) of num > ]','
  [Trigg_1 ':=' ] < variable (VAR) of triggdata >
  [ '\' T2 ':=' < variable (VAR) of triggdata > ]
  [ '\' T3 ':=' < variable (VAR) of triggdata > ]
  [ '\' T4 ':=' < variable (VAR) of triggdata > ]
  [ '\' T5 ':=' < variable (VAR) of triggdata > ]
  [ '\' T6 ':=' < variable (VAR) of triggdata > ]
  [ '\' T7 ':=' < variable (VAR) of triggdata > ]
  [ '\' T8 ':=' < variable (VAR) of triggdata > ] ´,'
  [Zone ':=' ] < expression (IN) of zonedata >
  [ '\' Inpos' :=' < expression (IN) of stoppointdata > ] ´,'
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\' WObj' :=' < persistent (PERS) of wobjdata > ]
  [ '\' Corr ] ';'
```

Related information

For information about	See
Circular movement with triggers	*TriggC - Circular robot movement with events on page 570*
Joint movement with triggers	*TriggJ - Axis-wise robot movements with events on page 597*
Definition of triggers	*TriggIO - Define a fixed position or time I/O event near a stop point on page 592* *TriggEquip - Define a fixed position and time I/O event on the path on page 582* *TriggInt - Defines a position related interrupt on page 588* *TriggCheckIO - Defines IO check at a fixed position on page 577* *TriggRampAO - Define a fixed position ramp AO event on the path on page 616* *TriggSpeed - Defines TCP speed proportional analog output with fixed position-time scale event on page 622*
Writes to a corrections entry	*CorrWrite - Writes to a correction generator on page 77*
Linear movement	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution*
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of zone data	*zonedata - Zone data on page 1232*
Definition of stop point data	*stoppointdata - Stop point data on page 1189*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*

Continues on next page

For information about	See
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*

1.213. TriggLIOs - Linear robot movements with I/O events

Usage

`TriggLIOs` (Trigg Linear I/O) is used to set output signals at fixed positions at the same time that the robot is making a linear movement.

The `TriggLIOs` instruction is optimized to give good accuracy when using movements with zones (compare with `TriggEquip`/`TriggL`).

Basic examples

Basic examples of the instruction `TriggLIOs` are illustrated below.

See also *More examples on page 613*.

Example 1

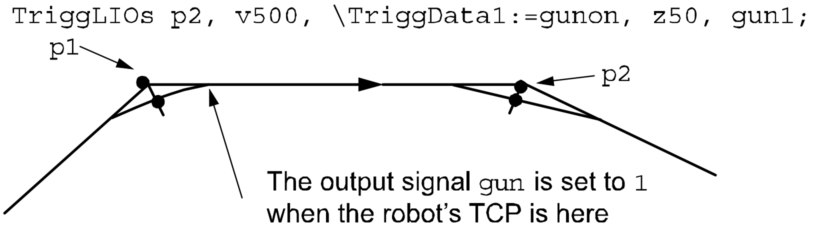
```
VAR triggios gunon{1};

gunon{1}.used:=TRUE;
gunon{1}.distance:=3;
gunon{1}.start:=TRUE;
gunon{1}.signalname:="gun";
gunon{1}.equiplag:=0;
gunon{1}.setvalue:=1;

MoveJ p1, v500, z50, gun1;
TriggLIOs p2, v500, \TriggData1:=gunon, z50, gun1;
MoveL p3, v500, z50, gun1;
```

The signal `gun` is set when the TCP is 3 mm after point `p1`.

The figure shows an example of a fixed position I/O event.



en0800000157

Arguments

```
TriggLIOs [\Conc] ToPoint [\ID] Speed [\T] [\TriggData1]
     [\TriggData2] [\TriggData3] Zone [\Inpos] Tool [\WObj]
     [\Corr]
```

`[ \Conc ]`

Concurrent

Data type: `switch`

Subsequent instructions are executed while the robot is moving. The argument can be used to avoid unwanted stops, caused by overloaded CPU, when using fly-by points. This is useful when the programmed points are very close together at high speeds.

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The argument is also useful when, for example, communicating with external equipment and synchronization between the external equipment and robot movement is not required. It can also be used to tune the execution of the robot path, to avoid warning 50024 Corner path failure or error 40082 Deceleration limit.

Using the argument `\Conc`, the number of movement instructions in succession is limited to 5. In a program section that includes `StorePath-RestoPath`, movement instructions with the argument `\Conc` are not permitted.

If this argument is omitted and the `ToPoint` is not a stop point then the subsequent instruction is executed some time before the robot has reached the programmed zone.

This argument cannot be used in a coordinated synchronized movement in a MultiMove System.

`ToPoint`

Data type: `robtarget`

The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).

`[ \ID ]`

Synchronization id

Data type: `identno`

This argument must be used in a MultiMove system, if it is a coordinated synchronized movement, and is not allowed in any other cases.

The specified ID number must be the same in all cooperating program tasks. The ID number gives a guarantee that the movements are not mixed up at runtime.

`Speed`

Data type: `speeddata`

The speed data that applies to movements. Speed data defines the velocity of the tool center point, the external axes, and of the tool reorientation.

`[ \T ]`

Time

Data type: `num`

This argument is used to specify the total time in seconds during which the robot moves. It is then substituted for the corresponding speed data.

`[\TriggData1]`

Data type: `array of triggios`

Variable (array) that refers to trigger conditions and trigger activity. When using this argument, it is possible to set analog output signals, digital output signals and digital group output signals. If using a digital group output signal there is a limitation on 23 signals in the group.

Continues on next page

`[\TriggData2]`

Data type: `array of triggstrgo`

Variable (array) that refers to trigger conditions and trigger activity. When using this argument, it is possible to set digital group output signals that consists of 32 signals in the group and can have a maximum set value of 4294967295. Only digital group output signals can be used.

`[\TriggData3]`

Data type: `array of triggiosdnum`

Variable (array) that refers to trigger conditions and trigger activity. When using this argument, it is possible to set analog output signals, digital output signals and digital group output signals that consists of 32 signals in the group and can have a maximum set value of 4294967295.

`Zone`

Data type: `zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`[ \Inpos ]`

In position

Data type: `stoppointdata`

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the `Zone` parameter.

`Tool`

Data type: `tooldata`

The tool in use when the robot moves. The tool center point is the point that is moved to the specified destination position.

`[ \WObj ]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot position in the instruction is related.

This argument can be omitted and if so then the position is related to the world coordinate system. If, on the other hand, a stationary TCP or coordinated external axes are used then this argument must be specified for a linear movement relative to the work object to be performed.

`[ \Corr ]`

Correction

Data type: `switch`

Correction data written to a corrections entry by the instruction `CorrWrite` will be added to the path and destination position if this argument is present.

Continues on next page

Program execution

See the instruction `MoveL` for information about linear movement.

With the instruction `TriggLIOs` it is possible to setup 1-50 different trigger activities on I/O signals along a path from A to B. The signals that can be used are digital output signals, digital group output signals and analog output signals. The trigger conditions are fulfilled either at a certain distance before the end point of the instruction, or at a certain distance after the start point of the instruction.

The instruction requires use of either `TriggData1`, `TriggData2` or `TriggData3` argument or all three of them. Use of any of the triggs is optional though. To inhibit use of a trigg the component `used` can be set to FALSE in the array element of the data types `triggios`/ `triggstrgo`/`triggiosdnum`. If no array element is in use, then the `TriggLIOs` instruction will behave as a `MoveL`, and no I/O activities will be carried out.

If stepping the program forward, the I/O activities are carried out. During stepping the execution backwards, no I/O activities at all are carried out.

If setting component `EquipLag` in `TriggData1`, `TriggData2` or `TriggData3` argument to a negative time (delay), the I/O signal can be set after the destination point (`ToPoint`).

If using the argument `TriggData2` or `TriggData3` it is possible to use values up to 4294967295, which is the maximum value a group of digital signals can have (32 signals in a group signal is max for the system).

More examples

More examples of how to use the instruction `TriggLIOs` are illustrated below.

Example 1

```
VAR triggios mytriggios{3}:= [[TRUE, 3, TRUE, 0, "go1", 55, 0],
      [TRUE, 15, TRUE, 0, "ao1", 10, 0], [TRUE, 3, FALSE, 0, "do1",
      1, 0]];
...
MoveL p1, v500, z50, gun1;
TriggLIOs p2, v500, \TriggData1:=mytriggios, z50, gun1;
MoveL p3, v500, z50, gun1;
```

The digital group output signal `go1` will be set to value 55 3 mm from `p1`. Analog output signal will be set to value 10 15 mm from `p1`. Digital output signal do1 will be set 3 mm from ToPoint `p2`.

Continues on next page

Example 2

```
VAR triggios mytriggios{3}:= [[TRUE, 3, TRUE, 0, "go1", 55, 0],
     [TRUE, 15, TRUE, 0, "ao1", 10, 0],  [TRUE, 3, FALSE, 0, "do1",
     1, 0]];
VAR triggstrgo mytriggstrgo{3}:= [[TRUE, 3, TRUE, 0, "go2", "1",
     0], [TRUE, 15, TRUE, 0, "go2", "800000", 0],  [TRUE, 4, FALSE,
     0, "go2", "4294967295", 0]];
VAR triggiosdnum mytriggiosdnum{3}:= [[TRUE, 10, TRUE, 0, "go3",
     4294967295, 0], [TRUE, 10, TRUE, 0, "ao2", 5, 0],  [TRUE, 10,
     TRUE, 0, "do2", 1, 0]];
...
MoveL p1, v500, z50, gun1;
TriggLIOs p2, v500, \TriggData1:=mytriggios \TriggData2:=
     mytriggstrgo \TriggData3:=mytriggiosdnum, z50, gun1;
MoveL p3, v500, z50, gun1;
```

The digital group output signal `go1` will be set to value 55 3 mm from `p1`. Analog output signal `ao1` will be set to value 10 15 mm from `p1`. Digital output signal `do1` will be set 3 mm from `ToPoint` `p2`. Those position events is setup by variable `mytriggios`. The variable `mytriggstrgo` sets up position events to occur 3 and 15 mm from `p1`. First the signal `go2` is set to 1, then it is set to 800000. The signal will be set to value 4294967295 4 mm from the `ToPoint` `p2`. This is the maximum value for a 32 bits digital output signal. The variable `mytriggiosdnum` sets up three position events to occur 10 mm from `p1`. First the signal `go3` is set to 4294967295, then `ao2` is set to 5 and last `do2` is set to 1.

Error handling

The following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the I/O unit.

`ERR_GO_LIM`

if the programmed `setvalue` argument for the specified digital group output signal `signalname` is outside limits. (Declared in `TriggData1`, `TriggData2` or `TriggData3`)

`ERR_AO_LIM`

if the programmed `setvalue` argument for the specified analog output signal `signalname` is outside limits. (Declared in `TriggData1` or `TriggData3`)

Limitations

If the current start point deviates from the usual so that the total positioning length of the instruction `TriggLIOs` is shorter than usual (e.g. at the start of `TriggLIOs` with the robot position at the end point) it may happen that several or all of the trigger conditions are fulfilled immediately and at the same position. In such cases, the sequence in which the trigger activities are carried out will be undefined. The program logic in the user program may not be based on a normal sequence of trigger activities for an “incomplete movement”.

Continues on next page

The limitation of the number of triggs in the instruction `TriggLIOs` is 50 for each programmed instruction. However, if those triggs is supposed to happen in a close distance, the system might not be able to handle that. That depends on how the movement is done, TCP speed used and how close the triggs are programmed. Those limitations exists, but it is hard to predict when those problems will occur.

Syntax

```
TriggLIOs
  ['\' Conc ',']
  [ ToPoint' :=' ] < expression (IN) of robtarget >
  [ '\' ID ':=' < expression (IN) of identno >] ','
  [ Speed ':=' ] < expression (IN) of speeddata >
  [ '\' T ':=' < expression (IN) of num > ]','
  [ '\' TriggData1' :=' ] < array {*} (VAR) of triggios >
  [ '\' TriggData2' :=' ] < array {*} (VAR) of triggstrgo >
  [ '\' TriggData3' :=' ] < array {*} (VAR) of triggiosdnum >
  [Zone ':=' ] < expression (IN) of zonedata >
  [ '\' Inpos' :=' < expression (IN) of stoppointdata > ] ´,'
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\' WObj' :=' < persistent (PERS) of wobjdata > ]
  [ '\' Corr ] ';'
```

Related information

For information about	See
Storage of trigg conditions and trigger activity	*triggios - Positioning events, trigg on page 1214*
Storage of trigg conditions and trigger activity for digital signal group consisting of 32 signals	*triggstrgo - Positioning events, trigg on page 1219*
Storage of trigg conditions and trigger activity	*triggiosdnum - Positioning events, trigg on page 1217*
Linear movement	Technical reference manual - RAPID overview, section Motion and I/O principles - Positioning during program execution
Motion in general	Technical reference manual - RAPID overview, section Motion and I/O principles

1.214. TriggRampAO - Define a fixed position ramp AO event on the path

Usage

`TriggRampAO` (*Trigg Ramp Analog Output*) is used to define conditions and actions for ramping up or down analog output signal value at a fixed position along the robot's movement path with possibility to do time compensation for the lag in the external equipment.

The data defined is used for implementation in one or more subsequent `TriggL`, `TriggC`, or `TriggJ` instructions. Beside these instructions, `TriggRampAO` can also be used in `CapL` or `CapC` instructions.

The type of trig actions connected to the same `TriggL/C/J` instruction can be `TriggRampAO` or any of `TriggIO`, `TriggEquip`, `TriggSpeed`, `TriggInt`, or `TriggCheckIO` instructions. Any type of combination is allowed except that only one `TriggSpeed` action on the same signal in the same `TriggL/C/J` instruction is allowed.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `TriggRampAO` are illustrated below.

See also *More examples on page 620*.

Example 1

```
VAR triggdata ramp_up;
...
TriggRampAO ramp_up, 0 \Start, 0.1, aolaser1, 8, 15;
MoveL p1, v200, z10, gun1;
TriggL p2, v200, ramp_up, z10, gun1;
```

The analog signal `aolaser1` will start ramping up its logical value from current value to the new value `8`, when the `TCP` of the tool `gun1` is `0,1` s before the centre of the corner path at `p1`. The whole ramp-up will be done while the robot moves `15` mm.

Example 2

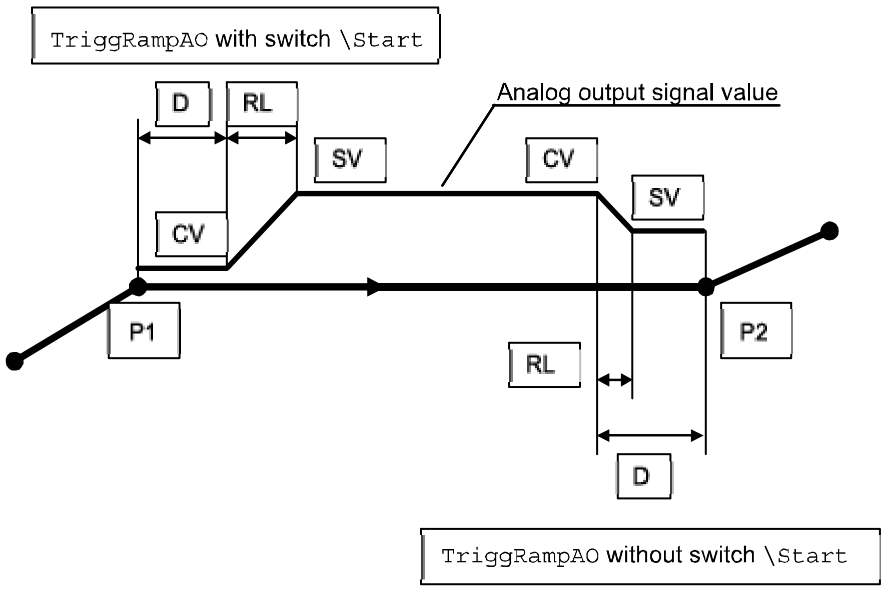
```
VAR triggdata ramp_down;
...
TriggRampAO ramp_down, 15, 0.1, aolaser1, 2, 10;
MoveL p3, v200, z10, gun1;
TriggL p4, v200, ramp_down, z10, gun1;
```

The analog signal `aolaser1` will start ramping down its logical value from current value to the new value `2`, when the `TCP` of the tool `gun1` is 15 mm plus `0,1` s before the centre of the corner path at `p4`. The whole ramp-down will be done while the robot moves `10` mm.

Continues on next page

Arguments

```
TriggRampAO TriggData Distance [\Start] EquipLag AOutput SetValue
      RampLength [\Time]
```



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D	Parameter `Distance`
RL	Parameter `RampLength`
CV	Current analog signal Value
SV	Parameter `SetValue` for the analog signal value
P1	`ToPoint` for preceding move instruction
P2	`ToPoint` for actual `TrigL/C/J` instruction

`TriggData`

Data type: `triggdata`

Variable for storing of the `triggdata` returned from this instruction. These `triggdata` can then be used in the subsequent `TriggL`, `TriggC` , `TriggJ`, `CapL`, or `CapC` instructions.

`Distance`

Data type: `num`

Defines the distance from the centre of the corner path where the ramp of the analog output shall start.

Specified as the distance in mm (positive value) from the end point (`ToPoint`) of the movement path (applicable if the argument `\Start` is not set).

See the section *Program Execution* for further details.

`[\Start]`

Data type: `switch`

Used when the distance for the argument `Distance` is related to the movement start point (preceding `ToPoint`) instead of the end point.

Continues on next page

`EquipLag`

Equipment Lag

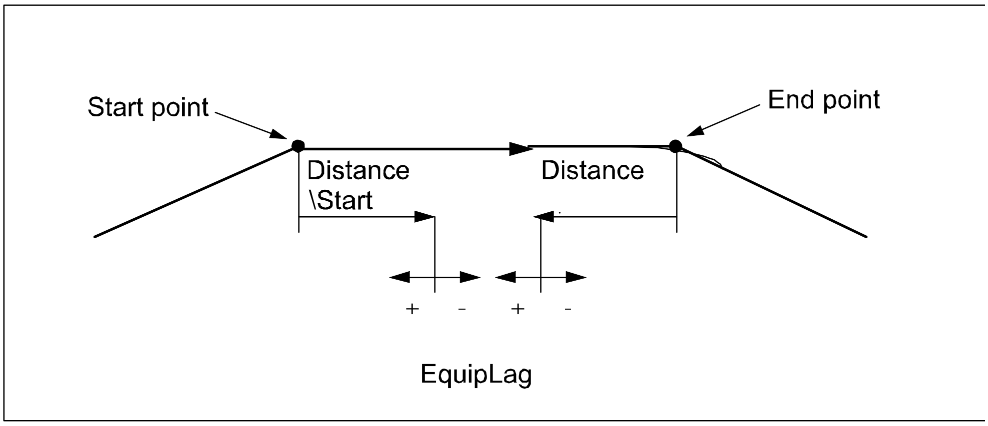
Data type: `num`

Specify the lag for the external equipment in s.

For compensation of external equipment lag, use positive argument value. Positive argument value means that the start of the ramping of the `AO` signal is done by the robot system at a specified time before the `TCP` physically reaches the specified distance point in relation to the movement start or end point.

Negative argument value means that starting the ramping of the `AO` signal is done by the robot system at a specified time. After that, the `TCP` has physically passed the specified distance point in relation to the movement start or end point.

The figure shows use of argument `EquipLag`.



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`AOutput`

Analog Output

Data type: `signalao`

The name of the analog output signal.

`SetValue`

Data type: `num`

The value to which the analog output signal should be ramped up or down to (must be within the allowed logical range value for the signal). The ramping is started with the current value of the analog output signal.

`RampLength`

Data type: `num`

The ramping length in mm along the `TCP` movement path.

`[\Time]`

Data type: `switch`

Used then the `RampLength` specifies the ramp time in s instead of ramping length.

Must be used, if subsequent `TriggL, TriggC`, or `TriggJ` specifies that the total movement should be done on time (argument `\T`) instead of speed.

Continues on next page

Program execution

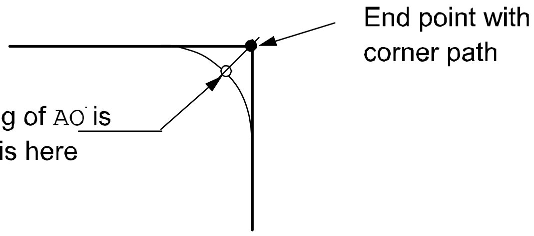
When running the instruction `TriggRampAO`, the trigger condition is stored in the specified variable for the argument `TriggData`.

Afterwards, when one of the instructions `TriggL`, `TriggC` or `TriggJ` is executed, the following are applicable with regard to the definitions in `TriggRampAO`:

The table describes the distance specified in the argument `Distance`:

Linear movement	The straight line distance
Circular movement	The circle arc length
Non-linear movement	The approximate arc length along the path (to obtain adequate accuracy, the distance should not exceed one half of the arc length).

The figure shows ramping of `AO` in a corner path.



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Program execution characteristics of `TriggRampAO` connected to any `TriggL/C/J`:

- The ramping of the `AO` is started when the robot reaches the specified `Distance` point on the robot path (with compensation for the specified `EquipLag`)
- The ramping function will be performed during a time period calculated from specified `RampLength` and the programmed `TCP` speed. The calculation takes into cosideration `VelSet`, manual speed override, and max. 250 mm/s in `MAN` mode but not any other speed limitations.
- Updating of the `AO` signal value from start (current read) value to specified `SetValue` will be done each 10 ms resulting in a staircase form. If the calculated ramp time or specified ramp time is greater than 0.5 s then the ramping frequency will slow down:
- <= 0,5s gives max. 50 step each 10 ms
- <= 1s gives max. 50 steps each 20 ms
- <= 1,5s gives max. 50 steps each 30 ms and so on

The `TriggRampAO` action is also done in `FWD` step but not in `BWD` step mode.

At any type of stop (ProgStop, Emergency Stop …) if the ramping function is active for the occasion:

- if ramping up, the `AO` is set to an old value momentarily.

- if ramping down, the `AO` is set to the new `SetValue` momentarily.

Continues on next page

More examples

More examples of how to use the instruction `TriggRampAO` are illustrated below.

Example 1

```
VAR triggdata ramp_up;
VAR triggdata ramp_down;
...
TriggRampAO ramp_up, 0 \Start, 0.1, aolaser1, 8, 15;
TriggRampAO ramp_down, 15, 0.1, aolaser1, 2, 10;
MoveL p1, v200, z10, gun1;
TriggL p2, v200, ramp_up, \T2:=ramp_down, z10, gun1;
```

In this example both the ramp-up and ramp-down of the `AO` is done in the same `TriggL` instruction on the same movement path. It works without any interference of the `AO` settings if the movement path is long enough.

The analog signal `aolaser1` will start ramping up its logical value from the current value to the new value `8` when the `TCP` of the tool `gun1` is 0,1 s before the centre of the corner path at `p1`. The whole ramp-up will be done while the robot moves `15` mm.

The analog signal `aolaser1` will start ramping down its logical value from the current value `8` to the new value `2` when the `TCP` of the tool `gun1` is 15 mm plus `0,1` s before the centre of the corner path at `p2`. The whole ramp-up will be done while the robot moves `10` mm.

Error handling

If the programmed `SetValue` argument for the specified analog output signal `AOutput` is out of limit then the system variable `ERRNO` is set to `ERR_AO_LIM`. This error can be handled in the error handler.

Limitations

The analog output signal value will not be compensated for lower `TCP`-speed in corner path or during other acceleration or deceleration phases (the `AO` is not `TCP` speed proportional).

Only the start point of the `AO` ramping will be done at the specified position on the path. The ramping up or down will be done with “dead calculation”, with high accuracy:

- At constant speed the deviation for the end of the `AO` ramping compared with the specified will be low.
- During acceleration or deceleration phases, such as near stop points, the deviation will be higher.
- Recommendation: use corner paths before ramp up and after ramp down.

If use of two or several `TriggRampAO` on the same analog output signal and connected to the same `TriggL/C/J` instrucion and both or several `RampLength` are located on the same part of the robot path then the `AO` settings will interact with each other.

The position (+/- time) related ramp `AO` event will start when the previous `ToPoint` is passed if the specified `Distance` from the actual `ToPoint` is not within the length of movement for the current `TriggL/C/J` instruction. The position (+/- time) related ramp `AO` event will start when the actual `ToPoint` is passed if the specified `Distance` from the previous `ToPoint` is not within the length of movement for the current `TriggL/C/J` instruction (with argument `\Start`).

Continues on next page

No support for restart of the ramping `AO` function after any type of stop (ProgStop, Emergency Stop …).

At Power Fail Restart the `TriggL/C/J` instruction is started from the beginning of the current Power Fail position.

Syntax

```
TriggRampAO
  [ TriggData ':=' ] < variable (VAR) of triggdata > ','
  [ Distance' :=' ] < expression (IN) of num >
  [ '\' Start ]' ,'
  [ EquipLag' :=' ] < expression (IN) of num > ','
  [ AOutput ':=' ] < variable (VAR) of signalao>' ,'
  [ SetValue ':=' ] < expression (IN) of num>' ,'
  [ RampLength ':=' ] < expression (IN) of num>' ,'
  [ '\' Time ]' ;'
```

Related information

For information about	See
Use of triggers	*TriggL - Linear robot movements with events on page 603* *TriggC - Circular robot movement with events on page 570* *TriggJ - Axis-wise robot movements with events on page 597*
Definition of other triggs	*TriggEquip - Define a fixed position and time I/O event on the path on page 582*
Storage of triggdata	*triggdata - Positioning events, trigg on page 1213*
Set of analog output signal	*SetAO - Changes the value of an analog output signal on page 431* *signalxx - Digital and analog signals on page 1181*
Configuration of event preset time	*Technical reference manual - System parameters*, section *Motion*

1.215. TriggSpeed - Defines TCP speed proportional analog output with fixed position-time scale event

Usage

`TriggSpeed` is used to define conditions and actions for control of an analog output signal with output value proportional to the actual TCP speed. The beginning, scaling, and ending of the analog output can be specified at a fixed position-time along the robot's movement path. It is possible to use time compensation for the lag in the external equipment for the beginning, scaling, and ending of the analog output and also for speed dips of the robot.

The data defined is used in one or more subsequent `TriggL`, `TriggC`, or `TriggJ` instructions.

This instruction can only be used in the main task `T_ROB1`, if in a MultiMove System, in Motion tasks.

Basic examples

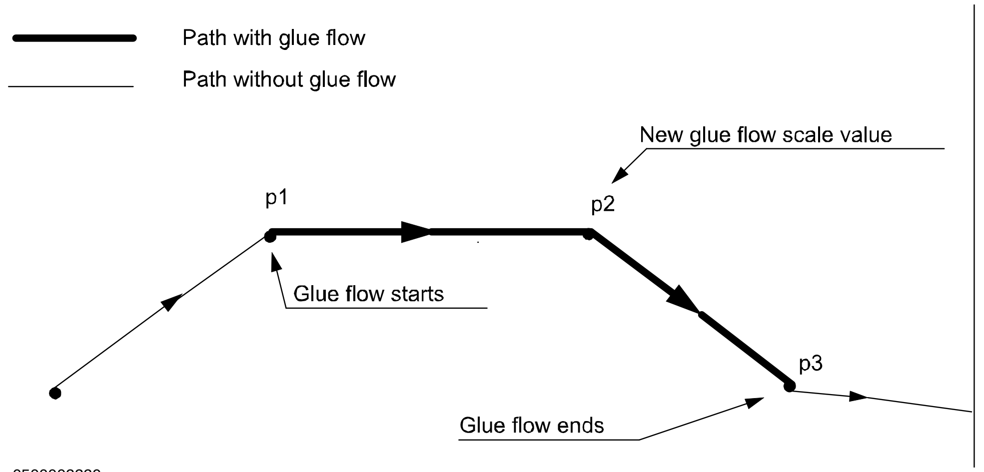
Basic examples of the instruction `TriggSpeed` are illustrated below.

See also *More examples on page 626*.

Example 1

```
VAR triggdata glueflow;
TriggSpeed glueflow, 0, 0.05, glue_ao, 0.8\DipLag=:0.04
     \ErrDO:=glue_err;
TriggL p1, v500, glueflow, z50, gun1;
TriggSpeed glueflow, 10, 0.05, glue_ao, 1;
TriggL p2, v500, glueflow, z10, gun1;
TriggSpeed glueflow, 0, 0.05, glue_ao, 0;
TriggL p3, v500, glueflow, z50, gun1;
```

The figure below illustrates an example of `TriggSpeed` sequence



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The glue flow (analog output `glue_ao`) with scale value `0.8` starts when TCP is `0.05` s before point `p1`, new glue flow scale value `1` when TCP is `10` mm plus `0.05` s before point `p2`, and the glue flow ends (scale value 0) when TCP is `0.05` s before point `p3`.

Any speed dip by the robot is time compensated in such a way that the analog output signal `glue_ao` is affected `0.04` s before the TCP speed dip occurs.

Continues on next page

If overflow of the calculated logical analog output value in `glue_ao` then the digital output signal `glue_err` is set. If there is no more overflow then `glue_err` is reset.

Arguments

```
TriggSpeed TriggData Distance [\Start] ScaleLag AOp ScaleValue
     [\DipLag] [\ErrDO] [\Inhib]
```

`TriggData`

Data type: `triggdata`

Variable for storing the `triggdata` returned from this instruction. These `triggdata` are then used in the subsequent `TriggL`, `TriggC`, or `TriggJ` instructions.

`Distance`

Data type: `num`

Defines the position on the path for change of the analog output value.

Specified as the distance in mm (positive value) from the end point of the movement path (applicable if the argument `\ Start` is not set).

See *Program execution on page 625* for further details.

`[ \Start ]`

Data type: `switch`

Used when the distance for the argument `Distance` starts at the movement's start point instead of the end point.

`ScaleLag`

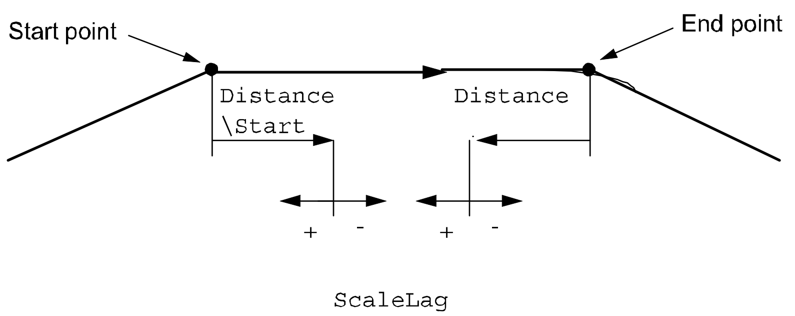
Data type: `num`

Specify the lag as time in s (positive value) in the external equipment for change of the analog output value (starting, scaling, and ending).

For compensation of external equipment lag, this argument value means that the analog output signal is set by the robot at a specified time before the TCP physically reaches the specified distance in relation to the movement's start or end point.

The argument can also be used to extend the analog output beyond the end point. Set the time in seconds that the robot shall keep the analog output. Set the time with a negative sign. The limit is -0.10 seconds.

The figure below illustrates the use of argument `ScaleLag`



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`AOp`

Analog Output

Data type: `signalao`

The name of the analog output signal.

`ScaleValue`

Data type: `num`

The scale value for the analog output signal.

The physical output value for the analog signal is calculated by the robot:

- Logical output value = Scale value * Actual TCP speed in mm/s.
- Physical output value = According definition in configuration for actual analog output signal with above Logical output value as input.

`[ \DipLag ]`

Data type: `num`

Specify the lag as time in s (positive value) for the external equipment when changing of the analog output value due to robot speed dips.

For compensation of external equipment lag, this argument value means that the analog output signal is set by the robot at a specified time before the TCP speed dip occurs.

This argument can only be used by the robot for the first `TriggSpeed` (in combination with one of `TriggL`, `TriggC`, or `TriggJ`) in a sequence of several `TriggSpeed` instructions. The first specified argument value is valid for all the following `TriggSpeed` in the sequence.

`[ \ErrDO ]`

Error Digital Output

Data type: `signaldo`

The name of the digital output signal for reporting analog value overflow.

If during movement the calculation of the logical analog output value for signal in argument `AOp` results in overflow due to overspeed then this signal is set and the physical analog output value is reduced to the maximum value. If there is no more overflow then the signal is reset.

This argument can only be used by the robot for the 1st `TriggSpeed` (in combination with one of `TriggL`, `TriggC`, or `TriggJ`) in a sequence of several `TriggSpeed` instructions. The 1st given argument value is valid for all the following `TriggSpeed` in the sequence.

`[ \Inhib ]`

Inhibit

Data type: `bool`

The name of a persistent variable flag for inhibiting the setting of the analog signal at runtime.

If this optional argument is used and the actual value of the specified flag is `TRUE` at the time for setting the analog signal then the specified signal `AOp` will be set to 0 instead of a calculated value.

This argument can only be used by the robot for the 1st `TriggSpeed` (in combination with one of `TriggL`, `TriggC`, or `TriggJ`) in a sequence of several `TriggSpeed` instructions. The 1st given argument value is valid for all the following `TriggSpeed` in the sequence.

Continues on next page

Program execution

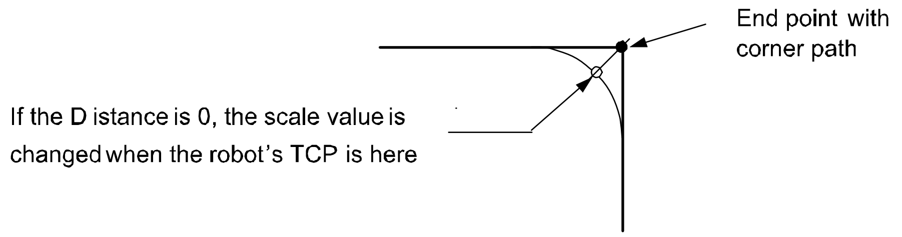
When running the instruction `TriggSpeed` the trigger condition is stored in the specified variable for the argument `TriggData`.

Afterwards, when one of the instructions `TriggL`, `TriggC`, or `TriggJ` is executed then the following are applicable with regard to the definitions in `TriggSpeed`:

For the distance specified in the argument `Distance`, see the table below.:

Linear movement	The straight line distance
Circular movement	The circle arc length
Non-linear movement	The approximate arc length along the path (to obtain adequate accuracy, the distance should not exceed one half of the arc length).

The figure below illustrates the fixed position-time scale value event on a corner path.



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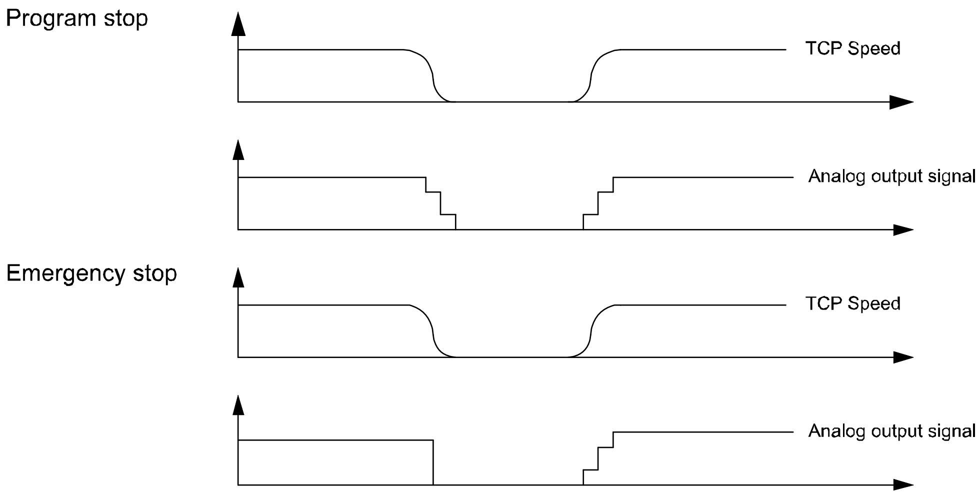
The position-time related scale value event will be generated when the start point (end point) is passed if the specified distance from the end point (start point) is not within the length of the movement of the current instruction (`TriggL`, `TriggC`, or `TriggJ`).

The 1:st `TriggSpeed` used by one of `TriggL`, `TriggC`, or `TriggJ` instruction will internally in the system create a process with the same name as the analog output signal. The same process will be used by all succeeding `TriggL`, `TriggC`, or `TriggJ` which refers to same signal name and setup by a `TriggSpeed` instruction.

The process will immediately set the analog output to 0, in the event of a program emergency stop. In the event of a program stop, the analog output signal will stay TCP-speed proportional until the robot stands still. The process keeps "alive" and ready for a restart. When the robot restarts, the signal is TCP-speed proportional directly from the start.



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The process will "die" after handling a scale event with value 0 if no succeeding `TriggL`, `TriggC`, or `TriggJ` is in the queue at the time.

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More examples

More examples of the instruction `TriggSpeed` are illustrated below.

Example 1

```
VAR triggdata flow;
TriggSpeed flow, 10 \Start, 0.05, flowsignal, 0.5 \DipLag:=0.03;
MoveJ p1, v1000, z50, tool1;
TriggL p2, v500, flow, z50, tool1;
```

The analog output signal `flowsignal` is set to a logical value = (`0.5` * actual TCP speed in mm/s) `0.05` s before the TCP passes a point located `10` mm after the start point `p`. The output value is adjusted to be proportional to the actual TCP speed during the movement to `p2`.

```
...
TriggL p3, v500, flow, z10, tool1;
```

The robot moves from `p2` to `p3` with the analog output value proportional to the actual TCP speed. The analog output value will be decreased at time `0.03` s before the robot reduces the TCP speed during the passage of the corner path `z10`.

Limitations

The limitations for the instruction `TriggSpeed` are illustrated below.

Accuracy of position-time related scale value event

Typical absolute accuracy values for scale value events ±5 ms.

Typical repeat accuracy values for scale value events ±2 ms.

Accuracy of TCP speed dips adaptation (deceleration - acceleration phases)

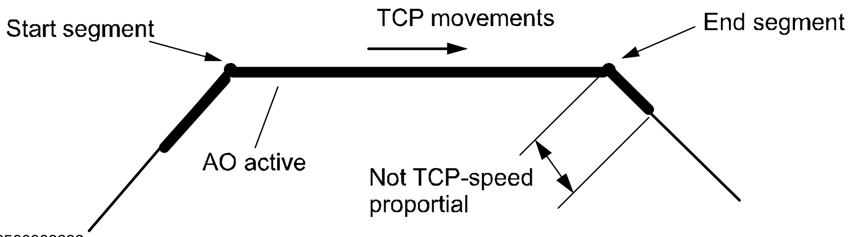
Typical absolute accuracy values for TCP speed dips adaptation ±5 ms.

Typical repeat accuracy values for TCP speed dips adaptation ±2ms (the value depends of the configured *Path resolution*).

Negative `ScaleLag`

If a negative value on parameter `ScaleLag` is used to move the zero scaling over to the next segment then the analog output signal will not be reset if a program stop occurs. An emergency stop will always reset the analog signal.

The analog signal is no longer TCP-speed proportional after the end point on the segment.



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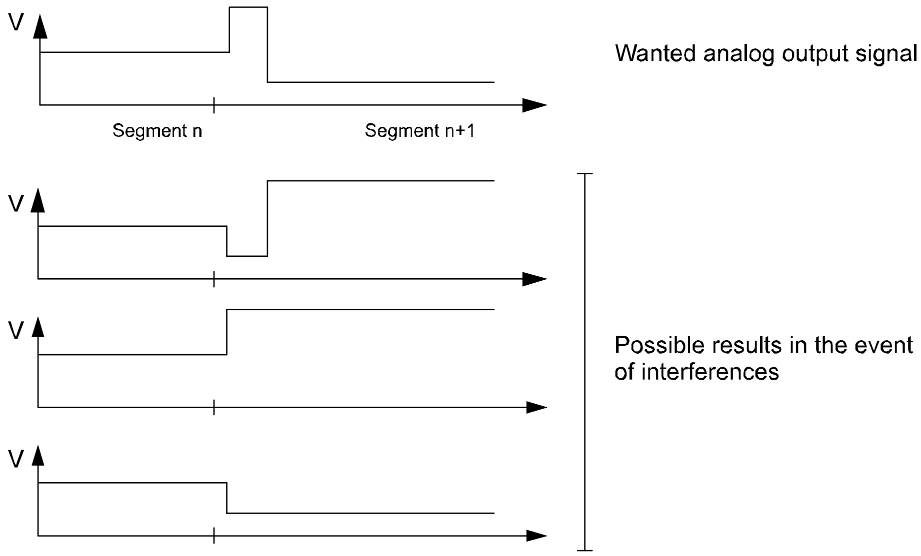
Error handling

Given two consecutive segments with `TriggL`/`TriggSpeed` instructions. A negative value in parameter `ScaleLag` makes it possible to move the scale event from the first segment to the beginning of the second segment. If the second segment scales at the beginning then there is no control if the two scales interfere.



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Related system parameters

The system parameter *Event Preset Time* is used to delay the robot to make it possible to activate/control the external equipment before the robot runs through the position.

The table below illustrates the recommendation for setup of system parameter *Event Preset Time*, where typical Servo Lag is 0.040 s..

`ScaleLag`	`DipLag`	**Required *Event Preset Time* to avoid runtime execution error**	**Recommended *Event Preset Time* to obtain best accuracy**
`ScaleLag > DipLag`	Always	`DipLag`, if `DipLag > Servo Lag`	`ScaleLag` in s plus 0.090 s
`ScaleLag < DipLag`	`DipLag < Servo Lag`	`- " -`	0.090 s
`- " -`	`DipLag >Servo Lag`	`- " -`	`DipLag` in s plus 0.030 s

Continues on next page

Syntax

```
TriggSpeed
  [ TriggData ':=' ] < variable (VAR) of triggdata>´,'
  [ Distance' :=' ] < expression (IN) of num>
  [ '\' Start ] ´,'
  [ ScaleLag':=' ] < expression (IN) of num> ´,'
  [ AOp ':='] < variable (VAR) of signalao> ´,'
  [ ScaleValue' :=' ] < expression (IN) of num>
  [ '\' DipLag' :=' < expression (IN) of num> ]
  [ '\' ErrDO' :=' < variable (VAR ) of signaldo> ]
  [ '\' Inhib' :=' < persistent (PERS ) of bool >] ´;'
```

Related information

For information about	See
Use of triggers	*TriggL - Linear robot movements with events on page 603* *TriggC - Circular robot movement with events on page 570* *TriggJ - Axis-wise robot movements with events on page 597*
Definition of other triggs	*TriggIO - Define a fixed position or time I/O event near a stop point on page 592* *TriggInt - Defines a position related interrupt on page 588* *TriggEquip - Define a fixed position and time I/O event on the path on page 582*
Storage of triggs	*triggdata - Positioning events, trigg on page 1213*
Configuration of Event preset time	*Technical reference manual - System parameters*, section *Motion - Motion Planner - Event Preset Time*

1.216. TriggStopProc - Generate restart data for trigg signals at stop

Usage

The instruction `TriggStopProc` creates an internal supervision process in the system for zero setting of specified process signals and the generation of restart data in a specified persistent variable at every program stop (`STOP`) or emergency stop (`QSTOP`) in the system.

`TriggStopProc` and the data type `restartdata` are intended to be used for restart after program stop (`STOP`) or emergency stop (`QSTOP`) of own process instructions defined in RAPID (`NOSTEPIN` routines).

It is possible in a user defined `RESTART` event routine to analyze the current restart data, step backwards on the path with instruction `StepBwdPath`, and activate suitable process signals before the movement restarts.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in any motion tasks.

Note for MultiMove system that only one `TriggStopProc` support process with the specified shadow signal name (argument `ShadowDO`) can be active in the system at the same time. It means that `TriggStopProc` supervises program stop or emergency stop in the program task where it was last executed.

Arguments

```
TriggStopProc RestartRef [\DO] [\GO1] [\GO2] [\GO3] [\GO4]
     ShadowDO
```

`RestartRef`

Restart Reference

Data type: `restartdata`

The persistent variable in which restart data will be available after every stop of program execution.

`[\DO1]`

Digital Output 1

Data type: `signaldo`

The signal variable for a digital process signal to be set to zero and supervised in restart data when program execution is stopped.

`[\GO1]`

Group Output 1

Data type: `signalgo`

The signal variable for a digital group process signal to be set to zero and supervised in restart data when program execution is stopped.

`[\GO2]`

Group Output 2

Data type: `signalgo`

The signal variable for a digital group process signal to be set to zero and supervised in restart data when program execution is stopped.

Continues on next page

`[\GO3]`

Group Output 3

Data type: `signalgo`

The signal variable for a digital group process signal to be set to zero and supervised in restart data when program execution is stopped.

`[\GO4]`

Group Output 4

Data type: `signalgo`

The signal variable for a digital group process signal to be set to zero and supervised in restart data when program execution is stopped.

At least one of the option parameters `D01, GO1 ... GO4` must be used.

`ShadowDO`

Shadow Digital Output

Data type: `signaldo`

The signal variable for the digital signal, which must mirror whether or not the process is active along the robot path.

This signal will not be set to zero by the process `TriggStopProc` at `STOP` or `QSTOP`, but its values will be mirrored in `restartdata`.

Program execution

Setup and execution of `TriggStopProc`

`TriggStopProc` must be called from both:

- the `START` event routine or in the unit part of the program (set `PP` to main, kill the internal process for `TriggStopProc`)
- the `POWERON` event routine (power off, kill the internal process for `TriggStopProc`)

The internal name of the process for `TriggStopProc` is the same as the signal name in the argument `ShadowDO`. If `TriggStopProc,` with the same signal name in argument `ShadowDO`, is executed twice from the same or another program task then only the last executed `TriggStopProc` will be active.

Execution of `TriggStopProc` only starts the supervision of I/O signals at `STOP` and `QSTOP`.

Program stop `STOP`

The process `TriggStopProc` comprises the following steps:

- Wait until the robot stands still on the path.
- Store the current value (prevalue according to `restartdata`) of all used process signals. Zero sets all used process signals except `ShadowDO`.
- Do the following during the next time slot, about 500 ms: - If some process signals change their value during this time: - Store the current value again (postvalue according to `restatdata`) - Set that signal to zero except `ShadowDO` - Count the number of value transitions (flanks) of the signal `ShadowDO`
- Update the specified persistent variable with restart data.

Continues on next page

Emergency stop (QSTOP)

The process `TriggStopProc` comprises the following steps:

- Do the next step as soon as possible.
- Store the current value (prevalue according to `restartdata`) of all used process signals. Set to zero all used process signals except `ShadowDO`.
- Do the following during the next time slot, about 500 ms: - If some process signal changes its value during this time: - Store its current value again (postvalue according to `restatdata`) - Set to zero that signal except `ShadowDO` - Count the number of value transitions (flanks) of the signal `ShadowDO`
- Update the specified persistent variable with restart data.

Critical area for process restart

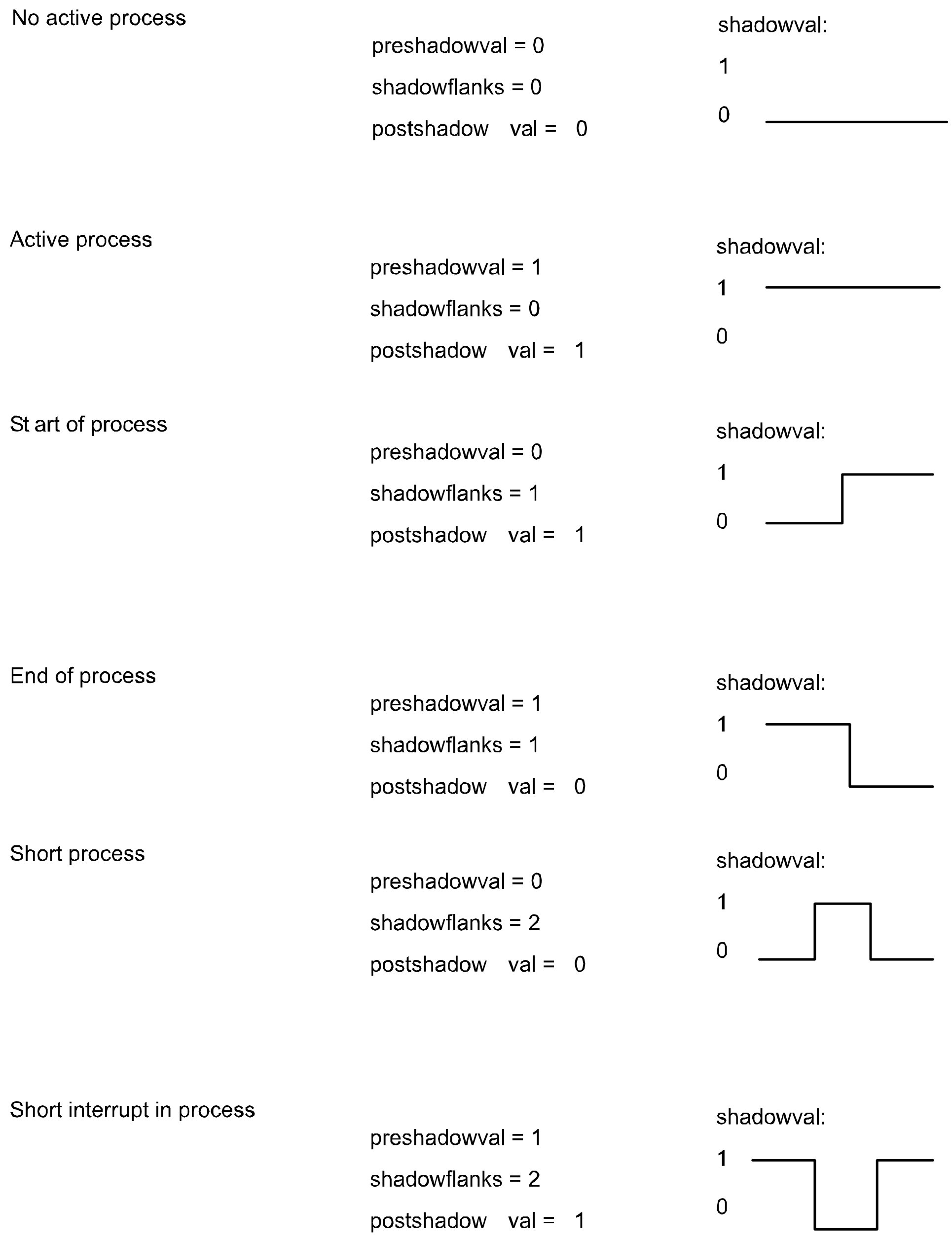
Both the robot servo and the external equipment have some lags. All the instructions in the `Trigg` family are designed so that all signals will be set at suitable places on the robot path, independently of different lags in external equipment, to obtain process results that are as good as possible. Because of this, the settings of I/O signals can be delayed between 0 - 80 ms internally in the system after the robot stands still at program stop (`STOP`) or after registration of an emergency stop (`QSTOP`). Because of this disadvantage for the restart functionality, both the prevalue, postvalue, and the shadow flanks are introduced in restart data.

If this critical timeslot of 0 - 80 ms coincides with the following application process cases then it is difficult to perform a good process restart:

- At the start of the application process
- At the end of the application process
- During a short application process
- During a short interrupt in the application process

Continues on next page

The figure below illustrates process phases at `STOP` or `QSTOP` within critical time slot 0-80 ms



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Performing a restart

A restart of process instructions (`NOSTEPIN` routines) along the robot path must be done in a `RESTART` event routine.

The `RESTART` event routine can consist of the following steps:

	Action
1.	After `QSTOP` the regain to path is done at program start.
2.	Analyze the restart data from the latest `STOP` or `QSTOP`.

Continues on next page

	Action
3.	Determine the strategy for process restart from the result of the analysis such as: - Process active, do process restart - Process inactive, do not process restart - Do suitable actions depending on type of process application: • Start of process • End of process • Short process • Short interrupt in process
4.	Step backwards on the path.
5.	Continue the program results in movement restart.

If waiting in any `STOP` or `QSTOP` event routine until the `TriggStopProc` process is ready with e.g. `WaitUntil (myproc.restartstop=TRUE), \MaxTime:=2;`, the user must always reset the flag in the `RESTART` event routine with e.g. `myproc.restartstop:=FALSE`. After that the restart is ready.

Error handling

If there is no contact with the I/O unit, the system variable `ERRNO` is set to `ERR_NORUNUNIT` and the execution continues in the error handler.

Limitation

No support for restart of process instructions after a power failure.

Syntax

```
TriggStopProc
  [ RestartRef ':=' ] < persistent (PERS) of restartdata>
  [ '\' DO1':=' < variable (VAR) of signaldo>
  [ '\' GO1':=' < variable (VAR) of signalgo> ]
  [ '\' GO2':=' < variable (VAR) of signalgo> ]
  [ '\' GO3':=' < variable (VAR) of signalgo> ]
  [ '\' GO4':=' < variable (VAR) of signalgo> ] ','
  [ ShadowDO':=' ] < variable (VAR) of signaldo> ';'
```


Related information

For information about	See
Process instructions	*TriggL - Linear robot movements with events on page 603* *TriggC - Circular robot movement with events on page 570*
Restart data	*restartdata - Restart data for trigg signals on page 1167*
Step backward on path	*StepBwdPath - Move backwards one step on path on page 499*

1.217. TryInt - Test if data object is a valid integer

Usage

`TryInt` is used to test if a given data object is a valid integer.

Basic examples

Basic examples of the instruction `TryInt` are illustrated below.

Example 1

```
VAR num myint := 4;
...
TryInt myint;
```

The value of `myint` will be evaluated and since `4` is a valid integer, the program execution continues.

Example 2

```
VAR dnum mydnum := 20000000;
...
TryInt mydnum;
```

The value of `mydnum` will be evaluated and since `20000000` is a valid dnum integer, the program execution continues.

Example 3

```
VAR num myint := 5.2;
...
TryInt myint;
...
ERROR
  IF ERRNO = ERR_INT_NOTVAL THEN
    myint := Round(myint);
    RETRY;
  ENDIF
```

The value of `myint` will be evaluated and since `5.2` is not a valid integer, an error will be raised. In the error handler, `myint` will be rounded to 5 and the instruction `TryInt` is executed one more time.

Arguments

```
TryInt DataObj | DataObj2
```

`DataObj`

Data Object

Data type: `num`

The data object to test if it is a valid integer.

`DataObj2`

Data Object 2

Data type: `dnum`

The data object to test if it is a valid integer.

Continues on next page

Program execution

The given data object is tested:

- If it is a valid integer, the execution continues with the next instruction.
- If it is not a valid integer, the execution continues in the error handler in an actual procedure.

Error handling

If `DataObj` contains a decimal value then the variable `ERRNO` will be set to `ERR_INT_NOTVAL`.

If the value of `DataObj` is larger or smaller then the integer value range of data type `num` then the variable `ERRNO` will be set to `ERR_INT_MAXVAL`.

If the value of `DataObj2` is larger or smaller then the integer value range of data type `dnum` then the variable `ERRNO` will be set to `ERR_INT_MAXVAL`.

These errors can be handled in the error handler.

Note that a value of `3.0` is evaluated as an integer, since `.0` can be ignored.

Syntax

```
TryInt
  [ DataObj ':=' ] < expression (IN) of num>
  | [ DataObj2 ':=' ] < expression (IN) of dnum>' ;'
```

Related information

For information about	See
Data type num	*num - Numeric values on page 1146*

1.218. TRYNEXT - Jumps over an instruction which has caused an error

Usage

The TRYNEXT instruction is used to resume execution after an error, starting with the instruction following the instruction that caused the error.

Basic examples

Basic examples of the instruction `TryNext` are illustrated below.

Example 1

```
reg2 := reg3/reg4;
...
ERROR
  IF ERRNO = ERR_DIVZERO THEN
     reg2:=0;
     TRYNEXT;
  ENDIF
```

An attempt is made to divide `reg3` by `reg4`. If `reg4` is equal to `0` (division by zero) then a jump is made to the error handler where `reg2` is assigned to `0`. The `TRYNEXT` instruction is then used to continue with the next instruction.

Program execution

Program execution continues with the instruction subsequent to the instruction that caused the error.

Limitations

The instruction can only exist in a routine's error handler.

Syntax

```
TRYNEXT';'
```

Related information

For information about	See
Error handlers	*Technical reference manual - RAPID overview*, section *Basic Characteristics- Error Recovery*

1.219. TuneReset - Resetting servo tuning

Usage

`TuneReset` is used to reset the dynamic behavior of all robot axes and external mechanical units to their normal values.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `TuneReset` are illustrated below.

Example 1

```
TuneReset;
```

Resetting tuning values for all axes to 100%.

Program execution

The tuning values for all axes are reset to 100%.

The default servo tuning values for all axes are automatically set by executing instruction `TuneReset`

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

Syntax

```
TuneReset ';'
```

Related information

For information about	See
Tuning servos	*TuneServo - Tuning servos on page 638*

1.220. TuneServo - Tuning servos

Usage

`TuneServo` is used to tune the dynamic behavior of separate axes on the robot. It is not necessary to use `TuneServo` under normal circumstances, but sometimes tuning can be optimized depending on the robot configuration and the load characteristics. For external axes `TuneServo` can be used for load adaptation.

Avoid doing `TuneServo` commands at the same time that the robot is moving. It can result in momentary high CPU loads causing error indication and stops.

Note! To obtain optimal tuning it is essential that the correct load data is used. Check this before using `TuneServo`.

Generally, optimal tuning values often differ between different robots. Optimal tuning may also change with time.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

WARNING!

Incorrect use of the `TuneServo` can cause oscillating movements or torques that can damage the robot. You must bear this in mind and be careful when using the `TuneServo`.

Improving path accuracy

For robots running at lower speeds, `TuneServo` can be used to improve the path accuracy by:

- Tuning `TUNE_KV` and `TUNE_TI` (see the tune types description below).
- Tuning friction compensation parameters (see below).

These two methods can be combined.

Other possibilities to improve the path accuracy:

- Decreasing path resolution can improve the path. Note: a value of path resolution which is too low will cause CPU load problems.
- The accuracy of straight lines can be improved by decreasing acceleration using `AccSet`. Example: `AccSet 20, 10`.

Continues on next page

Description

Reduce overshoots - `TUNE_DF`

`TUNE_DF` is used for reducing overshoots or oscillations along the path.

There is always an optimum tuning value that can vary depending on position and movement length. This optimum value can be found by changing the tuning in small steps (1 - 2%) on the axes that are involved in this unwanted behavior. Normally the optimal tuning will be found in the range 70% - 130%. Too low or too high tuning values have a negative effect and will impair movements considerably.

When the tuning value at the start point of a long movement differs considerably from the tuning value at the end point, it can be advantageous in some cases to use an intermediate point with a corner zone to define where the tuning value will change.

Some examples of the use of `TuneServo` to optimize tuning follow below:

- IRB 6400, in a press service application (extended and flexible load), **axes 4 - 6**: Reduce the tuning value for the current wrist axis until the movement is acceptable. A change in the movement will not be noticeable until the optimum value is approached. A low value will impair the movement considerably. Typical tuning value is 25%.
- IRB 6400, upper parts of working area. Axis 1 can often be optimized with a tuning value of 85% - 95%.
- IRB 6400, short movement (< 80 mm). Axis 1 can often be optimized with a tuning value of 94% - 98%.
- IRB 2400, with track motion. In some cases axes 2 - 3 can be optimized with a tuning value of 110% - 130%. The movement along the track can require a different tuning value compared with movement at right angles to the track.
- Overshoots and oscillations can be reduced by decreasing the acceleration or the acceleration ramp (`AccSet`), which will however increase the cycle time. This is an alternative method to the use of `TuneServo`.

Reduce overshoots - `TUNE_DG`

`TUNE_DG` can reduce overshoots on rare occasions. Normally it should not be used.

`TUNE_DF` should always be tried first in cases of overshooting.

Tuning of `TUNE_DG` can be performed with large steps in tune value (e.g. 50%, 100%, 200%, 400%).

Never use `TUNE_DG` when the robot is moving.

Continues on next page

Reduces vibrations with heavy loads - `TUNE_DH`

`TUNE_DH` can be used for reducing vibrations and overshooting (e.g. large flexible load).

Tune value must always be lower than 100. `TUNE_DH` increases path deviation and normally also increases cycle time.

Example:

- IRB6400 with large flexible loads which vibrates when the robot has stopped. Use `TUNE_DH` with tune value 15.

`TUNE_DH` should only be executed for one axis. All axes in the same mechanical unit automatically get the same `TuneValue`.

Never use `TUNE_DH` when the robot is moving.

Reduce path errors - `TUNE_DI`

`TUNE_DI` can be used for reducing path deviation at high speeds.

A tune value in the range 50 - 80 is recommended for reducing path deviation. Overshooting can increase (lower tune value means larger overshoot).

A higher tune value than 100 can reduce overshooting (but increases path deviation at high speed).

`TUNE_DI` should only be executed for one axis. All axes in the same mechanical unit automatically get the same `TuneValue`.

Only for ABB internal use - `TUNE_DK, TUNE_DL`

WARNING!

Only for ABB internal use. Do not use these tune types. Incorrect use can cause oscillating movements or torques that can damage the robot.

Tuning external axes - `TUNE_KP`, `TUNE_KV`, `TUNE_TI`

These tune types affect position control gain (kp), speed control gain (kv), and speed control integration time (ti) for external axes. These are used for adapting external axes to different load inertias. Basic tuning of external axes can also be simplified by using these tune types.

Tuning robot axes - `TUNE_KP`, `TUNE_KV`, `TUNE_TI`

For robot axes, these tune types have another significance and can be used for reducing path errors at low speeds (< 500 mm/s).

Recommended values: `TUNE_KV` 100 - 180%, `TUNE_TI` 50 - 100%. `TUNE_KP` should not be used for robot axes. Values of `TUNE_KV/TUNE_TI` which are too high or too low will cause vibrations or oscillations. Be careful if trying to exceed these recommended values. Make changes in small steps and avoid oscillating motors.

Always tune one axis at a time. Change the tuning values in small steps. Try to improve the path where this specific axis changes its direction of movement or where it accelerates or decelerates.

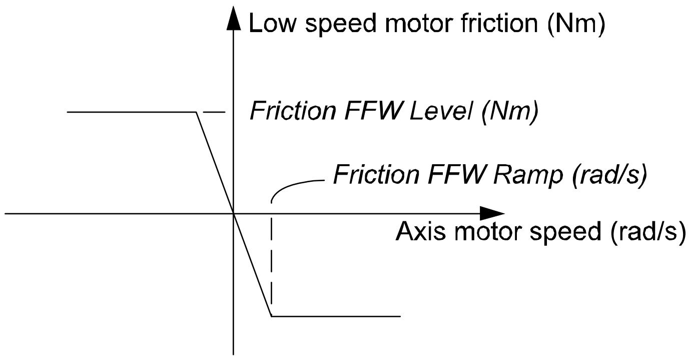
Never use these tune types at high speeds or when the required path accuracy is fulfilled.

Continues on next page

Friction compensation - TUNE_FRIC_LEV, TUNE_FRIC_RAMP

These tune types can be used to reduce robot path errors caused by friction and backlash at low speeds (10 - 200 mm/s). These path errors appear when a robot axis changes direction of movement. Activate friction compensation for an axis by setting the system parameter Motion/Control Parameters/Friction FFW On to Yes.

The friction model is a constant level with opposite sign of the axis speed direction. *Friction FFW Level (Nm)* is the absolute friction level at (low) speeds and is greater than *Friction FFW Ramp (rad/s)*. See the figure below, which shows a friction model.



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TUNE_FRIC_LEV overrides the value of the system parameter *Friction FFW Level*.

Tuning *Friction FFW Level* (using TUNE_FRIC_LEV) for each robot axis can improve the robot's path accuracy considerably in the speed range 20 - 100 mm/s. For larger robots (especially the IRB6400 family) the effect will, however, be minimal as other sources of tracking errors dominate these robots.

TUNE_FRIC_RAMP overrides the value of the system parameter *Friction FFW Ramp*. In most cases there is no need to tune the *Friction FFW Ramp*. The default setting will be appropriate.

Tune one axis at a time. Change the tuning value in small steps and find the level that minimizes the robot path error at positions on the path where this specific axis changes direction of movement. Repeat the same procedure for the next axis etc.

The final tuning values can be transferred to the system parameters. Example:

Friction FFW Level = 1. Final tune value (TUNE_FRIC_LEV) = 150%.

Set Friction FFW Level = 1.5 and tune value = 100% (default value) which is equivalent.

Arguments

```
TuneServo MecUnit Axis TuneValue [\Type]
```

MecUnit

Mechanical Unit

Data type: mecunit

The name of the mechanical unit.

Axis

Data type: num

The number of the current axis for the mechanical unit (1 - 6).

Continues on next page

`TuneValue`

Data type: `num`

Tuning value in percent (1 - 500). 100% is the normal value.

`[ \Type ]`

Data type: `tunetype`

Type of servo tuning. Available types are `TUNE_DF`, `TUNE_KP`, `TUNE_KV`, `TUNE_TI`, `TUNE_FRIC_LEV`, `TUNE_FRIC_RAMP`, `TUNE_DG`, `TUNE_DH`, `TUNE_DI`. Type `TUNE_DK` and `TUNE_DL` only for ABB internal use.

This argument can be omitted when using tuning type `TUNE_DF`.

Basic examples

Basic examples of the instruction `TuneServo` are illustrated below.

Example 1

```
TuneServo MHA160R1, 1, 110 \Type:= TUNE_KP;
```

Activating of tuning type `TUNE_KP` with the tuning value `110`% on axis `1` in the mechanical unit `MHA160R1`.

Program execution

The specified tuning type and tuning value are activated for the specified axis. This value is applicable for all movements until a new value is programmed for the current axis, or until the tuning types and values for all axes are reset using the instruction `TuneReset`.

The default servo tuning values for all axes are automatically set by executing instruction `TuneReset`

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

Limitations

Any active servo tuning are always set to default values at power fail.

This limitation can be handled in the user program at restart after power failure.

Syntax

```
TuneServo
  [MecUnit ':=' ] < variable (VAR) of mecunit>' ,'
  [Axis ':=' ] < expression (IN) of num> ','
  [TuneValue' :=' ] < expression (IN) of num>
  ['\' Type' :=' <expression (IN) of tunetype>]';'
```


Continues on next page

Related information

For information about	See
Other motion settings	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion settings*
Types of servo tuning	*tunetype - Servo tune type on page 1222*
Reset of all servo tunings	*TuneReset - Resetting servo tuning on page 637*
Tuning of external axes	*Application manual - Additional axes and stand alone controller*
Friction compensation	*Technical reference manual - System parameters*, section *Motion - Friction Compensation*

1.221. UIMsgBox - User Message Dialog Box type basic

Usage

`UIMsgBox` (*User Interaction Message Box*) is used to communicate with the user of the robot system on available user device, such as the FlexPendant. A message is written to the operator, who answers by selecting a button. The user selection is then transferred back to the program.

Basic examples

Basic examples of the instruction `UIMsgBox` are illustrated below.

See also *More examples on page 648*.

Example 1

```
UIMsgBox Continue the program ?;
```

The message `"Continue the program ?"` is displayed. The program proceeds when the user presses the default button OK.

Example 2

```
VAR btnres answer;
...
UIMsgBox
  \Header:="UIMsgBox Header",
  "Message Line 1"
  \MsgLine2:="Message Line 2"
  \MsgLine3:="Message Line 3"
  \MsgLine4:="Message Line 4"
  \MsgLine5:="Message Line 5"
  \Buttons:=btnOKCancel
  \Icon:=iconInfo
  \Result:=answer;
IF answer = resOK my_proc;
```


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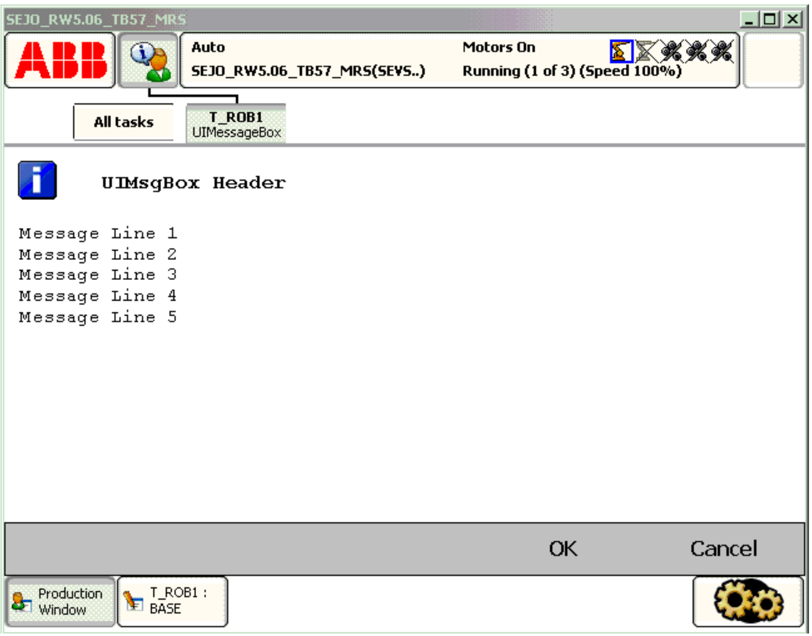

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Above message box with icon, header, message line 1 to 5, and push buttons is written on the FlexPendant display. Program execution waits until OK or Cancel is pressed. In other words, `answer` will be assigned 1 (OK) or 5 (Cancel) depending on which of the buttons is pressed. If answer is OK then `my_proc` will be called.

Note that Message Line 1 ... Message Line 5 are displayed on separate lines 1 to 5 (the switch `\Wrap` is not used).

Arguments

```
UIMsgBox [\Header] MsgLine1 [\MsgLine2] [\MsgLine3] [\MsgLine4]
      [\MsgLine5] [\Wrap] [\Buttons] [\Icon] [\Image] [\Result]
      [\MaxTime] [\DIBreak] [\DOBreak] [\BreakFlag]
```

`[\Header]`

Data type: `string`

Header text to be written at the top of the message box. Max. 40 characters.

`MsgLine1`

Message Line 1

Data type: `string`

Text line 1 to be written on the display. Max. 55 characters.

`[\MsgLine2]`

Message Line 2

Data type: `string`

Additional text line 2 to be written on the display. Max. 55 characters.

`[\MsgLine3]`

Message Line 3

Data type: `string`

Additional text line 3 to be written on the display. Max. 55 characters.

Continues on next page

`[\MsgLine4]`

Message Line 4

Data type: `string`

Additional text line 4 to be written on the display. Max. 55 characters.

`[\MsgLine5]`

Message Line 5

Data type: `string`

Additional text line 5 to be written on the display. Max. 55 characters.

`[\Wrap]`

Data type: *switch*

If selected, all the strings `MsgLine1 ... MsgLine5` will be concatenated to one string with a single space between each individual string and spread out on as few lines as possible.

Default, each message string *MsgLine1* ... *MsgLine5* will be on separate lines on the display.

`[\Buttons]`

Data type: `buttondata`

Defines the push buttons to be displayed. Only one of the predefined buttons combination of type `buttondata` can be used. See *Predefined data on page 648*.

Default, the system displays the OK button. (`\Buttons:=btn OK`).

`[\Icon]`

Data type: `icondata`

Defines the icon to be displayed. Only one of the predefined icons of type `icondata` can be used. See *Predefined data on page 648*.

Default no icon.

`[\Image]`

Data type: `string`

The name of the image that should be used. To launch your own images, the images have to be placed in the `HOME:` directory in the active system or directly in the active system.

The recommendation is to place the files in the `HOME:` directory so that they are saved if a Backup and Restore is done.

A warmstart is required and then the FlexPendant will load the images.

A demand on the system is that the RobotWare option *FlexPendant Interface* is used.

The image that will be showed can have the width of 185 pixels and the height of 300 pixels. If the image is bigger, only 185 * 300 pixels of the image will be shown starting at the top left of the image.

No exact value can be specified on the size that an image can have or the amount of images that can be loaded to the FlexPendant. It depends on the size of other files loaded to the FlexPendant. The program execution will just continue if an image is used that has not been loaded to the FlexPendant.

Continues on next page

`[\Result]`

Data type: `btnres`

The variable for which, depending on which button is pressed, the numeric value 0..7 is returned. Only one of the predefined constants of type `btnres` can be used to test the user selection. See *Predefined data on page 648*.

If any type of system break such as `\MaxTime`, `\DIBreak`, or `\DOBreak` or if `\Buttons:=btnNone, resUnkwn` equal to 0 is returned.

`[\MaxTime]`

Data type: `num`

The maximum amount of time in seconds that program execution waits. If no button is selected within this time then the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_MAXTIME` can be used to test whether or not the maximum time has elapsed.

`[\DIBreak]`

Digital Input Break

Data type: `signaldi`

The digital input signal that may interrupt the operator dialog. If no button is selected when the signal is set to 1 (or is already 1), the program continues to execute in the error handler, unless the `BreakFlag` is used (see below). The constant `ERR_TP_DIBREAK` can be used to test whether or not this has occurred.

`[\DOBreak]`

Digital Output Break

Data type: `signaldo`

The digital output signal that may interrupt the operator dialog. If no button is selected when the signal is set to 1 (or is already 1) then the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_DOBREAK` can be used to test whether or not this has occurred.

`[\BreakFlag]`

Data type: `errnum`

A variable (before used it is set to 0 by the system) that will hold the error code if `\MaxTime`, `\DIBreak`, or `\DOBreak` is used. The constants `ERR_TP_MAXTIME`, `ERR_TP_DIBREAK`, and `ERR_TP_DOBREAK` can be used to select the reason. If this optional variable is omitted then the error handler will be executed.

Program execution

The message box with icon, header, message lines, image, and buttons are displayed according to the programmed arguments. Program execution waits until the user selects one button or the message box is interrupted by time-out or signal action. The user selection and interrupt reason are transferred back to the program.

New message box on TRAP level takes the focus from the message box on the basic level.

Continues on next page

Predefined data

```
!Icons:
  CONST icondata iconNone := 0;
  CONST icondata iconInfo := 1;
  CONST icondata iconWarning := 2;
  CONST icondata iconError := 3;

!Buttons:
  CONST buttondata btnNone := -1;
  CONST buttondata btnOK := 0;
  CONST buttondata btnAbrtRtryIgn := 1;
  CONST buttondata btnOKCancel := 2;
  CONST buttondata btnRetryCancel := 3;
  CONST buttondata btnYesNo := 4;
  CONST buttondata btnYesNoCancel := 5;

!Results:
  CONST btnres resUnkwn := 0;
  CONST btnres resOK := 1;
  CONST btnres resAbort := 2;
  CONST btnres resRetry := 3;
  CONST btnres resIgnore := 4;
  CONST btnres resCancel := 5;
  CONST btnres resYes := 6;
  CONST btnres resNo := 7;
```

More examples

More examples of how to use the instruction `UIMsgBox` are illustrated below.

Example 1

```
VAR errnum err_var;
...
UIMsgBox \Header:= "Example 1", "Waiting for a break condition..."
      \Buttons:=btnNone \Icon:=iconInfo \MaxTime:=60 \DIBreak:=di5
      \BreakFlag:=err_var;

TEST err_var
CASE ERR_TP_MAXTIME:
  ! Time out break, max time 60 seconds has elapsed
CASE ERR_TP_DIBREAK:
  ! Input signal break, signal di5 has been set to 1
DEFAULT:
  ! Not such case defined
ENDTEST
```

The message box is displayed until a break condition has become true. The operator can not answer or remove the message box because `btnNone` is set for the argument `\Buttons`. The message box is removed when `di5` is set to 1 or at time out (after `60` seconds).

Continues on next page

Error handling

If parameter `\BreakFlag` is not used then these situations can then be dealt with by the error handler:

- If there is a time-out (parameter `\MaxTime`) before an input from the operator then the system variable `ERRNO` is set to `ERR_TP_MAXTIME` and the execution continues in the error handler.
- If digital input is set (parameter `\DIBreak`) before an input from the operator then the system variable `ERRNO` is set to `ERR_TP_DIBREAK` and the execution continues in the error handler.
- If a digital output is set (parameter `\DOBreak`) before an input from the operator then the system variable `ERRNO` is set to `ERR_TP_DOBREAK` and the execution continues in the error handler.

This situation can only be dealt with by the error handler:

- If there is no client, e.g. a FlexPendant, to take care of the instruction then the system variable `ERRNO` is set to `ERR_TP_NO_CLIENT` and the execution continues in the error handler.

Limitations

Avoid using too small of a value for the time-out parameter `\MaxTime` when `UIMsgBox` is frequently executed, like in a loop. It can result in an unpredictable behavior of the system performance, like slow response of the FlexPendant.

Syntax

```
UIMsgBox
  [´\´Header´:=´ <expression (IN) of string>´,´]
  [MsgLine1´:=´] <expression (IN) of string>
  [´\´MsgLine2´:=´<expression (IN) of string>]
  [´\´MsgLine3´:=´<expression (IN) of string>]
  [´\´MsgLine4´:=´<expression (IN) of string>]
  [´\´MsgLine5´:=´<expression (IN) of string>]
  [´\´Wrap]
  [´\´Buttons´:=´ <expression (IN) of buttondata>]
  [´\´Icon´:=´ <expression (IN) of icondata>]
  [‘\’Image´:=´<expression (IN) of string>]
  [´\´Result´:=´< var or pers (INOUT) of btnres>]
  [´\´MaxTime´:=´ <expression (IN) of num>]
  [´\´DIBreak´:=´ <variable (VAR) of signaldi>]
  [´\´DOBreak´:=´ <variable (VAR) of signaldo>]
  [´\´BreakFlag´:=´ <var or pers (INOUT) of errnum>]´;´
```


Continues on next page

Related information

For information about	See
Icon display data	*icondata - Icon display data on page 1121*
Push button data	*buttondata - Push button data on page 1089*
Push button result data	*btnres - Push button result data on page 1086*
User Interaction Message Box type advanced	*UIMessageBox - User Message Box type advanced on page 1057*
User Interaction Number Entry	*UINumEntry - User Number Entry on page 1064*
User Interaction Number Tune	*UINumTune - User Number Tune on page 1070*
User Interaction Alpha Entry	*UIAlphaEntry - User Alpha Entry on page 1032*
User Interaction List View	*UIListView - User List View on page 1050*
System connected to FlexPendant etc.	*UIClientExist - Exist User Client on page 1037*
FlexPendant interface	*Product Specification - Controller Software IRC5, RobotWare 5.0*, section *Communication - FlexPendant Interface*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

1.222. UIShow - User Interface show

Usage

`UIShow` (*User Interface Show*) is used to communicate with the user of the robot system on the available User Device such as the FlexPendant. With `UIShow` both individually written applications and standard applications can be launched from a RAPID program.

Basic examples

Basic examples of the instruction `UIShow` are illustrated below.

Example 1 and example 2 only works if the files `TpsViewMyAppl.dll` and `TpsViewMyAppl.gtpu.dll` is present in the `HOME:` directory, and a warmstart has been performed.

Example 1

```
CONST string Name:="TpsViewMyAppl.gtpu.dll";
CONST string Type:="ABB.Robotics.SDK.Views.TpsViewMyAppl";
CONST string Cmd1:="Init data string passed to the view";
CONST string Cmd2:="New init data string passed to the view";
PERS uishownum myinstance:=0;
VAR num mystatus:=0;
...
! Launch one view of my application MyAppl
UIShow Name, Type \InitCmd:=Cmd1 \InstanceID:=myinstance
     \Status:=mystatus;
! Update the view with new init command
UIShow Name, Type \InitCmd:=Cmd2 \InstanceID:=myinstance
     \Status:=mystatus;
```

The code above will launch the view `TpsViewMyAppl` with init command `Cmd1`, and then update the view with `Cmd2`.

Example 2

```
CONST string Name:="TpsViewMyAppl.gtpu.dll";
CONST string Type:="ABB.Robotics.SDK.Views.TpsViewMyAppl";
CONST string Cmd1:="Init data string passed to the view";
CONST string Cmd2:="New init data string passed to the view";
PERS uishownum myinstance:=0;
VAR num mystatus:=0;
...
! Launch one view of my application MyAppl
UIShow Name, Type \InitCmd:=Cmd1 \Status:=mystatus;
! Launch another view of the application MyAppl
UIShow Name, Type \InitCmd:=Cmd2 \InstanceID:=myinstance
     \Status:=mystatus;
```

The code above will launch the view `TpsViewMyAppl` with init command `Cmd1`. Then it launches another view with init command `Cmd2`.

Continues on next page

Example 3

```
CONST string Name:="tpsviewbackupandrestore.dll";
CONST string
     Type:="ABB.Robotics.Tps.Views.TpsViewBackupAndRestore";
VAR num mystatus:=0;
...
UIShow Name, Type \Status:=mystatus;
```

Launch standard application Backup and Restore.

Arguments

```
UIShow AssemblyName TypeName [\InitCmd] [\InstanceId] [\Status]
     [\NoCloseBtn]
```

`AssemblyName`

Data type: `string`

The name of the assembly that contains the view.

`TypeName`

Data type: `string`

This is the name of the view (the type to create). This is the fully qualified name of the type, i.e. its namespace is included.

`[\InitCmd]`

Init Command

Data type: `string`

A init data string passed to the view.

`[\InstanceId]`

Data type: `uishownum`

A parameter that represents a token used to identify a view. If a view is shown after the call to `UIShow` then a value that identifies the view is passed back. This token can then be used in other calls to `UIShow` to activate an already running view. If the value identifies an existing (running) view then the view will be activated. If it does not exist then a new instance will be created. This means that this parameter can be used to determine if a new instance will be launched or not. If its value identifies an already started view then this view will be activated regardless of the values of all other parameters. A recommendation is to use an unique `InstanceId` variable for each new application that is going to be launched with the `UIShow` instruction.

The parameter must be a persistent variable and the reason for this is that this variable should keep its value, even if the program pointer is moved to main. If executing the same `UIShow` as earlier and using the same variable then the same view will be activated if it is still open. If the view has been closed then a new view will be launched.

Continues on next page

[\Status]

Data type: num

Status indicates if the operation was successful or not. Note that if this option is used then the RAPID execution will be waiting until the instruction is completed, i.e. the view is launched.

This optional parameter is primary used for debugging purpose. (See *Error handling*)

Status	Description
0	OK
-1	No space left on the FlexPendant for the new view. Maximum 6 views can be open at the same time on the FlexPendant.
-2	Assembly could not be found, does not exist
-3	File was found, but could not be loaded
-4	Assembly exist, but no new instance could be created
-5	The typename is invalid for this assembly
-6	InstanceID does not match assembly to load

[\NoCloseBtn]

No Close Button

Data type: switch

NoCloseBtn disables the close button of the view.

Program execution

The UIShow instruction is used to launch individual applications on the FlexPendant. To launch individual applications, the assemblies have to be placed in the HOME: directory in the active system, or directly in the active system, or in an additional option. The recommendation is to place the files in the HOME: directory so that they are saved if a Backup and Restore is done. A warmstart is required and then the FlexPendant loads the new assemblies. A demand on the system is that the RobotWare option *FlexPendant Interface* is used.

It is also possible to launch standard applications such as Backup and Restore. Then there is no demand to have the RobotWare option *FlexPendant Interface*.

If using the parameter \Status then the program execution will wait until the application is launched. If errors in the application are not handled then it is only the result of the launch that is supervised. Without the \Status parameter, the FlexPendant is ordered to launch the application but there is no check to determine if it is possible to launch it or not.

Continues on next page

Error handling

If there is no client, e.g. a FlexPendant, to take care of the instruction then the system variable `ERRNO` is set to `ERR_TP_NO_CLIENT` and the execution continues in the error handler.

If parameter `\Status` is used then these situations can then be dealt with by the error handler:

- If there is no space left on the FlexPendant for the assembly then the system variable `ERRNO` is set to `ERR_UISHOW_FULL` and the execution continues in the error handler. The FlexPendant can have 6 views open at the same time.
- If something else goes wrong when trying to launch a view then the system variable `ERRNO` is set to `ERR_UISHOW_FATAL`, and the execution continues in the error handler.

Limitations

When using `UIShow` instruction to launch individual applications then it is a demand that the system is equipped with the option *FlexPendant Interface*.

Applications that have been launched with the `UIShow` instruction do not survive power fail situations. `POWER ON` event routine can be used to setup the application again.

Syntax

```
UIShow
  [AssemblyName ´:=´] < expression (IN) of string >’,’
  [TypeName ´:=´] < expression (IN) of string >’,’
  [’\’InitCmd’ :=’ < expression (IN) of string> ]
  [’\’InstanceId ’:=’ < persistent (PERS) of uishownum> ]
  [’\’Status ’:=’ < variable (VAR) of num> ]
  [’\’NoCloseBtn ]’;’
```

Related information

For information about	See
FlexPendant nterface	*Product Specification - Controller Software IRC5, RobotWare 5.0*, section *Communication - FlexPendant Interface*
Building individual applications for the FlexPendant	*Application manual - Robot Application Builder*
uishownum	*uishownum - Instance ID for UIShow on page 1223*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

1.223. UnLoad - UnLoad a program module during execution

Usage

`UnLoad` is used to unload a program module from the program memory during execution.

The program module must have previously been loaded into the program memory using the instructions `Load` or `StartLoad - WaitLoad`.

Basic examples

Basic examples of the instruction `UnLoad` are illustrated below.

See also *More examples* below.

Example 1

```
UnLoad diskhome \File:="PART_A.MOD";
```

`UnLoad` the program module PART_A.MOD from the program memory that was previously loaded into the program memory with `Load`. (See instruction `Load`). `diskhome` is a predefined string constant "HOME:".

Arguments

```
UnLoad [\ErrIfChanged] | [\Save] FilePath [\File]
```

`[\ErrIfChanged]`

Data type: `switch`

If this argument is used, and the module has been changed since it was loaded into the system, then the instruction will generate the error recovery code `ERR_NOTSAVED`.

`[\Save]`

Data type: `switch`

If this argument is used then the program module is saved before the unloading starts. The program module will be saved at the original place specified in the `Load` or `StartLoad` instruction.

`FilePath`

Data type: `string`

The file path and the file name to the file that will be unloaded from the program memory. The file path and the file name must be the same as in the previously executed `Load` or `StartLoad` instruction. The file name shall be excluded when the argument `\File` is used.

`[\File]`

Data type: `string`

When the file name is excluded in the argument `FilePath`, then it must be defined with this argument. The file name must be the same as in the previously executed `Load` or `StartLoad` instruction.

Continues on next page

Program execution

To be able to execute an `UnLoad` instruction in the program, a `Load` or `StartLoad - WaitLoad` instruction with the same file path and name must have been executed earlier in the program.

The program execution waits for the program module to finish unloading before the execution proceeds with the next instruction.

After that the program module is unloaded, and the rest of the program modules will be linked.

For more information see the instructions `Load` or `StartLoad-Waitload`.

More examples

More examples of how to use the instruction `UnLoad` are illustrated below.

Example 1

```
UnLoad "HOME:/DOORDIR/DOOR1.MOD";
```

`UnLoad` the program module `DOOR1.MOD` from the program memory that was previously loaded into the program memory.

Example 2

```
UnLoad "HOME:" \File:="DOORDIR/DOOR1.MOD";
```

Same as in example 1 above but another syntax.

Example 3

```
Unload \Save, "HOME:" \File:="DOORDIR/DOOR1.MOD";
```

Same as in examples 1 and 2 above but saves the program module before unloading.

Limitations

It is not allowed to unload a program module that is executing (program pointer in the module).

TRAP routines, system I/O events, and other program tasks cannot execute during the unloading.

Avoid ongoing robot movements during the unloading.

Program stop during execution of `UnLoad` instruction can result in guard stop with motors off and error message "20025 Stop order timeout" on the FlexPendant.

Error handling

If the file in the `UnLoad` instruction cannot be unloaded because of ongoing execution within the module or wrong path (module not loaded with `Load` or `StartLoad`) then the system variable `ERRNO` is set to `ERR_UNLOAD`.

If the argument `\ErrIfChanged` is used and the module has been changed then the execution of this routine will set the system variable `ERRNO` to `ERR_NOTSAVED`.

Those errors can then be handled in the error handler.

Continues on next page

Syntax

```
UnLoad
  ['\'ErrIfChanged ','] | ['\'Save ',']
  [FilePath':=']<expression (IN) of string>
  ['\'File':=' <expression (IN) of string>]';'
```

Related information

For information about	See
Check program references	*CheckProgRef - Check program references on page 37*
Load a program module	*Load - Load a program module during execution on page 208* *StartLoad - Load a program module during execution on page 482* *WaitLoad - Connect the loaded module to the task on page 682*

1.224. UnpackRawBytes - Unpack data from rawbytes data

Usage

`UnpackRawBytes` is used to unpack the contents of a container of type `rawbytes` to variables of type `byte`, `num`, `dnum` or `string`.

Basic examples

Basic examples of the instruction `UnpackRawBytes` are illustrated below.

Example 1

```
VAR iodev io_device;
VAR rawbytes raw_data_out;
VAR rawbytes raw_data_in;
VAR num integer;
VAR dnum bigInt;
VAR num float;
VAR string string1;
VAR byte byte1;
VAR byte data1;

! Data packed in raw_data_out according to the protocol
...
Open "chan1:", io_device\Bin;
WriteRawBytes io_device, raw_data_out;
ReadRawBytes io_device, raw_data_in\Time := 1;
Close io_device;
```

According to the protocol that is known to the programmer, the message is sent to device `"chan1:"`. Then the answer is read from the device.

The answer contains, for an example, the following:

byte number:	contents:
1-4	integer‘ 5’
5-8	float‘ 234.6’
9-25	string "This is real fun!"
26	hex value‘ 4D’
27	ASCII code 122, i.e. ‘z’
28-36	integer’ 4294967295’
37-40	integer’ 4294967295’

```
UnpackRawBytes raw_data_in, 1, integer \IntX := DINT;
```

The contents of `integer` will be `5`.

```
UnpackRawBytes raw_data_in, 5, float \Float4;
```

The contents of `float` will be `234.6` decimal.

```
UnpackRawBytes raw_data_in, 9, string1 \ASCII:=17;
```

The contents of `string1` will be `"This is real fun!"`.

```
UnpackRawBytes raw_data_in, 26, byte1 \Hex1;
```

Continues on next page

The contents of `byte1` will be `´4D´` hexadecimal.

```
UnpackRawBytes raw_data_in, 27, data1 \ASCII:=1;
```

The contents of `data1` will be `122`, the ASCII code for "z".

```
UnpackRawBytes raw_data_in, 28, bigInt \IntX := LINT;
```

The contents of `bigInt` will be `4294967295`.

```
UnpackRawBytes raw_data_in, 37, bigInt \IntX := UDINT;
```

The contents of `bigInt` will be `4294967295`.

Arguments

```
UnpackRawBytes RawData [ \Network ] StartIndex Value
      [ \Hex1 ] | [ \IntX ] | [ \Float4 ] | [ \ASCII ]
```

`RawData`

Data type: `rawbytes`

Variable container to unpack data from.

`[ \Network ]`

Data type: `switch`

Indicates that integer and float shall be unpacked from big-endian (network order) represented in `RawData`. ProfiBus and InterBus use big-endian.

Without this switch, integer and float will be unpacked in little-endian (not network order) representation from `RawData`. DeviceNet uses little-endian.

Only relevant together with option parameter `\IntX - UINT`, `UDINT`, ULINT, INT, DINT, LINT and `\Float4`.

`StartIndex`

Data type: `num`

`StartIndex`, between 1 and 1024, indicates where to start unpacking data from `RawData`.

`Value`

Data type: `anytype`

Variable containing the data that was unpacked from `RawData`.

Allowed data types are: `byte`, `num`, `dnum` or `string`. Array cannot be used.

`[ \Hex1 ]`

Data type: `switch`

The data to be unpacked and placed in `Value` has hexadecimal format in 1 `byte` and will be converted to decimal format in a `byte` variable.

`[ \IntX ]`

Data type: `inttypes`

The data to be unpacked has the format according to the specified constant of data type `inttypes`. The data will be converted to a `num` or a `dnum` variable containing an integer and stored in `Value`.

See *Predefined data*.

Continues on next page

`[ \Float4 ]`

Data type: `switch`

The data to be unpacked and placed in Value has float, 4 bytes, format, and it will be converted to a `num` variable containing a float.

`[ \ASCII ]`

Data type: `num`

The data to be unpacked and placed in `Value` has `byte` or `string` format.

If `Value` is of type `byte` then the data will be interpreted as ASCII code and converted to `byte` format (1 character).

If `Value` is of type `string` then the data will be stored as `string` (1...80 characters). String data is not NULL terminated in data of type `rawbytes`.

One of arguments `\Hex1`, `\IntX`, `\Float4` or `\ASCII` must be programmed.

The following combinations are allowed:

Data type of Value:	Allowed option parameters:
`num` *)	`\IntX`
`dnum` **)	`\IntX`
`num`	`\Float4`
`string`	`\ASCII:=n with n between 1 and 80`
`byte`	`\Hex1 \ASCII:=1`

*) Must be an integer within the value range of selected symbolic constant `USINT`, `UINT`, `UDINT`, SINT, `INT` or `DINT`.

**) Must be an integer within the value range of selected symbolic constant `USINT`, `UINT`, `UDINT`, ULINT, SINT, `INT`, `DINT` or LINT.

Program execution

During program execution data is unpacked from the container of type `rawbytes` into a variable of type `anytype`.

Predefined data

The following symbolic constants of the data type `inttypes` are predefined and can be used to specify the integer in parameter `\IntX`.

Symbolic constant	Constant value	Integer format	Integer value range
`USINT`	1	Unsigned 1 byte integer	0 ... 255
`UINT`	2	Unsigned 2 byte integer	0 ... 65 535
`UDINT`	4	Unsigned 4 byte integer	0 ... 8 388 608 *) 0 ... 4 294 967 295 ****)
`ULINT`	8	Unsigned 8 byte integer	0 ... 4 503 599 627 370 496**)
`SINT`	- 1	Signed 1 byte integer	- 128... 127
`INT`	- 2	Signed 2 byte integer	- 32 768 ... 32 767

Continues on next page

Symbolic constant	Constant value	Integer format	Integer value range
DINT	- 4	Signed 4 byte integer	- 8 388 607 ... 8 388 608 *) -2 147 483 648 ... 2 147 483 647 ***)
LINT	- 8	Signed 8 byte integer	- 4 503 599 627 370 496... 4 503 599 627 370 496 **)

*) RAPID limitation for storage of integer in data type `num`.

**) RAPID limitation for storage of integer in data type `dnum`.

***) Range when using a dnum variable and inttype `DINT`.

****) Range when using a dnum variable and inttype `UDINT`.

Syntax

```
UnpackRawBytes
  [RawData ´:=´ ] < variable (VAR) of rawbytes>
  [ '\' Network ] ´,´
  [StartIndex ´:=´ ] < expression (IN) of num> ´,´
  [Value ':=' ] < variable (VAR) of anytype>
  [ '\' Hex1 ]
  | [ '\' IntX' :=' < expression (IN) of inttypes>]
  | [' \' Float4 ]
  | [ '\' ASCII' :=' < expression (IN) of num>] ';'
```

Related information

For information about	See
`rawbytes` data	*rawbytes - Raw data on page 1165*
Get the length of `rawbytes` data	*RawBytesLen - Get the length of rawbytes data on page 940*
Clear the contents of `rawbytes` data	*ClearRawBytes - Clear the contents of rawbytes data on page 49*
Copy the contents of `rawbytes` data	*CopyRawBytes - Copy the contents of rawbytes data on page 67*
Pack DeviceNet header into `rawbytes` data	*PackDNHeader - Pack DeviceNet Header into rawbytes data on page 287*
Pack data into `rawbytes` data	*PackRawBytes - Pack data into rawbytes data on page 290*
Write `rawbytes` data	*WriteRawBytes - Write rawbytes data on page 725*
Read `rawbytes` data	*ReadRawBytes - Read rawbytes data on page 352*
Unpack data from `rawbytes` data	*UnpackRawBytes - Unpack data from rawbytes data on page 658*
Bit/Byte Functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Mathematics - Bit Functions*
String functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - String Functions*

1.225. VelSet - Changes the programmed velocity

Usage

`VelSet` is used to increase or decrease the programmed velocity of all subsequent positioning instructions. This instruction is also used to maximize the velocity.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `VelSet` are illustrated below.

See also *More examples on page 663*.

Example 1

```
VelSet 50, 800;
```

All the programmed velocities are decreased to 50% of the value in the instruction. However, the TCP velocity is not permitted to exceed 800 mm/s.

Arguments

```
VelSet Override Max
```

`Override`

Data type: `num`

Desired velocity as a percentage of programmed velocity. 100% corresponds to the programmed velocity.

`Max`

Data type: `num`

Maximum TCP velocity in mm/s.

Program execution

The programmed velocity of all subsequent positioning instructions is affected until a new `VelSet` instruction is executed.

The argument `Override` affects:

- All velocity components (TCP, orientation, rotating, and linear external axes) in `speeddata`.
- The programmed velocity override in the positioning instruction (the argument `\V`).
- Timed movements.

The argument `Override` does not affect:

- The welding speed in `welddata`.
- The heating and filling speed in `seamdata`.

Continues on next page

The argument `Max` only affects the velocity of the TCP.

The default values for `Override` and `Max` are 100% and `vmax.v_tcp` mm/s *) respectively. These values are automatically set

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

*) Max. TCP speed for the used robot type and normal practical TCP values. The RAPID function `MaxRobSpeed` returns the same value.

More examples

More examples of how to use the instruction `VelSet` are illustrated below.

Example 1

```
VelSet 50, 800;
MoveL p1, v1000, z10, tool1;
MoveL p2, v2000, z10, tool1;
MoveL p3, v1000\T:=5, z10, tool1;
```

The speed is 500 mm/s to point `p1` and `800` mm/s to `p2`. It takes `10` seconds to move from `p2` to `p3`.

Limitations

The maximum speed is not taken into consideration when the time is specified in the positioning instruction.

Syntax

```
VelSet
  [ Override ´:=´ ] < expression (IN) of num > ´,´
  [ Max ´:=´ ] < expression (IN) of num > ´;´
```

Related information

For information about	See
Definition of velocity	*speeddata - Speed data on page 1185*
Max. TCP speed for this robot	*MaxRobSpeed - Maximum robot speed on page 892*
Positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*

1.226. WaitAI - Waits until an analog input signal value is set

Usage

`WaitAI` (*Wait Analog Input*) is used to wait until an analog input signal value is set.

Basic examples

Basic examples of the instruction `WaitAI` are illustrated below.

Example 1

```
WaitAI ai1, \GT, 5;
```

Program execution only continues after the `ai1` analog input has value greater than 5.

Example 2

```
WaitAI ai1, \LT, 5;
```

Program execution only continues after the `ai1` analog input has value less than 5.

Arguments

```
WaitAI Signal [\LT] | [\GT] Value [\MaxTime] [\ValueAtTimeout]
```

`Signal`

Data type: `signalai`

The name of the analog input signal.

`[\LT]`

Less Than

Data type: `switch`

If using this parameter, the `WaitAI` instruction waits until the analog signal value is less than the value in `Value`.

`[\GT]`

Greater Than

Data type: `switch`

If using this parameter the `WaitAI` instruction waits until the analog signal value is greater than the value in `Value`.

`Value`

Data type: `num`

The desired value of the signal.

`[\MaxTime]`

Maximum Time

Data type: `num`

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the condition is met, the error handler will be called, if there is one, with the error code `ERR_WAIT_MAXTIME`. If there is no error handler, the execution will be stopped.

Continues on next page

`[\ValueAtTimeout]`

Data type: `num`

If the instruction time-out, the current signal value will be stored in this variable. The variable will only be set if the system variable `ERRNO` is set to `ERR_WAIT_MAXTIME`.

Program execution

If the value of the signal is correct when the instruction is executed, the program simply continues with the following instruction.

If the signal value is incorrect, the robot enters a waiting state and the program continues when the signal changes to the correct value. The change is detected with an interrupt, which gives a fast response (not polled).

When the robot is waiting, the time is supervised. By default, the robot can wait forever, but the maximal waiting time can be specified with the optional argument `\MaxTime`. If this max. time is exceeded, an error is raised.

If program execution is stopped, and later restarted, the instruction evaluates the currentvalue of the signal. Any change during program stop is rejected.

In manual mode and if the waiting time is greater than 3 s, an alert box will pop up asking if you want to simulate the instruction. If you do not want the alert box to appear, you can set system parameter SimMenu to NO (*Technical reference manual - System parameters*, section *Controller - System Misc*).

More examples

More examples of the instruction `WaitAI` are illustrated below.

Example 1

```
VAR num myvalattimeout:=0;
WaitAO ai1, \LT, 5 \MaxTime:=4 \ValueAtTimeout:=myvalattimeout;
ERROR
  IF ERRNO=ERR_WAIT_MAXTIME THEN
     TPWrite "Value of ai1 at timeout:" + ValToStr(myvalattimeout);
     TRYNEXT;
  ELSE
     ! No error recovery handling
  ENDIF
```

Program execution continues only if `ai1` is less than 5, or when timing out. If timing out, the value of the signal `ai1` at timeout can be logged without another read of signal.

Continues on next page

Error handling

If there is a time-out (parameter `\MaxTime`) before the signal changes to the right value, the system variable `ERRNO` is set to `ERR_WAIT_MAXTIME` and the execution continues in the error handler.

If there is no contact with the I/O unit, the system variable `ERRNO` is set to `ERR_NORUNUNIT` and the execution continues in the error handler.

If the programmed `Value` argument for the specified analog input signal `Signal` is outside limits, the system variable `ERRNO` is set to `ERR_AO_LIM` and the execution continues in the error handler.

These situations can then be dealt with by the error handler.

Syntax

```
WaitAI
  [ Signal ':=' ] < variable (VAR) of signalai> ´,´
  [ '\' LT] | [ '\' GT] ','
  [ Value ':=' ] < expression (IN) of num>
  ['\'MaxTime ´:='<expression (IN) of num>]
  [ '\'ValueAtTimeout' :=' < variable (VAR) of num >] ';'
```

Related information

For information about	See
Waiting until a condition is satisfied	*WaitUntil - Waits until a condition is met on page 697*
Waiting for a specified period of time	*WaitTime - Waits a given amount of time on page 695*
Waiting until an analog output is set/reset	*WaitAO - Waits until an analog output signal value is set on page 667*

1.227. WaitAO - Waits until an analog output signal value is set

Usage

`WaitAO` (*Wait Analog Output*) is used to wait until an analog output signal value is set.

Basic examples

Basic examples of the instruction `WaitAO` are illustrated below.

Example 1

```
WaitAO ao1, \GT, 5;
```

Program execution only continues after the `ao1` analog output has value greater than 5.

Example 2

```
WaitAO ao1, \LT, 5;
```

Program execution only continues after the `ao1` analog output has value less than 5.

Arguments

```
WaitAO Signal [\LT] | [\GT] Value [\MaxTime] [\ValueAtTimeout]
```

`Signal`

Data type: `signalao`

The name of the analog output signal.

`[\LT]`

Less Than

Data type: `switch`

If using this parameter, the `WaitAO` instruction waits until the analog signal value is less than the value in `Value`.

`[\GT]`

Greater Than

Data type: `switch`

If using this parameter, the `WaitAO` instruction waits until the analog signal value is greater than the value in `Value`.

`Value`

Data type: `num`

The desired value of the signal.

`[\MaxTime]`

Maximum Time

Data type: `num`

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the condition is met, the error handler will be called, if there is one, with the error code `ERR_WAIT_MAXTIME`. If there is no error handler, the execution will be stopped.

Continues on next page

`[\ValueAtTimeout]`

Data type: `num`

If the instruction time-out, the current signal value will be stored in this variable. The variable will only be set if the system variable `ERRNO` is set to `ERR_WAIT_MAXTIME`.

Program execution

If the value of the signal is correct when the instruction is executed, the program simply continues with the following instruction.

If the signal value is incorrect, the robot enters a waiting state and the program continues when the signal changes to the correct value. The change is detected with an interrupt, which gives a fast response (not polled).

When the robot is waiting, the time is supervised. By default, the robot can wait forever, but the maximal waiting time can be specified with the optional argument `\MaxTime`. If this max. time is exceeded, an error is raised.

If program execution is stopped, and later restarted, the instruction evaluates the currentvalue of the signal. Any change during program stop is rejected.

In manual mode and if the waiting time is greater than 3 s, an alert box will pop up asking if you want to simulate the instruction. If you do not want the alert box to appear, you can set system parameter SimMenu to NO (*Technical reference manual - System parameters*, section *Controller - System Misc*).

More examples

More examples of the instruction `WaitAO` are illustrated below.

Example 1

```
VAR num myvalattimeout:=0;
WaitAO ao1, \LT, 5 \MaxTime:=4 \ValueAtTimeout:=myvalattimeout;
ERROR
  IF ERRNO=ERR_WAIT_MAXTIME THEN
    TPWrite "Value of ao1 at timeout:" + ValToStr(myvalattimeout);
    TRYNEXT;
  ELSE
    ! No error recovery handling
  ENDIF
```

Program execution continues only if `ao1` is less than 5, or when timing out. If timing out, the value of the signal `ao1` at timeout can be logged without another read of signal.

Continues on next page

Error handling

If there is a time-out (parameter `\MaxTime`) before the signal changes to the right value, the system variable `ERRNO` is set to `ERR_WAIT_MAXTIME` and the execution continues in the error handler.

If there is no contact with the I/O unit, the system variable `ERRNO` is set to `ERR_NORUNUNIT` and the execution continues in the error handler.

If the programmed `Value` argument for the specified analog output signal `Signal` is outside limits, the system variable `ERRNO` is set to `ERR_AO_LIM` and the execution continues in the error handler.

These situations can then be dealt with by the error handler.

Syntax

```
WaitAO
  [ Signal ':=' ] < variable (VAR) of signalao> ´,'
  [ '\' LT] | [ '\' GT] ','
  [ Value ':=' ] < expression (IN) of num>
  ['\'MaxTime ´:='<expression (IN) of num>]
  [ '\'ValueAtTimeout' :=' < variable (VAR) of num >] ';'
```

Related information

For information about	See
Waiting until a condition is satisfied	*WaitUntil - Waits until a condition is met on page 697*
Waiting for a specified period of time	*WaitTime - Waits a given amount of time on page 695*
Waiting until an analog input is set/reset	*WaitAI - Waits until an analog input signal value is set on page 664*

1.228. WaitDI - Waits until a digital input signal is set

Usage

`WaitDI` (*Wait Digital Input*) is used to wait until a digital input is set.

Basic examples

Basic examples of the instruction `WaitDI` are illustrated below.

Example 1

```
WaitDI di4, 1;
```

Program execution continues only after the `di4` input has been set.

Example 2

```
WaitDI grip_status, 0;
```

Program execution continues only after the `grip_status` input has been reset.

Arguments

```
WaitDI Signal Value [\MaxTime] [\TimeFlag]
```

`Signal`

Data type: `signaldi`

The name of the signal.

`Value`

Data type: `dionum`

The desired value of the signal.

`[\MaxTime]`

Maximum Time

Data type: `num`

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the condition is met then the error handler will be called, if there is one, with the error code `ERR_WAIT_MAXTIME`. If there is no error handler then the execution will be stopped.

`[\TimeFlag]`

Timeout Flag

Data type: `bool`

The output parameter that contains the value TRUE if the maximum permitted waiting time runs out before the condition is met. If this parameter is included in the instruction then it is not considered to be an error if the max. time runs out. This argument is ignored if the `MaxTime` argument is not included in the instruction.

Continues on next page

Program execution

If the value of the signal is correct, when the instruction is executed, then the program simply continues with the following instruction.

If the signal value is not correct then the robot enters a waiting state and when the signal changes to the correct value, the program continues. The change is detected with an interrupt, which gives a fast response (not polled).

When the robot is waiting, the time is supervised, and if it exceeds the max time value then the program will continue if a `TimeFlag` is specified or raise an error if it's not. If a `TimeFlag` is specified then this will be set to TRUE if the time is exceeded. Otherwise it will be set to FALSE.

If program execution is stopped, and later restarted, the instruction evaluates the currentvalue of the signal. Any change during program stop is rejected.

In manual mode, after waiting in 3 s then an alert box will pop up asking if you want to simulate the instruction. If you don't want the alert box to appear you can set the system parameter SimMenu to NO (*Technical reference manual - System parameters*, section *Controller - System Misc*).

Error handling

Following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the unit.

Syntax

```
WaitDI
  [ Signal ':=' ] < variable (VAR) of signaldi>' ,'
  [ Value ':=' ] < expression (IN) of dionum>
  ['\'MaxTime' :='<expression (IN) of num>]
  ['\'TimeFlag':='<variable (VAR) of bool>] ';'
```

Related information

For information about	See
Waiting until a condition is satisfied	*WaitUntil - Waits until a condition is met on page 697*
Waiting for a specified period of time	*WaitTime - Waits a given amount of time on page 695*

1.229. WaitDO - Waits until a digital output signal is set

Usage

`WaitDO` (*Wait Digital Output*) is used to wait until a digital output is set.

Basic examples

Basic examples of the instruction `WaitDO` are illustrated below.

Example 1

```
WaitDO do4, 1;
```

Program execution continues only after the `do4` output has been set.

Example 2

```
WaitDO grip_status, 0;
```

Program execution continues only after the `grip_status` output has been reset.

Arguments

```
WaitDO Signal Value [\MaxTime] [\TimeFlag]
```

`Signal`

Data type: `signaldo`

The name of the signal.

`Value`

Data type: `dionum`

The desired value of the signal.

`[\MaxTime]`

Maximum Time

Data type: `num`

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the condition is met and the `TimeFlag` argument is not used then the error handler can be called with the error code `ERR_WAIT_MAXTIME`. If there is no error handler then the execution will be stopped.

`[\TimeFlag]`

Timeout Flag

Data type: `bool`

The output parameter that contains the value TRUE if the maximum permitted waiting time runs out before the condition is met. If this parameter is included in the instruction then it is not considered to be an error if the maximum time runs out. This argument is ignored if the `MaxTime` argument is not included in the instruction.

Continues on next page

Program execution

If the value of the output signal is correct, when the instruction is executed, then the program simply continues with the following instruction.

If the value of the output signal is not correct then the robot enters a waiting state. When the signal changes to the correct value then the program continues. The change is detected with an interrupt, which gives a fast response (not polled).

When the robot is waiting, the time is supervised, and if it exceeds the maximum time value then the program will continue if a `TimeFlag` is specified or raise an error if its not. If a `TimeFlag` is specified then this will be set to TRUE if the time is exceeded. Otherwise it will be set to FALSE.

If program execution is stopped, and later restarted, the instruction evaluates the currentvalue of the signal. Any change during program stop is rejected.

In manual mode, after waiting in 3 s then an alert box will pop up asking if you want to simulate the instruction. If you do not want the alert box to appear you can set system parameter SimulateMenu to NO (*Technical reference manual - System parameters*, section *Controller - System Misc*).

Error handling

Following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the unit.

Syntax

```
WaitDO
  [ Signal ´:=´] < variable (VAR) of signaldo >´,´
  [ Value ':=' ] < expression (IN) of dionum>
  ['\'MaxTime' :='<expression (IN) of num>]
  ['\'TimeFlag':='<variable (VAR) of bool>]';'
```

Related information

For information about	See
Waiting until a condition is satisfied	*WaitUntil - Waits until a condition is met on page 697*
Waiting for a specified period of time	*WaitTime - Waits a given amount of time on page 695*
Waiting until an input is set/reset	*WaitDI - Waits until a digital input signal is set on page 670*

1.230. WaitGI - Waits until a group of digital input signals are set

Usage

`WaitGI` (*Wait Group digital Input*) is used to wait until a group of digital input signals are set to specified values.

Basic examples

Basic examples of the instruction `WaitGI` are illustrated below.

See also *More examples on page 676*.

Example 1

```
WaitGI gi4, 5;
```

Program execution continues only after the `gi4` input has the value 5.

Example 2

```
WaitGI grip_status, 0;
```

Program execution continues only after the `grip_status` input has been reset.

Arguments

```
WaitGI Signal [\NOTEQ] | [\LT] | [\GT] Value | Dvalue [\MaxTime]
    [\ValueAtTimeout] | [\DvalueAtTimeout]
```

`Signal`

Data type: `signalgi`

The name of the digital group input signal.

`[\NOTEQ]`

NOT EQual

Data type: `switch`

If using this parameter, the `WaitGI` instruction waits until the digital group signal value divides from the value in `Value`.

`[\LT]`

Less Than

Data type: `switch`

If using this parameter, the `WaitGI` instruction waits until the digital group signal value is less than the value in `Value`.

`[\GT]`

Greater Than

Data type: `switch`

If using this parameter, the `WaitGI` instruction waits until the digital group signal value is greater than the value in `Value`.

Continues on next page

`Value`

Data type: `num`

The desired value of the signal. Must be an integer value within the working range of the used digital group input signal. The permitted value is dependent on the number of signals in the group. Max value that can be used in the `Value` argument is 8388608, and that is the value a 23 bit digital signal can have as maximum value.

`Dvalue`

Data type: `dnum`

The desired value of the signal. Must be an integer value within the working range of the used digital group input signal. The permitted value is dependent on the number of signals in the group. The maximal amout of signal bits a digital group signal can have is 32. With a `dnum` variable it is possible to cover the value range 0-4294967295, which is the value range a 32 bits digital signal can have.

`[\MaxTime]`

Maximum Time

Data type: `num`

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the condition is met, the error handler will be called (if there is one) with the error code `ERR_WAIT_MAXTIME`. If there is no error handler, the execution will be stopped.

`[\ValueAtTimeout]`

Data type: `num`

If the instruction time-out, the current signal value will be stored in this variable. The variable will only be set if the system variable `ERRNO` is set to `ERR_WAIT_MAXTIME`. If the `Dvalue` argument is used, use argument `DvalueAtTimeout` to store current value on signal (reason: limitation of maximum integer value for `num`).

`[\DvalueAtTimeout]`

Data type: `dnum`

If the instruction time-out, the current signal value will be stored in this variable. The variable will only be set if the system variable `ERRNO` is set to `ERR_WAIT_MAXTIME`.

Continues on next page

Program execution

If the value of the signal is correct when the instruction is executed, the program simply continues with the following instruction.

If the signal value is not correct, the robot enters a waiting state and the program continues when the signal changes to the correct value. The change is detected with an interrupt, which gives a fast response (not polled).

When the robot is waiting, the time is supervised. By default, the robot can wait forever, but the maximal waiting time can be specified with the optional argument `\MaxTime`. If this max. time is exceeded, an error is raised.

If program execution is stopped, and later restarted, the instruction evaluates the currentvalue of the signal. Any change during program stop is rejected.

In manual mode and if the waiting time is greater than 3 s, an alert box will pop up asking if you want to simulate the instruction. If you do not want the alert box to appear, you can set system parameter SimMenu to NO (*Technical reference manual - System parameters*, section *Controller - System Misc*).

More examples

More examples of the instruction `WaitGI` are illustrated below.

Example 1

```
WaitGI gi1,\NOTEQ,0;
```

Program execution only continues after the `gi1` differs from the value 0.

Example 2

```
WaitGI gi1,\LT,1;
```

Program execution only continues after the `gi1` is less than 1.

Example 3

```
WaitGI gi1,\GT,0;
```

Program execution continues only after the `gi1` is greater than 0.

Example 4

```
VAR num myvalattimeout:=0;
WaitGI gi1, 5 \MaxTime:=4 \ValueAtTimeout:=myvalattimeout;
ERROR
  IF ERRNO=ERR_WAIT_MAXTIME THEN
     TPWrite "Value of gi1 at timeout:" + ValToStr(myvalattimeout);
     TRYNEXT;
  ELSE
     ! No error recovery handling
  ENDIF
```

Program execution continues only if `gi1` is equal to 5, or when timing out. If timing out, the value of the signal `gi1` at timeout can be logged without another read of signal.

Continues on next page

Error handling

If there is a time-out (parameter `\MaxTime`) before the signal changes to the right value, the system variable `ERRNO` is set to `ERR_WAIT_MAXTIME` and the execution continues in the error handler.

If there is no contact with the I/O unit, the system variable `ERRNO` is set to `ERR_NORUNUNIT` and the execution continues in the error handler.

If the programmed `Value` or `Dvalue` argument for the specified digital group input signal `Signal` is outside limits, the system variable `ERRNO` is set to `ERR_GO_LIM` and the execution continues in the error handler.

These situations can then be dealt with by the error handler.

Syntax

```
WaitGI
  [ Signal ':=' ] < variable (VAR) of signalgi> ´,´
  ['\' NOTEQ] | [ '\' LT] | [ '\' GT] ','
  [ Value ':=' ] < expression (IN) of num>
  | [ Dvalue' :=' ] < expression (IN) of dnum>
  ['\'MaxTime ´:='<expression (IN) of num>]
  [ '\'ValueAtTimeout' :=' < variable (VAR) of num > ]
  | [ '\'DvalueAtTimeout' :=' < variable (VAR) of dnum > ]';'
```

Related information

For information about	See
Waiting until a condition is satisfied	*WaitUntil - Waits until a condition is met on page 697*
Waiting for a specified period of time	*WaitTime - Waits a given amount of time on page 695*
Waiting until a group of digital output signals are set/reset	*WaitGO - Waits until a group of digital output signals are set on page 678*

1.231. WaitGO - Waits until a group of digital output signals are set

Usage

`WaitGO` (*Wait Group digital Output*) is used to wait until a group of digital output signals are set to a specified value.

Basic examples

Basic examples of the instruction `WaitGO` are illustrated below.

See also *More examples on page 680*.

Example 1

```
WaitGO go4, 5;
```

Program execution only continues after the `go4` output has value 5.

Example 2

```
WaitGO grip_status, 0;
```

Program execution only continues after the `grip_status` output has been reset.

Arguments

```
WaitGO Signal [\NOTEQ] | [\LT] | [\GT] Value | Dvalue [\MaxTime]
     [\ValueAtTimeout] | [\DvalueAtTimeout]
```

`Signal`

Data type: `signalgo`

The name of the digital group output signal.

`[\NOTEQ]`

NOT EQual

Data type: `switch`

If using this parameter, the `WaitGO` instruction waits until the digital group signal value divides from the value in `Value`.

`[\LT]`

Less Than

Data type: `switch`

If using this parameter, the `WaitGO` instruction waits until the digital group signal value is less than the value in `Value`.

`[\GT]`

Greater Than

Data type: `switch`

If using this parameter, the `WaitGO` instruction waits until the digital group signal value is greater than the value in `Value`.

Continues on next page

`Value`

Data type: `num`

The desired value of the signal. Must be an integer value within the working range of the used digital group output signal. The permitted value is dependent on the number of signals in the group. Max value that can be used in the `Value` argument is 8388608, and that is the value a 23 bit digital signal can have as maximum value.

`Dvalue`

Data type: `dnum`

The desired value of the signal. Must be an integer value within the working range of the used digital group output signal. The permitted value is dependent on the number of signals in the group. The maximal amout of signal bits a digital group signal can have is 32. With a `dnum` variable it is possible to cover the value range 0-4294967295, which is the value range a 32 bits digital signal can have.

`[\MaxTime]`

Maximum Time

Data type: `num`

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the condition is met, the error handler will be called, if there is one, with the error code `ERR_WAIT_MAXTIME`. If there is no error handler, the execution will be stopped.

`[\ValueAtTimeout]`

Data type: `num`

If the instruction time-out, the current signal value will be stored in this variable. The variable will only be set if the system variable `ERRNO` is set to `ERR_WAIT_MAXTIME`. If the `Dvalue` argument is used, use argument `DvalueAtTimeout` to store current value on signal (reason: limitation of maximum integer value for `num`).

`[\DvalueAtTimeout]`

Data type: `dnum`

If the instruction time-out, the current signal value will be stored in this variable. The variable will only be set if the system variable `ERRNO` is set to `ERR_WAIT_MAXTIME`.

Continues on next page

Program execution

If the value of the signal is correct when the instruction is executed, the program simply continues with the following instruction.

If the signal value is incorrect, the robot enters a waiting state and the program continues when the signal changes to the correct value. The change is detected with an interrupt, which gives a fast response (not polled).

When the robot is waiting, the time is supervised. By default, the robot can wait forever, but the maximal waiting time can be specified with the optional argument `\MaxTime`. If this max. time is exceeded, an error is raised.

If program execution is stopped, and later restarted, the instruction evaluates the currentvalue of the signal. Any change during program stop is rejected.

In manual mode and if the waiting time is greater than 3 s, an alert box will pop up asking if you want to simulate the instruction. If you do not want the alert box to appear, you can set the system parameter SimMenu to NO (*Technical reference manual - System parameters*, section *Controller - System Misc*).

More examples

More examples of the instruction `WaitGO` are illustrated below.

Example 1

```
WaitGO go1,\NOTEQ,0;
```

Program execution only continues after the `go1` differs from the value 0.

Example 2

```
WaitGO go1,\LT,1;
```

Program execution only continues after the `go1` is less than 1.

Example 3

```
WaitGO go1,\GT,0;
```

Program execution only continues after the `go1` is greater than 0.

Example 4

```
VAR num myvalattimeout:=0;
WaitGO go1, 5 \MaxTime:=4 \ValueAtTimeout:=myvalattimeout;
ERROR
  IF ERRNO=ERR_WAIT_MAXTIME THEN
    TPWrite "Value of go1 at timeout:" + ValToStr(myvalattimeout);
    TRYNEXT;
  ELSE
    ! No error recovery handling
  ENDIF
```

Program execution continues only if `go1` is equal to 5, or when timing out. If timing out, the value of the signal `go1` at timeout can be logged without another read of signal.

Continues on next page

Error handling

If there is a time-out (parameter `\MaxTime`) before the signal changes to the right value, the system variable `ERRNO` is set to `ERR_WAIT_MAXTIME` and the execution continues in the error handler.

If there is no contact with the I/O unit, the system variable `ERRNO` is set to `ERR_NORUNUNIT` and the execution continues in the error handler.

If the programmed `Value` or `Dvalue` argument for the specified digital group output signal `Signal` is outside limits, the system variable `ERRNO` is set to `ERR_GO_LIM` and the execution continues in the error handler.

These situations can then be dealt with by the error handler.

Syntax

```
WaitGO
  [ Signal ':=' ] < variable (VAR) of signalgo> ´,´
  ['\' NOTEQ] | [ '\' LT] | [ '\' GT] ','
  [ Value ':=' ] < expression (IN) of num>
  | [ Dvalue' :=' ] < expression (IN) of dnum>
  ['\'MaxTime ´:='<expression (IN) of num>]
  [ '\'ValueAtTimeout' :=' < variable (VAR) of num > ]
  | [ '\'DvalueAtTimeout' :=' < variable (VAR) of dnum > ]';'
```

Related information

For information about	See
Waiting until a condition is satisfied	*WaitUntil - Waits until a condition is met on page 697*
Waiting for a specified period of time	*WaitTime - Waits a given amount of time on page 695*
Waiting until a group of digital input signals are set/reset	*WaitGI - Waits until a group of digital input signals are set on page 674*

1.232. WaitLoad - Connect the loaded module to the task

Usage

`WaitLoad` is used to connect the with `StartLoad` loaded module to the program task.

The loaded program module will be added to the modules already existing in the program memory.

The with `StartLoad` loaded module must be connected to the program task with the instruction `WaitLoad` before any of its symbols/routines can be used.

`WaitLoad` can also unload a program module if the optional switches are used. This will minimize the number of links (1 instead of 2).

`WaitLoad` can also check for any unsolved references if the optional switch `\CheckRef` is used.

Basic examples

Basic examples of the instruction `WaitLoad` are illustrated below.

See also *More examples on page 683*.

Example 1

```
VAR loadsession load1;
...
StartLoad "HOME:/PART_A.MOD", load1;
MoveL p10, v1000, z50, tool1 \WObj:=wobj1;
MoveL p20, v1000, z50, tool1 \WObj:=wobj1;
MoveL p30, v1000, z50, tool1 \WObj:=wobj1;
MoveL p40, v1000, z50, tool1 \WObj:=wobj1;
WaitLoad load1;
%"routine_x"%;
UnLoad "HOME:/PART_A.MOD";
```

Load the program module `PART_A.MOD` from `HOME:` into the program memory. In parallel, move the robot. Then connect the new program module to the program task and call the routine `routine_x` in the module `PART_A`.

Arguments

```
WaitLoad [\UnloadPath] [\UnloadFile] LoadNo [\CheckRef]
```

`[\UnloadPath]`

Data type: `string`

The file path and the file name to the file that will be unloaded from the program memory. The file name should be excluded when the argument `\UnloadFile` is used.

`[\UnloadFile]`

Data type: `string`

When the file name is excluded in the argument `\UnloadPath`, then it must be defined with this argument.

Continues on next page

`LoadNo`

Data type: `loadsession`

This is a reference to the load session, created by the instruction `StartLoad` that is needed to connect the loaded program module to the program task.

`[\CheckRef]`

Data type: `switch`

Check after loading of the module for unsolved references in the program task. If not used no check for unsolved references are done.

Program execution

The instruction `WaitLoad` will first wait for the loading to be completed, if it is not already done, and then the module will be linked and initialized. The initiation of the loaded module sets all variables at module level to their initial values.

Unresolved references will always be accepted for the loading operations `StartLoad - WaitLoad` if parameter `\CheckRef` is not used, but it will be a run time error on execution of an unresolved reference.

The system starts with the unloading operation, if specified. If the unloading of the module fails, then no new module will be loaded.

If any error from the loading operation, including unresolved references if use of switch `\CheckRef`, the loaded module will not be available any more in the program memory.

To obtain a good program structure, that is easy to understand and maintain, all loading and unloading of program modules should be done from the main module, which is always present in the program memory during execution.

For loading a program that contains a main procedure to a main program (with another `main` procedure), see instruction `Load`.

More examples

More examples of the instruction `WaitLoad` are illustrated below.

Example 1

```
StartLoad "HOME:/DOORDIR/DOOR2.MOD", load1;
...
WaitLoad \UnloadPath:="HOME:/DOORDIR/DOOR1.MOD", load1;
```

Load the program module `DOOR2.MOD` from `HOME:` in the directory `DOORDIR` into the program memory and connect the new module to the task. The program module `DOOR1.MOD` will be unloaded from the program memory.

Example 2

```
StartLoad "HOME:" \File:="DOORDIR/DOOR2.MOD", load1;
! The robot can do some other work
WaitLoad \UnloadPath:="HOME:" \File:= "DOORDIR/DOOR1.MOD", load1;
```

It is the same as the instructions below but the robot can do some other work during the loading time and also do it faster (only one link instead of the two links below).

```
Load "HOME:" \File:="DOORDIR/DOOR2.MOD";
UnLoad "HOME:" \File:="DOORDIR/DOOR1.MOD";
```


Continues on next page

Error handling

If the file specified in the `StartLoad` instruction cannot be found then the system variable `ERRNO` is set to `ERR_FILNOTFND` at execution of `WaitLoad`.

If some other type of problems to read the file to load then the system variable `ERRNO` will be set to `ERR_IOERROR`.

If argument `LoadNo` refers to an unknown load session then the system variable `ERRNO` is set to `ERR_UNKPROC`.

If the module cannot be loaded because the program memory is full then the system variable `ERRNO` is set to `ERR_PRGMEMFULL`.

If the module is already loaded into the program memory then the system variable `ERRNO` is set to `ERR_LOADED`.

If the loaded module contains syntax errors, the system variable `ERRNO` is set to `ERR_SYNTAX`.

If the loaded module result in fatal link errors, the system variable `ERRNO` is set to `ERR_LINKREF`.

If `WaitLoad` is used with the switch `\CheckRef` to check for any reference error and the program memory contains unresolved references, the system variable `ERRNO` is set to `ERR_LINKREF`.

The following errors can only occur when the argument `\UnloadPath`is used in the instruction `WaitLoad`:

- If the module specified in the argument `\UnloadPath` cannot be unloaded because of ongoing execution within the module then the system variable ERRNO is set to `ERR_UNLOAD`.
- If the module specified in the argument `\UnloadPath` cannot be unloaded because the program module is not loaded with `Load` or `StartLoad-WaitLoad` from the RAPID program then the system variable `ERRNO` is also set to `ERR_UNLOAD`.

These errors can then be handled in the `ERROR` handler. If some of these error occurs, the actual module will be unloaded and will not be available in the `ERROR` handler.

NOTE!

RETRY cannot be used for error recovery for any errors from `WaitLoad`.

Limitations

It is not possible to change the current value of some PERS variable by loading the same module with a new init value for the actual PERS variable.

Example:

- File `my_module.mod` with declaration `PERS num my_pers:=1;` is loaded in the system.
- The file `my_module.mod` is edited on disk with new persistent value eg. `PERS num my_pers:=3;`
- The code below is executed.
- After loading the `my_module.mod` again, the value of `my_pers` is still `1` instead of `3`.

```
StartLoad \Dynamic, "HOME:/my_module.mod", load1;
...
WaitLoad \UnLoadPath:="HOME:/my_module.mod", load1;
```

Continues on next page

This limitation is a consequence of `PERS` variable characteristic. The current value of the `PERS` variable will not be changed by the new loaded `PERS` init value if the `PERS` variable is in any use at the loading time.

The above problems will not occur if the following code is executed instead:

```
UnLoad "HOME:/my_module.mod";
StartLoad \Dynamic, "HOME:/my_module.mod", load1;
...
WaitLoad load1;
```

Another option is to use a CONST for the init value and do the following assignment in the beginning of the execution in the new module: `my_pers := my_const;`

Syntax

```
WaitLoad
  [ '\' UnloadPath ':=' <expression (IN) of string>' ',']
  [ '\' UnloadFile' :=' <expression (IN) of string> ',']
  [ LoadNo ':=' ] <variable (VAR) of loadsession>
  [ '\' CheckRef ] ';'
```

Related information

For information about	See
Load a program module during execution	*StartLoad - Load a program module during execution on page 482*
Load session	*loadsession - Program load session on page 1138*
Load a program module	*Load - Load a program module during execution on page 208*
Unload a program module	*UnLoad - UnLoad a program module during execution on page 655*
Cancel loading of a program module	*CancelLoad - Cancel loading of a module on page 35*
Check program references	*CheckProgRef - Check program references on page 37*
Procedure call with Late binding	*Technical reference manual - RAPID overview*, section *Basic characteristics - Routines - Procedure call*

1.233. WaitRob - Wait until stop point or zero speed

Usage

`WaitRob` waits until the robot and external axes have reached stop point or have zero speed.

Basic examples

Basic examples of the instruction `WaitRob` are illustrated below.

See also *More examples on page 686*.

Example 1

```
WaitRob \InPos;
```

Program execution waits until the robot and external axes have reached stop point.

Arguments

```
WaitRob [\InPos] | [\ZeroSpeed]
```

[\InPos]

In Position

Data type: `switch`

If this argument is used then the robot and external axes must have reached the stop point (`ToPoint` of current move instruction) before the execution can continue.

[\ZeroSpeed]

Zero Speed

Data type: `switch`

If this argument is used then the robot and external axes must have zero speed before the execution can continue.

If none of the arguments `\InPos` and `\ZeroSpeed` are entered, an error message will be displayed.

More examples

More examples of how to use the instruction `WaitRob` are illustrated below.

Example 1

```
PROC stop_event()
  WaitRob \ZeroSpeed;
  SetDO rob_moving, 0;
ENDPROC
```

The example shows an event routine that executes at program stop. The digital out signal `rob_moving` is 1 as long as the robot is moving and is set to 0 when the robot and external axes has stopped moving after a program stop.

Syntax

```
WaitRob
  [ '\' InPos ] | [ '\' ZeroSpeed ]';'
```

Continues on next page

Related information

For information about	See
Motion in general	*Technical reference manual - RA]PID overview*, section *Motion and I/O principles*
Other positioning instructions	*Technical reference manual - RA]PID overview*, section RAPID summary - Motion
Definition of stop point data	*stoppointdata - Stop point data on page 1189*

1.234. WaitSyncTask - Wait at synchronization point for other program tasks

Usage

`WaitSyncTask` is used to synchronize several program tasks at a special point in each program. Each program task waits until all program tasks have reach the named synchronization point.

NOTE!

`WaitSyncTask` only synchronize the program execution. To reach synchronization of both the program execution and the robot movements, the move instruction before the `WaitSyncTask` must be a stop-point in all involved program tasks. It is also possible to synchronize both the program execution and the robot movements by using `WaitsyncTask \Inpos ...` in all involved program tasks.

WARNING!

To reach safe synchronization functionality, the meeting point (parameter `SyncID`) must have an unique name in each program task. The name must also be the same for the program tasks that should meet in the meeting point.

Basic examples

Basic examples of the instruction `WaitSyncTask` are illustrated below.

See also *More examples on page 690*.

Example 1

Program example in task `T_ROB1`

```
PERS tasks task_list{2} := [ ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;

...
WaitSyncTask sync1, task_list;
...
```

Example 2

Program example in task `T_ROB2`

```
PERS tasks task_list{2} := [ ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;

...
WaitSyncTask sync1, task_list;
...
```

The program task, that first reaches `WaitSyncTask` with identity `sync1`, waits until the other program task reaches its `WaitSyncTask` with the same identity `sync1`. Then both program tasks `T_ROB1` and `T_ROB2` continue their execution.

Continues on next page

Arguments

```
WaitSyncTask [\InPos] SyncID TaskList [\TimeOut]
```

`[\InPos]`

In Position

Data type: `switch`

If this argument is used then the robot and external axes must have come to a standstill before this program task starts waiting for other program tasks to reach its meeting point specified in the `WaitSyncTask` instruction.

`SyncID`

Synchronization identity

Data type: `syncident`

Variable that specifies the name of the synchronization (meeting) point. Data type `syncident` is a non-value type only used as an identifier for naming the synchronization point.

The variable must be defined and have an equal name in all cooperated program tasks. It is recommended to always define the variable global in each program task (`VAR syncident ...`).

`TaskList`

Data type: `tasks`

Persistent variable, that in a task list (array) specifies the name (`string`) of the program tasks, that should meet in the synchronization point with its name according to the argument `SyncID`.

The persistent variable must be defined and have an equal name and equal contents in all cooperated program tasks. It is recommended to always define the variable global in the system (`PERS tasks ...`).

`[\TimeOut]`

Data type: `num`

The max. time for waiting for the other program tasks to reach the synchronization point. Time-out in seconds (resolution 0.001s). If this argument is not specified then the program task will wait for ever.

If this time runs out before all program tasks have reached the synchronization poin then the error handler will be called, if there is one, with the error code `ERR_WAITSYNCTASK`. If there is no error handler then the execution will be stopped.

Continues on next page

Program execution

The actual program task will wait at `WaitSyncTask` until the other program tasks in the `TaskList` have reached the same `SyncID` point. At that time the respective program task will continue to execute its next instruction.

`WaitSyncTask` can be programmed between move instructions with corner zone in between. Depending on the timing balance between the program tasks at execution time, the system can:

- at best timing, keep all corner zones.
- at worst timing, only keep the corner zone for the program task that reaches the `WaitSyncTask` last. For the other program tasks it will result in stop points.

It is possible to exclude program tasks for testing purposes from FlexPendant - Task Selection Panel.

The following principles can be used:

- Principle 1) Exclude the program task cycle-permanent from Task Selection Panel before starting from main (after set of `PP` to main) - This disconnection will be valid during the whole program cycle.
- Principle 2) Exclude the program task temporarily from the Task Selection Panel between some `WaitSyncTask` instructions in the program cycle - The system will only run the other connected tasks but will, with error message, force the user to connect the excluded program tasks before passing co-operated `WaitSyncTask`.
- Principle 3) If running according principle 2, it is possible to exclude some program task's permanent cycle from Task Selection Panel for further running according to principle 1 by executing the service routine `SkipTaskExec`.

Note that the Task Selection Panel is locked when running the system in synchronized movements.

More examples

More examples of the instruction `WaitSyncTask` are illustrated below.

Example 1

Program example in task `T_ROB1`

```
PERS tasks task_list{2} := [ ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;

...
WaitSyncTask \InPos, sync1, task_list \TimeOut := 60;
...
ERROR
  IF ERRNO = ERR_WAITSYNCTASK THEN
     RETRY;
  ENDIF
```


Continues on next page

The program task `T_ROB1` waits in instruction `WaitSyncTask` until its mechanical units are in position and after that it waits for the program task `T_ROB2` to reach its synchronization point with the same identity. After waiting for `60` s, the error handler is called with `ERRNO` equal to `ERR_WAITSYNCTASK`. Then the instruction `WaitSyncTask` is called again for an additional 60 s.

Error handling

If a time-out occurs because `WaitSyncTask` not ready in time then the system variable `ERRNO` is set to `ERR_WAITSYNCTASK`.

This error can be handled in the `ERROR` handler.

Limitation

If this instruction is preceded by a move instruction then that move instruction must be programmed with a stop point (zonedata `fine`), not a fly-by point. Otherwise restart after power failure will not be possible.

`WaitSyncTask \InPos` cannot be executed in a RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart, or Step.

Syntax

```
WaitSyncTask
  [´\´ InPos ´,´]
  [ SyncID ´:=´ ] < variable (VAR) of syncident> ´,´
  [ TaskList ´:=´ ] < persistent array {*} (PERS) of tasks>
  [ ´\´ TimeOut ´:=´ < expression (IN) of num > ] ´;´
```

Related information

For information about	See
Specify cooperated program tasks	*tasks - RAPID program tasks on page 1204*
Identity for synchronization point	*syncident - Identity for synchronization point on page 1200*

1.235. WaitTestAndSet - Wait until variable unset - then set

Usage

`WaitTestAndSet` instruction waits for a specified `bool` persistent variable value to become `FALSE`. When the variable value becomes `FALSE`, the instruction will set value to `TRUE` and continue the execution. The persistent variable can be used as a binary semaphore for synchronization and mutual exclusion.

This instruction has the same underlying functionality as the `TestAndSet` function, but the `WaitTestAndSet` is waiting as long as the `bool` is `FALSE` while the `TestAndSet` instruction terminates immediately.

It is not recommended to use `WaitTestAndSet` instruction in a TRAP routine, UNDO handler, or event routines.

Examples of resources that can need protection from access at the same time:

- Use of some RAPID routines with function problems when executed in parallel.
- Use of the FlexPendant - Operator Log.

Basic examples

Basic examples of the instruction `WaitTestAndSet` are illustrated below.

See also *More examples on page 693*.

Example 1

`MAIN` program task:

```
PERS bool tproutine_inuse := FALSE;
...
WaitTestAndSet tproutine_inuse;
TPWrite "First line from MAIN";
TPWrite "Second line from MAIN";
TPWrite "Third line from MAIN";
tproutine_inuse := FALSE;
```

`BACK1` program task:

```
PERS bool tproutine_inuse := FALSE;
...
WaitTestAndSet tproutine_inuse;
TPWrite "First line from BACK1";
TPWrite "Second line from BACK1";
TPWrite "Third line from BACK1";
tproutine_inuse := FALSE;
```

To avoid mixing up the lines in the Operator Log (one from `MAIN` and one from `BACK1`) the use of the `WaitTestAndSet` function guarantees that all three lines from each task are not separated.

If program task `MAIN` takes the semaphore `WaitTestAndSet(tproutine_inuse)` first then program task `BACK1` must wait until the program task `MAIN` has left the semaphore.

Continues on next page

Arguments

```
WaitTestAndSet Object
```

`Object`

Data type: `bool`

User defined data object to be used as semaphore. The data object must be a persistent variable `PERS`. If `WaitTestAndSet` are used between different program tasks then the object must be a global `PERS`.

Program execution

This instruction will in one indivisible step check and set the user defined persistent variable like code example below:

- if it has the value `FALSE`, set it to `TRUE`
- if it has the value `TRUE`, wait until it become `FALSE` and then set it to `TRUE`

```
IF Object = FALSE THEN
  Object := TRUE;
ELSE
  ! Wait until it become FALSE
  WaitUntil Object = FALSE;
  Object := TRUE;
ENDIF
```

After that the instruction is ready. To avoid problems, because persistent variables keep their value if program pointer PP is moved to main, always set the semaphore object to `FALSE` in the `START` event routine.

More examples

More examples of the instruction `WaitTestAndSet` are illustrated below.

Example 1

```
PERS bool semPers:= FALSE;
...
PROC doit(...)
  WaitTestAndSet semPers;
  ...
  semPers := FALSE;
ENDPROC
```

NOTE!

If program execution is stopped in the routine `doit` and the program pointer is moved to `main` then the variable `semPers` will not be reset. To avoid this, reset the variable `semPers` to `FALSE` in the `START` event routine.

Syntax

```
WaitTestAndSet
  [ Object ':=' ] < persistent (PERS) of bool> ´;'
```


Continues on next page

Related information

For information about	See
Test variable and set if unset (type polled with WaitTime)	*TestAndSet - Test variable and set if unset on page 1017*

1.236. WaitTime - Waits a given amount of time

Usage

`WaitTime` is used to wait a given amount of time. This instruction can also be used to wait until the robot and external axes have come to a standstill.

Basic examples

Basic examples of the instruction `WaitTime` are illustrated below.

See also *More examples* below.

Example 1

```
WaitTime 0.5;
```

Program execution waits 0.5 seconds.

Arguments

```
WaitTime [\InPos] Time
```

`[\InPos]`

In Position

Data type: `switch`

If this argument is used then the robot and external axes must have come to a standstill before the waiting time starts to be counted. This argument can only be used if the task controls mechanical units.

`Time`

Data type: `num`

The time, expressed in seconds, that program execution is to wait. Min. value 0 s. Max. value no limit. Resolution 0.001 s.

Program execution

Program execution temporarily stops for the given amount of time. Interrupt handling and other similar functions, nevertheless, are still active.

In manual mode, if waiting time is greater than 3 s then an alert box will pop up asking if you want to simulate the instruction. If you do not want the alert box to appear you can set the system parameter Controller/System Misc./ Simulate Menu to 0.

More examples

More examples of how to use the instruction `WaitTime` are illustrated below.

Example 1

```
WaitTime \InPos,0;
```

Program execution waits until the robot and the external axes have come to a standstill.

Continues on next page

Limitations

Argument `\Inpos` cannot be used together with SoftServo.

If this instruction is preceded by a move instruction then that move instruction must be programmed with a stop point (zonedata fine), not a fly-by point. Otherwise restart after power failure will not be possible.

`WaitTime \Inpos` cannot be executed in a RAPID routine connected to any of following special system events: PowerOn, Stop, QStop, Restart, or Step.

Syntax

```
WaitTime
  ['\'InPos',']
  [Time ':='] <expression (IN) of num>';'
```

Related information

For information about	See
Waiting until a condition is met	*WaitUntil - Waits until a condition is met on page 697*
Waiting until an I/O is set/reset	*WaitDI - Waits until a digital input signal is set on page 670*

1.237. WaitUntil - Waits until a condition is met

Usage

`WaitUntil` is used to wait until a logical condition is met; for example, it can wait until one or several inputs have been set.

Basic examples

Basic examples of the instruction `WaitUntil` are illustrated below.

See also *More examples on page 698*.

Example 1

```
WaitUntil di4 = 1;
```

Program execution continues only after the `di4` input has been set.

Arguments

```
WaitUntil [\InPos] Cond [\MaxTime] [\TimeFlag] [\PollRate]
```

`[\InPos]`

In Position

Data type: `switch`

If this argument is used then the robot and external axes must have reached the stop point (`ToPoint` of current move instruction) before the execution can continue. This argument can only be used if the task controls mechanical units.

`Cond`

Data type: `bool`

The logical expression that is to be waited for.

`[\MaxTime]`

Data type: `num`

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the condition is set then the error handler will be called, if there is one, with the error code `ERR_WAIT_MAXTIME`. If there is no error handler then the execution will be stopped.

`[\TimeFlag]`

Timeout Flag

Data type: `bool`

The output parameter that contains the value TRUE if the maximum permitted waiting time runs out before the condition is met. If this parameter is included in the instruction then it is not considered to be an error if the max. time runs out. This argument is ignored if the `MaxTime` argument is not included in the instruction.

Continues on next page

`[\PollRate]`

Polling Rate

Data type: `num`

The polling rate in seconds for checking if the condition in argument `Cond` is `TRUE`. This means that `WaitUntil` first check the condition at once, and if not `TRUE` then every specified second until `TRUE`. Min. polling rate value 0.01 s. If this argument is not used then the default polling rate is set to 0.1 s.

Program execution

If the programmed condition is not met on execution of a `WaitUntil` instruction then condition is checked again every 100 ms (or according value specified in argument `Cond`).

When the robot is waiting the time is supervised, and if it exceeds the max time value then the program will continue if a `TimeFlag` is specified or raise an error if it's not. If a `TimeFlag` is specified then this will be set to TRUE if the time is exceeded. Otherwise it will be set to false.

In manual mode, after waiting more than 3 s, an alert box will pop up asking if you want to simulate the instruction. If you don't want the alert box to appear then you can set system parameter SimMenu to NO (*Technical reference manual - System parameters*, section *Controller - System Misc*).

More examples

More examples of how to use the instruction `WaitUntil` are illustrated below.

Example 1

```
VAR bool timeout;
WaitUntil start_input = 1 AND grip_status = 1\MaxTime := 60
      \TimeFlag := timeout;
IF timeout THEN
  TPWrite "No start order received within expected time";
ELSE
  start_next_cycle;
ENDIF
```

If the two input conditions are not met within `60` seconds then an error message will be written on the display of the FlexPendant.

Example 2

```
WaitUntil \Inpos, di4 = 1;
```

Program execution waits until the robot has come to a standstill and the `di4` input has been set.

Continues on next page

Example 3

```
WaitUntil di4 = 1 \MaxTime:=5;
..
ERROR
  IF ERRNO = ERR_NORUNUNIT THEN
    TPWrite "The I/O unit is not running";
    TRYNEXT;
  ELSEIF ERRNO = ERR_WAIT_MAX THEN
    RAISE;
  ELSE
    Stop;
  ENDIF
```

Program execution waits until the `di4` input has been set. If the I/O unit has been disabled, or the waiting time expires, the execution continues in the error handler.

Error handling

If there is a time-out (parameter `\MaxTime`) before the condition has changed to the right value, the system variable `ERRNO` is set to `ERR_WAIT_MAXTIME` and the execution continues in the error handler.

If there is a signal used in the condition, and there is no contact with the I/O unit, the system variable `ERRNO` is set to `ERR_NORUNUNIT` and the execution continues in the error handler.

These situations can then be dealt with by the error handler.

Limitation

Argument `\Inpos` can not be used together with SoftServo.

If this instruction is preceded by a move instruction then that move instruction must be programmed with a stop point (zonedata fine), not a fly-by point. Otherwise restart after power failure will not be possible.

`WaitUntil \Inpos` cannot be executed in a RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart, or Step.

`WaitUntil \Inpos` cannot be used together with `StopMove` to detect if the movement has been stopped. The `WaitUntil` instruction can be hanging forever in that case. It does not detect that the movement has stopped, it detects that the robot and external axes has reached the last programmed ToPoint (MoveX, SearchX, TriggX).

Syntax

```
WaitUntil
  ['\'InPos',']
  [Cond ':='] <expression (IN) of bool>
  ['\'MaxTime' :='<expression (IN) of num>]
  ['\'TimeFlag' :='<variable (VAR) of bool>]
  ['\'PollRate' :='<expression (IN) of num>]';'
```


Continues on next page

Related information

For information about	See
Waiting until an input is set/reset	*WaitDI - Waits until a digital input signal is set on page 670*
Waiting a given amount of time	*WaitTime - Waits a given amount of time on page 695*
Expressions	*Technical reference manual - RAPID overview*, section *Basic characteristics - Expressions*

1.238. WaitWObj - Wait for work object on conveyor

Usage

`WaitWObj` (*Wait Work Object*) connects to a work object in the start window on the conveyor mechanical unit.

Basic examples

Basic examples of the instruction `WaitWObj` are illustrated below.

See also *More examples on page 702*.

Example 1

```
WaitWObj wobj_on_cnv1;
```

The program connects to the first object in the object queue that is within the start window on the conveyor. If there is no object in the start window then execution waits for an object.

Arguments

```
WaitWObj WObj [ \RelDist ] [\MaxTime] [\TimeFlag]
```

`WObj`

Work Object

Data type: `wobjdata`

The moving work object (coordinate system) to which the robot position in the instruction is related. The mechanical unit conveyor is to be specified by the `ufmec` in the work object.

`[ \RelDist ]`

Relative Distance

Data type: `num`

Waits for an object to enter the start window and go beyond the distance specified by the argument. If the work object is already connected then execution waits until the object passes the given distance. If the object has already gone past the `\RelDist` then execution continues.

`[\MaxTime]`

Maximum Time

Data type: `num`

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the object connection or `\Reldist` reached then the error handler will be called, if there is one, with the error code `ERR_WAIT_MAXTIME`. If there is no error handler then the execution will be stopped.

`[\TimeFlag]`

Timeout Flag

Data type: `bool`

The output parameter that contains the value `TRUE` if the maximum permitted waiting time runs out before the object connection or `\Reldist` is reached. If this parameter is included in the instruction then it is not considered to be an error if the max. time runs out. This argument is ignored if the `MaxTime` argument is not included in the instruction.

Continues on next page

Program execution

If there is no object in the start window then program execution waits. If an object is present then the work object is connected to the conveyor and execution continues.

If a second `WaitWObj` instruction is issued while connected then an error is returned unless the `\RelDist` optional argument is used.

More examples

More examples of the instruction `WaitWObj` are illustrated below.

Example 1

```
WaitWObj wobj_on_cnv1\RelDist:=500.0;
```

If not connected then wait for the object to enter the start window and then wait for the object to pass the 500 mm point on the conveyor.

If already connected to the object then wait for the object to pass 500 mm.

If not connected then wait for an object in the start window.

Example 2

```
WaitWObj wobj_on_cnv1\RelDist:=0.0;
```

If already connected then continue execution as the object has already gone past 0.0 mm.

Example 3

```
WaitWObj wobj_on_cnv1;
WaitWObj wobj_on_cnv1\RelDist:=0.0;
```

The first `WaitWObj` connects to the object in the start window. The second `WaitWObj` will return immediately if the object is still connected. But it will wait for the next object if the previous object had moved past the maximum distance or was dropped.

Example 4

```
WaitWObj wobj_on_cnv1\RelDist:=500.0\MaxTime:=0.1
    \Timeflag:=flag1;
```

The `WaitWobj` will return immediately if the object has passed 500 mm but otherwise will wait 0.1 sec for an object. If no object passes 500 mm during this 0.1 sec the instruction will return with flag1 =`TRUE`.

Limitations

It requires 50 ms to connect to the first object in the start window. Once connected, a second `WaitWObj` with `\RelDist` optional argument will take only normal RAPID instruction execution time.

Error handling

If the following errors occur during execution of the `WaitWobj` instruction then the system variable `ERRNO` will be set. These errors can then be handled in the error handler.

`ERR_CNV_NOT_ACT`	The conveyor is not activated.
`ERR_CNV_CONNECT`	The `WaitWobj` instruction is already connected.
`ERR_CNV_DROPPED`	The object that the instruction `WaitWobj` was waiting for has been dropped by another task. (DSQC 354Revision 2: an object had passed the start window)
`ERR_WAIT_MAXTIME`	The object did not come in time and there is no Timeflag

Continues on next page

Syntax

```
WaitWObj
  [ WObj' :=']< persistent (PERS) of wobjdata> ';'
  [ '\' RelDist ':=' < expression (IN) of num > ]
  ['\'MaxTime ':='<expression (IN) of num>]
  ['\'TimeFlag ':='<variable (VAR) of bool>]' ;'
```

Related information

For information about	See
Drop workobject on conveyor	*DropWObj - Drop work object on conveyor on page 86*
Conveyor tracking	*Application manual - Conveyor tracking*

1.239. WarmStart - Restart the controller

Usage

`WarmStart` is used to restart the controller.

The system parameters can be changed from RAPID with the instruction `WriteCfgData`. You must restart the controller in order for a change to have effect on some of the system parameters. The restart can be done with this instruction `WarmStart`.

Basic examples

Basic examples of the instruction `WarmStart` are illustrated below.

Example 1

```
WriteCfgData "/MOC/MOTOR_CALIB/rob1_1","cal_offset",offset1;
WarmStart;
```

Writes the value of the `num` variable `offset1` as calibration offset for axis 1 on `rob1` and generates a restart of the controller.

Program execution

`Warmstart` takes effect at once and the program pointer is set to the next instruction.

Syntax

```
WarmStart ´;´
```

Related information

For information about	See
Write attribute of a system parameter	*WriteCfgData - Writes attribute of a system parameter on page 721*
Configuration	*Technical reference manual - System parameters*

1.240. WHILE - Repeats as long as ...

Usage

`WHILE` is used when a number of instructions are to be repeated as long as a given condition expression evaluates to a TRUE value.

Basic examples

Basic examples of the instruction `WHILE` are illustrated below.

Example 1

```
WHILE reg1 < reg2 DO
  ...
  reg1 := reg1 + 1;
ENDWHILE
```

Repeats the instructions in the `WHILE`-block as long as `reg1 < reg2`.

Arguments

```
WHILE Condition DO ... ENDWHILE
```

`Condition`

Data type: `bool`

The condition that must be evaluated to a `TRUE` value for the instructions in the `WHILE`-block to be executed.

Program execution

1. The condition expression is evaluated. If the expression evaluates to a `TRUE` value then the instructions in the `WHILE`-block are executed.
2. The condition expression is then evaluated again, and if the result of this evaluation is `TRUE` then the instructions in the `WHILE`-block are executed again.
3. This process continues until the result of the expression evaluation becomes `FALSE`.

The iteration is then terminated and the program execution continues from the instruction after the `WHILE`-block.

If the result of the expression evaluation is `FALSE` at the very outset then the instructions in the `WHILE`-block are not executed at all, and the program control transfers immediately to the instruction that follows after the `WHILE`-block.

Remarks

If it is possible to determine the number of repetitions then the `FOR` instruction can be used.

Syntax

```
(EBNF)
WHILE <conditional expression> DO
  <instruction list>
ENDWHILE
```


Continues on next page

Related information

For information about	See
Expressions	*Technical reference manual - RAPID overview*, section *Basic characteristics - Expressions*
Repeats a given number of times	*FOR - Repeats a given number of times on page 108*

1.241. WorldAccLim - Control acceleration in world coordinate system

Usage

`WorldAccLim` (*World Acceleration Limitation*) is used to limit the acceleration/deceleration of the tool (and payload) in the world coordinate system.

Only implemented for robot type IRB5400-04, IRB6600, and IRB7600 with track motion.

The limitation will be achieved all together in the gravity center point of the actual tool, actual payload (if present), and the mounting flange of the robot.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the instruction `WorldAccLim` are illustrated below.

Example 1

```
WorldAccLim  \On := 3.5;
```

Acceleration is limited to `3.5` m/s^2.

Example 2

```
WorldAccLim \Off;
```

The acceleration is reset to maximum (default).

Arguments

```
WorldAccLim [\On]|[\Off]
```

`[ \On ]`

Data type: `num`

The absolute value of the acceleration limitation in m/s^2.

`[ \Off ]`

Data type: `switch`

Maximum acceleration (default).

Program execution

The acceleration limitations applies for the next executed robot segment and is valid until a new `WorldAccLim` instruction is executed.

The maximum acceleration (`WorldAccLim \Off`) is automatically set

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

It is recommended to use just one type of limitation of the acceleration. If a combination of instructions `WorldAccLim`, `AccSet`, and `PathAccLim` are done then the system reduces the acceleration/deceleration in the following order:

- according `WorldAccLim`
- according `AccSet`
- according `PathAccLim`

Continues on next page

Limitations

The minimum acceleration allowed is 1 m/s^2.

Error handling

If the argument `On` is set to a value that is too low then the system variable ERRNO is set to ERR_ACC_TOO_LOW. This error can then be handled in the error handler.

Syntax

```
WorldAccLim
  [´\’On ’:=’ <expression (IN) of num>] | [´\’Off ]’;’
```

Related information

For information about	See
Positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Motion settings data	*motsetdata - Motion settings data on page 1141*
Reduction of acceleration	*AccSet - Reduces the acceleration on page 15*
Limitation of acceleration along the path	*PathAccLim - Reduce TCP acceleration along the path on page 295*

1.242. Write - Writes to a character-based file or serial channel

Usage

`Write` is used to write to a character-based file or serial channel. The value of certain data can be written as well as text.

Basic examples

Basic examples of the instruction `Write` are illustrated below.

See also *More examples on page 711*.

Example 1

```
Write logfile, "Execution started";
```

The text `Execution started` is written to the file with reference name `logfile`.

Example 2

```
VAR num reg1:=5;
...
Write logfile, "No of produced parts="\Num:=reg1;
```

The text `No of produced parts=5`, is written to the file with the reference name `logfile`.

Arguments

```
Write IODevice String [\Num] | [\Bool] | [\Pos] | [\Orient] |
     [\Dnum] [\NoNewLine]
```

`IODevice`

Data type: `iodev`

The name (reference) of the current file or serial channel.

`String`

Data type: `string`

The text to be written.

`[\Num]`

Numeric

Data type: `num`

The data whose numeric values are to be written after the text string.

`[\Bool]`

Boolean

Data type: `bool`

The data whose logical values are to be written after the text string.

`[\Pos]`

Position

Data type: `pos`

The data whose position is to be written after the text string.

Continues on next page

`[\Orient]`

Orientation

Data type: `orient`

The data whose orientation is to be written after the text string.

`[\Dnum]`

Numeric

Data type: `dnum`

The data whose numeric values are to be written after the text string.

`[\NoNewLine]`

Data type: `switch`

Omits the line-feed character that normally indicates the end of the text, i.e. next `write` instruction will continue on the same line.

Program execution

The text string is written to a specified file or serial channel. A line-feed character (LF) is also written, but can be omitted if the argument `\NoNewLine` is used.

If one of the arguments `\Num`, `\Bool`, `\Pos`, or `\Orient` is used then its value is first converted to a text string before being added to the first string. The conversion from value to text string takes place as follows:

Argument	Value	Text string
`\Num`	23	“23”
`\Num`	1.141367	“1.14137”
`\Bool`	`TRUE`	“TRUE”
`\Pos`	[1817.3,905.17,879.11]	"[1817.3,905.17,879.11]"
`\Orient`	[0.96593,0,0.25882,0]	“[0.96593,0,0.25882,0]"
`\Dnum`	4294967295	"4294967295"

The value is converted to a string with standard RAPID format. This means in principle 6 significant digits. If the decimal part is less than 0.000005 or greater than 0.999995, the number is rounded to an integer.

Continues on next page

More examples

More examples of the instruction `Write` are illustrated below.

Example 1

```
VAR iodev printer;
VAR num reg1:=0
VAR num stopprod_value:=0
...
Open "com2:", printer\Write;
stopprod_value:=stopprod;
WHILE stopprod_value = 0 DO
  produce_part;
  reg1:=reg1+1;
  Write printer, "Produced part="\Num:=reg1\NoNewLine;
  Write printer, " "\NoNewLine;
  Write printer, CTime();
  stopprod_value:=stopprod;
ENDWHILE
Close printer;
```

A line, including the number of the produced part and the time, is outputed to a printer each cycle. The printer is connected to serial channel `com2:`. The printed message could look like this:

`Produced part=473`	09:47:15

Limitations

The arguments `\Num`, `\Dnum`, `\Bool`, `\Pos`, and `\Orient` are mutually exclusive and thus cannot be used simultaneously in the same instruction.

This instruction can only be used for files or serial channels that have been opened for writing.

Error handling

If an error occurs during writing then the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

Syntax

```
Write
  [IODevice':='] <variable (VAR) of iodev>','
  [String':='] <expression (IN) of string>
  ['\'Num':=' <expression (IN) of num> ]
  | ['\'Bool':=' <expression (IN) of bool> ]
  | ['\'Pos':=' <expression (IN) of pos> ]
  | ['\'Orient':=' <expression (IN) of orient> ]
  | ['\'Dnum':=' <expression (IN) of dnum> ]
  ['\'NoNewLine]';'
```


Continues on next page

Related information

For information about	See
Opening a file or serial channel	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*

1.243. WriteAnyBin - Writes data to a binary serial channel or file

Usage

`WriteAnyBin` (*Write Any Binary*) is used to write any type of data to a binary serial channel or file.

Basic examples

Basic examples of the instruction `WriteAnyBin` are illustrated below.

See also *More examples on page 714*.

Example 1

```
VAR iodev channel2;
VAR orient quat1 := [1, 0, 0, 0];
...
Open "com2:", channel2 \Bin;
WriteAnyBin channel2, quat1;
```

The `orient` data `quat1` is written to the channel referred to by `channel2`.

Arguments

```
WriteAnyBin IODevice Data
```

`IODevice`

Data type: `iodev`

The name (reference) of the binary serial channel or file for the writing operation.

`Data`

Data type: `ANYTYPE`

Data to be written.

Program execution

As many bytes as required for the specified data are written to the specified binary serial channel or file.

Limitations

This instruction can only be used for serial channels or files that have been opened for binary writing.

The data to be written by this instruction `WriteAnyBin` must be value data type such as `num`, `bool`, or `string`. Record, record component, array, or array element of these value data types can also be used. Entire data or partial data with semi-value or non-value data types cannot be used.

Error handling

If an error occurs during writing then the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

Continues on next page

More examples

More examples of the instruction `WriteAnyBin` are illustrated below.

Example 1

```
VAR iodev channel;
VAR num input;
VAR robtarget cur_robt;

Open "com2:", channel\Bin;

! Send the control character enq
WriteStrBin channel, "\05";
! Wait for the control character ack
input := ReadBin (channel \Time:= 0.1);
IF input = 6 THEN
  ! Send current robot position
  cur_robt := CRobT(\Tool:= tool1\WObj:= wobj1);
  WriteAnyBin channel, cur_robt;
ENDIF

Close channel;
```

The current position of the robot is written to a binary serial channel.

Limitations

Because `WriteAnyBin-ReadAnyBin` is designed to only send internal controller data between `IRC5` control systems, no data protocol is released and the data cannot be interpreted on any `PC`.

Control software development can break the compatibility, and therefore it is not possible to use `WriteAnyBin-ReadAnyBin` between different software versions of RobotWare. If a `WriteAnyBin` to file is done with RobotWare version 5.07, the file cannot be read by instruction `ReadAnyBin` with RobotWare version 5.08. And the opposite case, if a `WriteAnyBin` to file is done with RobotWare version 5.08, the file cannot be read by instruction `ReadAnyBin` with RobotWare version 5.07.

Version 0 for IRC5 controller software equal or less than `RW5.07`

Version 1 for IRC5 controller software equal or greater than `RW5.08`

Always compatible within all revisions of any software versions.

Syntax

```
WriteAnyBin
  [IODevice':='] <variable (VAR) of iodev>','
  [Data':='] <expression (IN) of ANYTYPE>';'
```


Continues on next page

Related information

For information about	See
Opening, etc. of serial channels or files	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*
Read data from a binary serial channel or file	*ReadAnyBin - Read data from a binary serial channel or file on page 340*

1.244. WriteBin - Writes to a binary serial channel

Usage

`WriteBin` is used to write a number of bytes to a binary serial channel.

Basic examples

Basic examples of the instruction `WriteBin` are illustrated below.

See also *More examples on page 717*.

Example 1

```
WriteBin channel2, text_buffer, 10;
```

`10` characters from the `text_buffer` list are written to the channel referred to by `channel2`.

Arguments

```
WriteBin IODevice Buffer NChar
```

`IODevice`

Data type: `iodev`

Name (reference) of the current serial channel.

`Buffer`

Data type: `array of num`

The list (array) containing the numbers (characters) to be written.

`NChar`

Number of Characters

Data type: `num`

The number of characters to be written from the `Buffer`.

Program execution

The specified number of numbers (characters) in the list is written to the serial channel.

Limitations

This instruction can only be used for serial channels that have been opened for binary writing.

Error handling

If an error occurs during writing then the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

Continues on next page

More examples

More examples of how to use the instruction `WriteBin` are illustrated below.

Example 1

```
VAR iodev channel;
VAR num out_buffer{20};
VAR num input;
VAR num nchar;
Open "com2:", channel\Bin;

out_buffer{1} := 5;!( enq )
WriteBin channel, out_buffer, 1;
input := ReadBin (channel \Time:= 0.1);

IF input = 6 THEN !( ack )
  out_buffer{1} := 2;!( stx )
  out_buffer{2} := 72;!( 'H' )
  out_buffer{3} := 101;!( 'e' )
  out_buffer{4} := 108;!( 'l' )
  out_buffer{5} := 108;!( 'l' )
  out_buffer{6} := 111;!( 'o' )
  out_buffer{7} := 32;!( ' ' )
  out_buffer{8} := StrToByte("w"\Char);!( 'w' )
  out_buffer{9} := StrToByte("o"\Char);!( 'o' )
  out_buffer{10} := StrToByte("r"\Char);!( 'r' )
  out_buffer{11} := StrToByte("l"\Char);!( 'l' )
  out_buffer{12} := StrToByte("d"\Char);!( 'd' )
  out_buffer{13} := 3;!( etx )
  WriteBin channel, out_buffer, 13;
ENDIF
```

After a handshake (`enq,ack`) the text string `Hello world` (with associated control characters) is written to a serial channel. The function `StrToByte` is used in the same cases to convert a string into a `byte` (`num`) data.

Syntax

```
WriteBin
  [IODevice':='] <variable (VAR) of iodev>','
  [Buffer':='] <array {*} (IN) of num>','
  [NChar':='] <expression (IN) of num>';'
```

Continues on next page

Related information

For information about	See
Opening, etc. of serial channels	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*
Convert a string to a byte data	*StrToByte - Converts a string to a byte data on page 1007*
Byte data	*byte - Integer values 0 - 255 on page 1091*

1.245. WriteBlock - write block of data to device

Usage

`WriteBlock` is used to write a block of data to a device connected to the serial sensor interface. The data is fetched from a file.

The sensor interface communicates with sensors over serial channels using the RTP1 transport protocol.

This is an example of a sensor channel configuration.

COM_PHY_CHANNEL:

- Name “COM1:”
- Connector “COM1”
- Baudrate 19200

COM_TRP:

- Name “sen1:”
- Type “RTP1”
- PhyChannel “COM1”

Basic examples

Basic example of the instruction `WriteBlock` are illustrated below.

Example 1

```
CONST string SensorPar := "flp1:senpar.cfg";
CONST num ParBlock:= 1;

! Connect to the sensor device "sen1:" (defined in sio.cfg).
SenDevice "sen1:";

! Write sensor parameters from flp1:senpar.cfg
! to sensor datablock 1.

WriteBlock "sen1:", ParBlock, SensorPar;
```

Arguments

```
WriteBlock device BlockNo FileName [ \TaskName ]
```

`device`

Data type: `string`

The I/O device name configured in sio.cfg for the sensor used.

`BlockNo`

Data type: `num`

The argument `BlockNo` is used to select the data block in the sensor block to be written.

Continues on next page

`FileName`

Data type: `string`

The argument `FileName` is used to select a file from which data is written to the data block in the sensor selected by the `BlockNo` argument.

`[ \TaskName ]`

Data type: `string`

The argument `TaskName` makes it possible to access devices in other RAPID tasks.

Fault management

Error constant (`ERRNO` value)	Description
`SEN_NO_MEAS`	Measurement failure
`SEN_NOREADY`	Sensor unable to handle command
`SEN_GENERRO`	General sensor error
`SEN_BUSY`	Sensor bus
`SEN_UNKNOWN`	Unknown sensor
`SEN_EXALARM`	External sensor error
`SEN_CAALARM`	Internal sensor error
`SEN_TEMP`	Sensor temperature error
`SEN_VALUE`	Illegal communication value
`SEN_CAMCHECK`	Sensor check failure
`SEN_TIMEOUT`	Communication error

Syntax

```
WriteBlock
  [ device ':=' ] < expression(IN) of string>','
  [ BlockNo' :=' ] < expression (IN) of num > ','
  [ FileName' :=' ] < expression (IN) of string > ','
  [ '\' TaskName' :=' < expression (IN) of string > ] ';'
```

Related information

For information about	See
Connect to a sensor device	*SenDevice - connect to a sensor device on page 425*
Write a sensor variable	*WriteVar - write variable on page 729*
Read a sensor data block	*ReadBlock - read a block of data from device on page 343*
Configuration of sensor communication	*Technical reference manual - System parameters*, section *Communication*

1.246. WriteCfgData - Writes attribute of a system parameter

Usage

`WriteCfgData` is used to write one attribute of a system parameter (configuration data).

Besides writing named parameters, it is also possible to search and update unnamed parameters

Basic examples

Basic examples of the instruction `WriteCfgData` are illustrated below. Both of these examples show how to write named parameter data.

Example 1

```
VAR num offset1 := 1.2;
...
WriteCfgData "/MOC/MOTOR_CALIB/rob1_1","cal_offset",offset1;
```

Written in the `num` variable `offset1`, the calibration offset for axis `1` on `rob_1` .

Example 2

```
VAR string io_unit := "my_unit";
...
WriteCfgData "/EIO/EIO_SIGNAL/process_error","Unit",io_unit;
```

Written in the `string` variable `io_unit`, the name of the I/O unit where the signal `process_error` is defined.

Arguments

```
WriteCfgData InstancePath Attribute CfgData [\ListNo]
```

`InstancePath`

Data type: `string`

Specifies the path to the parameter to be accessed.

For named parameters, the format of this string is `/DOMAIN/TYPE/ParameterName`.

For unnamed parameters, the format of this string is `/DOMAIN/TYPE/Attribute/AttributeValue`.

`Attribute`

Data type: `string`

The name of the attribute of the parameter to be written.

`CfgData`

Data type: `anytype`

The data object from which the new data to store is read. Depending on the attribute type, valid types are `bool`, `num`, or `string`.

Continues on next page

`[\ListNo]`

Data type: `num`

Variable holding the instance number of the `Attribute` + `AttributeValue` to be found and updated.

First occurrence of the `Attribute` + `AttributeValue` has instance number 0. If there are more instances to search for then the returned value in `\ListNo` will be incremented with 1. Otherwise if there are no more instance then the returned value will be -1. The predefined constant `END_OF_LIST` can be used for check if there are more instances to search for.

Program execution

The value of the attribute specified by the `Attribute` argument is set according to the value of the data object specified by the `CfgData` argument.

If using format `/DOMAIN/TYPE/ParameterName` in `InstancePath` then only named parameters can be accessed, i.e. parameters where the first attribute is `name`, `Name`, or `NAME`.

For unnamed parameters, use the optional parameter `\ListNo` to specify which instance to write the attribute value to. It is updated after each successful write to the next available instance to write to.

More examples

More examples of the instruction `WriteCfgdata` are illustrated below. Both of these examples show how to write to unnamed parameters.

Example 1

```
VAR num read_index;
VAR num write_index;
VAR string read_str;
...
read_index:=0;
write_index:=0;
ReadCfgData "/EIO/EIO_CROSS/Act1/do_13", "Res", read_str,
      \ListNo:=read_index;
WriteCfgData "/EIO/EIO_CROSS/Act1/do_13", "Res", "my"+read_str,
      \ListNo:=write_index;
```

Reads the resultant signal for the unnamed digital actor signal `do_13` and places the name in the string variable `read_str`. Then update the name to `di_13` with prefix "`my`".

In this example, domain EIO has the following cfg code:

EIO_CROSS:

-Res "di_1" -Act1 "do_2"

-Res "di_2" -Act1 "do_2"

-Res "di_13" -Act1 "do_13"

Continues on next page

Example 2

```
VAR num read_index;
VAR num write_index;
VAR string read_str;
...
read_index:=0;
write_index:=0;
WHILE read_index <> END_OF_LIST DO
  ReadCfgData "/EIO/EIO_SIGNAL/Unit/USERIO", "Name", read_str,
       \ListNo:=read_index;
  IF read_index <> END_OF_LIST THEN
    WriteCfgData "/EIO/EIO_SIGNAL/Unit/USERIO", "Name",
         "my"+read_str, \ListNo:=write_index;
  ENDIF
ENDWHILE
```

Read the names of all signals defined for the I/O unit `USERIO`. Change the names on the signals to the read name with the prefix "`my`".

In this example, domain EIO has the following cfg code:

EIO_SIGNAL:

-Name "USERDO1" -SignalType "DO" -Unit "USERIO" -UnitMap "0"

-Name "USERDO2" -SignalType "DO" -Unit "USERIO" -UnitMap "1"

-Name "USERDO3" -SignalType "DO" -Unit "USERIO" -UnitMap "2"

Error handling

If it is not possible to find the data specified with “`InstancePath` + `Attribute`” in the configuration database then the system variable ERRNO is set to `ERR_CFG_NOTFND`.

If the data type for parameter `CfgData` is not equal to the real data type for the found data specified with“`InstancePath` + `Attribute`” in the configuration database then the system variable ERRNO is set to `ERR_CFG_ILLTYPE`.

If the data for parameter `CfgData` is outside limits (max./min. value) then the system variable `ERRNO` is set to `ERR_CFG_LIMIT`.

If trying to write internally written protected data then the system variable ERRNO is set to `ERR_CFG_INTERNAL`.

If variable in argument `\ListNo` has a value outside range of available instances (0 ... n) when executing the instruction then `ERRNO` is set to `ERR_CFG_OUTOFBOUNDS`.

These errors can then be handled in the error handler.

Continues on next page

Limitations

The conversion from RAPID program units (mm, degree, second etc.) to system parameter units (m, radian, second etc.) for `CfgData` of data type `num` must be done by the user in the RAPID program.

You must manually restart the controller or execute the instruction `WarmStart` in order for the change to have effect.

If using format `/DOMAIN/TYPE/ParameterName` in `InstancePath` then only named parameters can be accessed, i.e. parameters where the first attribute is `name`, `Name`, or `NAME`.

RAPID strings are limited to 80 characters. In some cases, this can be in theory too small for the definition of `InstancePath`, `Attribute`, or `CfgData`.

Predefined data

The predefined constant `END_OF_LIST` with value -1 can be used to stop writing when no more instances can be found.

Syntax

```
WriteCfgData
[ InstancePath' :=' ] < expression (IN) of string >','
[ Attribute' :=' ] < expression (IN) of string >','
[ CfgData' :=' ] < expression (IN) of anytype >
['\'ListNo':=' < variable (VAR) of num >]';'
```

Related information

For information about	See
Definition of string	*string - Strings on page 1195*
Read attribute of a system parameter	*ReadCfgData - Reads attribute of a system parameter on page 345*
Get robot name in current task	*RobName - Get the TCP robot name on page 966*
Configuration	*Technical reference manual - System parameters*
Warm start of the system	*WarmStart - Restart the controller on page 704*

1.247. WriteRawBytes - Write rawbytes data

Usage

`WriteRawBytes` is used to write data of type `rawbytes` to a device opened with `Open\Bin`.

Basic examples

Basic examples of the instruction `WriteRawBytes` are illustrated below.

Example 1

```
VAR iodev io_device;
VAR rawbytes raw_data_out;
VAR rawbytes raw_data_in;
VAR num float := 0.2;
VAR string answer;

ClearRawBytes raw_data_out;
PackDNHeader "10", "20 1D 24 01 30 64", raw_data_out;
PackRawBytes float, raw_data_out, (RawBytesLen(raw_data_out)+1)
     \Float4;

Open "/FCI1:/dsqc328_1", io_device \Bin;
WriteRawBytes io_device, raw_data_out;
ReadRawBytes io_device, raw_data_in \Time:=1;
Close io_device;

UnpackRawBytes raw_data_in, 1, answer \ASCII:=10;
```

In this example `raw_data_out` is cleared and then packed with DeviceNet header and a float with value `0.2`.

A device, `"/FCI1/:dsqc328_1"`, is opened and the current valid data in `raw_data_out` is written to the device. Then the program waits for at most 1 second to read from the device, which is stored in the `raw_data_in`.

After having closed the device “`/FCI1/:dsqc328_1`”, then the read data is unpacked as a string of `10` characters and stored in answer.

Arguments

```
WriteRawBytes IODevice RawData [\NoOfBytes]
```

`IODevice`

Data type: `iodev`

`IODevice` is the identifier of the device to which `RawData` shall be written.

`RawData`

Data type: `rawbytes`

`RawData` is the data container to be written to `IODevice`.

Continues on next page

`[\NoOfBytes]`

Data type: `num`

`\NoOfBytes` tells how many bytes of `RawData` should be written to `IODevice`, starting at index 1.

If `\NoOfBytes` is not present then the current length of valid bytes in the variable `RawData` is written to device IODevice.

Program execution

During program execution, data is written to the device indicated by `IODevice`.

If using `WriteRawBytes` for field bus commands, such as DeviceNet, then the field bus always sends an answer. The answer must be handle in RAPID with the `ReadRawBytes` instruction.

The current length of valid bytes in the `RawData` variable is not changed.

Error handling

If an error occurs during writing then the system variable `ERRNO` is set to `ERR_FILEACC`.

This error can then be dealt with by the error handler.

Syntax

```
WriteRawBytes
  [IODevice ':=' ] < variable (VAR) of iodev> ´,'
  [RawData ':=' ] < variable (VAR) of rawbytes>
  [´\'NoOfBytes' :=' < expression (IN) of num>]';'
```

Related information

For information about	See
`rawbytes` data	*rawbytes - Raw data on page 1165*
Get the length of `rawbytes` data	*RawBytesLen - Get the length of rawbytes data on page 940*
Clear the contents of `rawbytes` data	*ClearRawBytes - Clear the contents of rawbytes data on page 49*
Copy the contents of `rawbytes` data	*CopyRawBytes - Copy the contents of rawbytes data on page 67*
Pack DeviceNet header into `rawbytes` data	*PackDNHeader - Pack DeviceNet Header into rawbytes data on page 287*
Pack data into `rawbytes` data	*PackRawBytes - Pack data into rawbytes data on page 290*
Read `rawbytes` data	*ReadRawBytes - Read rawbytes data on page 352*
Unpack data from `rawbytes` data	*UnpackRawBytes - Unpack data from rawbytes data on page 658*

1.248. WriteStrBin - Writes a string to a binary serial channel

Usage

`WriteStrBin` (*Write String Binary*) is used to write a string to a binary serial channel or binary file.

Basic examples

Basic examples of the instruction `WriteStrBin` are illustrated below.

See also *More examples on page 728*.

Example 1

```
WriteStrBin channel2, "Hello World\0A";
```

The string `"Hello World\0A"` is written to the channel referred to by `channel2`. The string is in this case ended with new line `\0A`. All characters and hexadecimal values written with `WriteStrBin` will be unchanged by the system.

Arguments

```
WriteStrBin IODevice Str
```

`IODevice`

Data type: `iodev`

Name (reference) of the current serial channel.

`Str`

String

Data type: `string`

The text to be written.

Program execution

The text string is written to the specified serial channel or file.

Limitations

This instruction can only be used for serial channels or files that have been opened for binary reading and writing.

Error handling

If an error occurs during writing then the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

Continues on next page

More examples

More examples of how to use the instruction `WriteStrBin` are illustrated below.

Example 1

```
VAR iodev channel;
VAR num input;
Open "com2:", channel\Bin;

! Send the control character enq
WriteStrBin channel, "\05";
! Wait for the control character ack
input := ReadBin (channel \Time:= 0.1);
IF input = 6 THEN
  ! Send a text starting with control character stx and ending with
       etx
  WriteStrBin channel, "\02Hello world\03";
ENDIF

Close channel;
```

After a handshake the text string `Hello world` (with associated control characters in hexadecimal) is written to a binary serial channel.

Syntax

```
WriteStrBin
  [IODevice':='] <variable (VAR) of iodev>','
  [Str':='] <expression (IN) of string>';'
```

Related information

For information about	See
Opening, etc. of serial channels	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*
Read binary sting	*ReadStrBin - Reads a string from a binary serial channel or file on page 956*

1.249. WriteVar - write variable

Usage

`WriteVar` is used to write a variable to a device connected to the serial sensor interface.

The sensor interface communicates with sensors over serial channels using the RTP1 transport protocol.

This is an example of a sensor channel configuration.

COM_PHY_CHANNEL:

- Name “COM1:”
- Connector “COM1”
- Baudrate 19200

COM_TRP:

- Name “sen1:”
- Type “RTP1”
- PhyChannel “COM1”

Basic examples

Basic examples of the instruction `WriteVar` are illustrated below.

Example 1

```
! Define variable numbers
CONST num SensorOn := 6;
CONST num XCoord := 8;
CONST num YCoord := 9;
CONST num ZCoord := 10;
VAR pos SensorPos;

! Connect to the sensor device“ sen1:” (defined in sio.cfg).
SenDevice "sen1:";

! Request start of sensor meassurements
WriteVar "sen1:", SensorOn, 1;

! Read a cartesian position from the sensor.
SensorPos.x := ReadVar "sen1:", XCoord;
SensorPos.y := ReadVar "sen1:", YCoord;
SensorPos.z := ReadVar "sen1:", ZCoord;

! Stop sensor
WriteVar "sen1:", SensorOn, 0;
```


Continues on next page

Arguments

```
WriteVar device VarNo VarData [ \TaskName ]
```

`device`

Data type: `string`

The I/O device name configured in sio.cfg for the sensor used.

`VarNo`

Data type: `num`

The argument `VarNo` is used to select the sensor variable.

`VarData`

Data type: `num`

The argument `VarData` defines the data which is to be written to the variable selected by the `VarNo` argument.

`[ \TaskName ]`

Data type: `string`

The argument `TaskName` makes it possible to access devices in other RAPID tasks.

Fault management

Error constant (`ERRNO`) value	Description
`SEN_NO_MEAS`	Measurement failure
`SEN_NOREADY`	Sensor unable to handle command
`SEN_GENERRO`	General sensor error
`SEN_BUSY`	Sensor busy
`SEN_UNKNOWN`	Unknown sensor
`SEN_EXALARM`	External sensor error
`SEN_CAALARM`	Internal sensor error
`SEN_TEMP`	Sensor temperature error
`SEN_VALUE`	Illegal communication value
`SEN_CAMCHECK`	Sensor check failure
`SEN_TIMEOUT`	Communication error

Syntax

```
WriteVar
  [ device ':=' ] < expression (IN) of string> ','
  [ VarNo ':=' ] < expression (IN) of num > ','
  [ VarData' :=' ] < expression (IN) of num > ','
  [ '\' TaskName' :=' < expression (IN) of string > ] ';'
```


Continues on next page

Related information

For information about	See
Connect to a sensor device	*SenDevice - connect to a sensor device on page 425*
Read a sensor variable	*ReadVar - Read variable from a device on page 958*
Write a sensor data block	*WriteBlock - write block of data to device on page 719*
Read a sensor data block	*ReadBlock - read a block of data from device on page 343*
Configuration of sensor communication	*Technical reference manual - System parameters*, section *Communication*

1.250. WZBoxDef - Define a box-shaped world zone

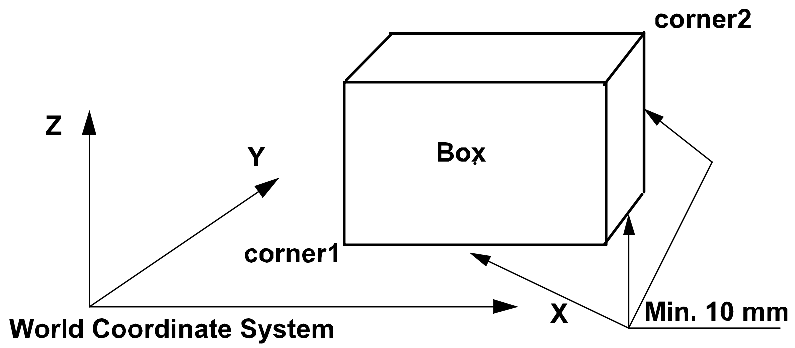
Usage

`WZBoxDef` (*World Zone Box Definition*) is used to define a world zone that has the shape of a straight box with all its sides parallel to the axes of the World Coordinate System.

Basic examples

Basic examples of the instruction `WZBoxDef` are illustrated below.

Example 1



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```
VAR shapedata volume;
CONST pos corner1:=[200,100,100];
CONST pos corner2:=[600,400,400];
...
WZBoxDef \Inside, volume, corner1, corner2;
```

Define a straight box with coordinates parallel to the axes of the world coordinate system and defined by the opposite corners `corner1` and `corner2`.

Arguments

```
WZBoxDef [\Inside] | [\Outside] Shape LowPoint HighPoint
```

`[\Inside]`

Data type: `switch`

Define the volume inside the box.

`[\Outside]`

Data type: `switch`

Define the volume outside the box (inverse volume).

One of the arguments `\Inside` or `\Outside` must be specified.

`Shape`

Data type: `shapedata`

Variable for storage of the defined volume (private data for the system).

Continues on next page

`LowPoint`

Data type: `pos`

Position (x,y,z) in mm defining one lower corner of the box.

`HighPoint`

Data type: `pos`

Position (x,y,z) in mm defining the corner diagonally opposite to the previous one.

Program execution

The definition of the box is stored in the variable of type `shapedata` (argument `Shape`), for future use in `WZLimSup` or `WZDOSet` instructions.

Limitations

The `LowPoint` and `HighPoint` positions must be valid for opposite corners (with different x, y, and z coordinate values).

If the robot is used to point out the `LowPoint` or `HighPoint` then work object `wobj0` must be active (use of component `trans` in `robtarget` e.g. `p1.trans` as argument).

Syntax

```
WZBoxDef
  [['\'Inside] | ['\'Outside]',']
  [LowPoint':=']<expression (IN) of pos>','
  [Shape':=']<variable (VAR) of shapedata>','
  [HighPoint':=']<expression (IN) of pos>';'
```

Related information

For information about	See
World Zones	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - World zones*
World zone shape	*shapedata - World zone shape data on page 1179*
Define sphere-shaped world zone	*WZSphDef - Define a sphere-shaped world zone on page 756*
Define cylinder-shaped world zone	*WZCylDef - Define a cylinder-shaped world zone on page 734*
Define a world zone for home joints	*WZHomeJointDef - Define a world zone for home joints on page 746*
Define a world zone for limit joints	*WZLimJointDef - Define a world zone for limitation in joints on page 749*
Activate world zone limit supervision	*WZLimSup - Activate world zone limit supervision on page 753*
Activate world zone digital output set	*WZDOSet - Activate world zone to set digital output on page 738*

1.251. WZCylDef - Define a cylinder-shaped world zone

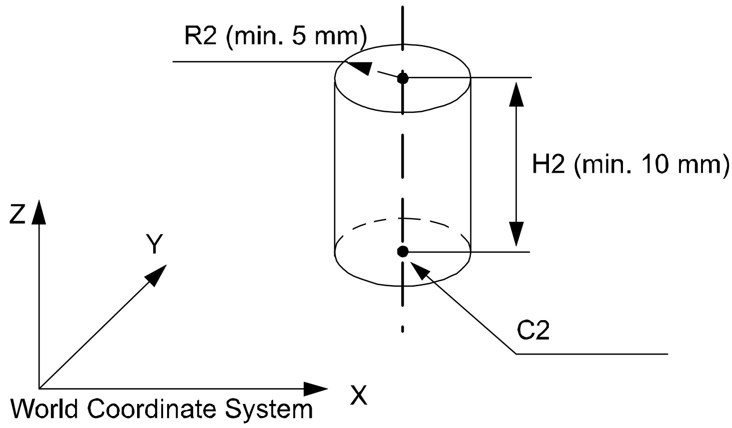
Usage

`WZCylDef` (*World Zone Cylinder Definition*) is used to define a world zone that has the shape of a cylinder with the cylinder axis parallel to the z-axis of the World Coordinate System.

Basic examples

Basic examples of the instruction `WZCylDef` are illustrated below.

Example 1



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```
VAR shapedata volume;
CONST pos C2:=[300,200,200];
CONST num R2:=100;
CONST num H2:=200;
...
WZCylDef \Inside, volume, C2, R2, H2;
```

Define a cylinder with the center of the bottom circle in `C2`, radius `R2`, and height `H2`.

Arguments

```
WZCylDef [\Inside] | [\Outside] Shape CentrePoint Radius Height
```

`[\Inside]`

Data type: `switch`

Define the volume inside the cylinder.

`[\Outside]`

Data type: `switch`

Define the volume outside the cylinder (inverse volume).

One of the arguments `\Inside` or `\Outside` must be specified.

`Shape`

Data type: `shapedata`

Variable for storage of the defined volume (private data for the system).

Continues on next page

`CentrePoint`

Data type: `pos`

Position (x,y,z) in mm defining the center of one circular end of the cylinder.

`Radius`

Data type: `num`

The radius of the cylinder in mm.

`Height`

Data type: `num`

The height of the cylinder in mm. If it is positive (+z direction), the `CentrePoint` argument is the center of the lower end of the cylinder (as in the above example). If it is negative (-z direction) then the `CentrePoint` argument is the center of the upper end of the cylinder.

Program execution

The definition of the cylinder is stored in the variable of type `shapedata` (argument `Shape`) for future use in `WZLimSup` or `WZDOSet` instructions.

Limitations

If the robot is used to point out the `CentrePoint` then the work object `wobj0` must be active (use of component `trans` in `robtarget` e.g. `p1.trans` as argument).

Syntax

```
WZCylDef
  ['\'Inside] | ['\'Outside]','
  [Shape':=']<variable (VAR) of shapedata>','
  [centerPoint':=']<expression (IN) of pos>','
  [Radius':=']<expression (IN) of num>','
  [Height':=']<expression (IN) of num>';'
```

Related information

For information about	See
World Zones	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - World zones*
World zone shape	*shapedata - World zone shape data on page 1179*
Define box-shaped world zone	*WZBoxDef - Define a box-shaped world zone on page 732*
Define sphere-shaped world zone	*WZSphDef - Define a sphere-shaped world zone on page 756*
Define a world zone for home joints	*WZHomeJointDef - Define a world zone for home joints on page 746*
Define a world zone for limit joints	*WZLimJointDef - Define a world zone for limitation in joints on page 749*
Activate world zone limit supervision	*WZLimSup - Activate world zone limit supervision on page 753*
Activate world zone digital output set	*WZDOSet - Activate world zone to set digital output on page 738*

1.252. WZDisable - Deactivate temporary world zone supervision

Usage

`WZDisable` (*World Zone Disable*) is used to deactivate the supervision of a temporary world zone previously defined either to stop the movement or to set an output.

Basic examples

Basic examples of the instruction `WZDisable` are illustrated below.

Example 1

```
VAR wztemporary wzone;
...
PROC...
  WZLimSup \Temp, wzone, volume;
  MoveL p_pick, v500, z40, tool1;
  WZDisable wzone;
  MoveL p_place, v200, z30, tool1;
ENDPROC
```

When moving to `p_pick`, the position of the robot's TCP is checked so that it will not go inside the specified volume `wzone`. This supervision is not performed when going to `p_place`.

Arguments

```
WZDisable WorldZone
```

`WorldZone`

Data type: `wztemporary`

Variable or persistent variable of type `wztemporary`, which contains the identity of the world zone to be deactivated.

Program execution

The temporary world zone is deactivated. This means that the supervision of the robot's TCP, relative to the corresponding volume, is temporarily stopped. It can be re-activated via the `WZEnable` instruction.

Limitations

Only a temporary world zone can be deactivated. A stationary world zone is always active.

Syntax

```
WZDisable
  [WorldZone':=']<variable or persistent (INOUT) of
       wztemporary>';'
```


Continues on next page

Related information

For information about	See
World Zones	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - World zones*
World zone shape	*shapedata - World zone shape data on page 1179*
Temporary world zone data	*wztemporary - Temporary world zone data on page 1230*
Activate world zone limit supervision	*WZLimSup - Activate world zone limit supervision on page 753*
Activate world zone set digital output	*WZDOSet - Activate world zone to set digital output on page 738*
Activate world zone	*WZEnable - Activate temporary world zone supervision on page 742*
Erase world zone	*WZFree - Erase temporary world zone supervision on page 744*

1.253. WZDOSet - Activate world zone to set digital output

Usage

`WZDOSet` (*World Zone Digital Output Set*) is used to define the action and to activate a world zone for supervision of the robot movements.

After this instruction is executed, when the robot's TCP or the robot/external axes (zone in joints) is inside the defined world zone or is approaching close to it, a digital output signal is set to the specified value.

Basic examples

Basic examples of the instruction `WZDOSet` are illustrated below.

See also *More examples on page 740*.

Example 1

```
VAR wztemporary service;

PROC zone_output()
  VAR shapedata volume;
  CONST pos p_service:=[500,500,700];
  ...
  WZSphDef \Inside, volume, p_service, 50;
  WZDOSet \Temp, service \Inside, volume, do_service, 1;
ENDPROC
```

Definition of temporary world zone `service` in the application program that sets the signal `do_service` when the robot's TCP is inside the defined sphere during program execution or when jogging.

Arguments

```
WZDOSet [\Temp] | [\Stat] WorldZone [\Inside] | [\Before] Shape
     Signal SetValue
```

`[\Temp]`

Temporary

Data type: `switch`

The world zone to define is a temporary world zone.

`[\Stat]`

Stationary

Data type: `switch`

The world zone to define is a stationary world zone.

One of the arguments `\Temp` or `\Stat` must be specified.

Continues on next page

`WorldZone`

Data type: `wztemporary` or `wzstationary`

Variable or persistent variable, that will be updated with the identity (numeric value) of the world zone.

If using the switch `\Temp`, the data type must be `wztemporary`. If using the switch `\Stat`, the data type must be `wzstationary`.

`[\Inside]`

Data type: `switch`

The digital output signal will be set when the robot's TCP or specified axes are inside the defined volume.

`[\Before]`

Data type: `switch`

The digital output signal will be set before the robot's TCP or specified axes reaches the defined volume (as soon as possible before the volume).

One of the arguments `\Inside` or `\Before` must be specified.

`Shape`

Data type: `shapedata`

The variable that defines the volume of the world zone.

`Signal`

Data type: `signaldo`

The name of the digital output signal that will be changed.

If a stationary worldzone is used then the signal must be written as protected for access from the user (RAPID, FP). Set Access Level for the signal in System Parameters or specified axes.

`SetValue`

Data type: `dionum`

Desired value of the signal (0 or 1) when the robot's TCP is inside the volume or just before it enters the volume.

When outside or just outside the volume then the signal is set to the opposite value.

Program execution

The defined world zone is activated. From this moment the robot's TCP position (or robot/external joint position) is supervised, and the output will be set when the robot's TCP position (or robot/external joint position) is inside the volume (`\Inside`) or comes close to the border of the volume (`\Before`).

If using `WZHomeJointDef` or `WZLimJointDef` together with `WZDOSet` then the digital output signal is set only if all active axes with joint space supervision are before or inside the joint space.

Continues on next page

More examples

More examples of how to use the instruction `WZDOSet` are illustrated below.

Example 1

```
VAR wztemporary home;
VAR wztemporary service;
PERS wztemporary equip1:=[0];

PROC main()
  ...
  ! Definition of all temporary world zones
  zone_output;
  ...
  ! equip1 in robot work area
  WZEnable equip1;
  ...
  ! equip1 out of robot work area
  WZDisable equip1;
  ...
  ! No use for equip1 any more
  WZFree equip1;
  ...
ENDPROC

PROC zone_output()
  VAR shapedata volume;
  CONST pos p_home:=[800,0,800];
  CONST pos p_service:=[800,800,800];
  CONST pos p_equip1:=[-800,-800,0];
  ...
  WZSphDef \Inside, volume, p_home, 50;
  WZDOSet \Temp, home \Inside, volume, do_home, 1;
  WZSphDef \Inside, volume, p_service, 50;
  WZDOSet \Temp, service \Inside, volume, do_service, 1;
  WZCylDef \Inside, volume, p_equip1, 300, 1000;
  WZLimSup \Temp, equip1, volume;
  ! equip1 not in robot work area
  WZDisable equip1;
ENDPROC
```

Definition of temporary world zones `home` and `service` in the application program, that sets the signals `do_home` and `do_service`, when the robot is inside the sphere `home` or `service` respectively during program execution or when jogging.

Also, definition of a temporary world zone `equip1`, which is active only in the part of the robot program when `equip1` is inside the working area for the robot. At that time the robot stops before entering the `equip1` volume, both during program execution and manual jogging. `equip1` can be disabled or enabled from other program tasks by using the persistent variable `equip1` value.

Continues on next page

Limitations

A world zone cannot be redefined by using the same variable in the argument `WorldZone`.

A stationary world zone cannot be deactivated, activated again, or erased in the RAPID program.

A temporary world zone can be deactivated (`WZDisable`), activated again (`WZEnable`), or erased (`WZFree`) in the RAPID program.

Syntax

```
WZDOSet
  [['\'Temp] | ['\'Stat]',']
  [WorldZone':=']<variable or persistent (INOUT) of wztemporary>
  ['\'Inside] | ['\'Before] ','
  [Shape':=']<variable (VAR) of shapedata>','
  [Signal':=']<variable (VAR) of signaldo>','
  [SetValue':=']<expression (IN) of dionum>';'
```

Related information

For information about	See
World Zones	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - World zones*
World zone shape	*shapedata - World zone shape data on page 1179*
Temporary world zone	*wztemporary - Temporary world zone data on page 1230*
Stationary world zone	*wzstationary - Stationary world zone data on page 1228*
Define straight box-shaped world zone	*WZBoxDef - Define a box-shaped world zone on page 732*
Define sphere-shaped world zone	*WZSphDef - Define a sphere-shaped world zone on page 756*
Define cylinder-shaped world zone	*WZCylDef - Define a cylinder-shaped world zone on page 734*
Define a world zone for home joints	*WZHomeJointDef - Define a world zone for home joints on page 746*
Activate world zone limit supervision	*WZLimSup - Activate world zone limit supervision on page 753*
Signal access level	*Technical reference manual - System parameters*, section *I/O - Signal - Access Level*

1.254. WZEnable - Activate temporary world zone supervision

Usage

`WZEnable` (*World Zone Enable*) is used to re-activate the supervision of a temporary world zone, previously defined either to stop the movement or to set an output.

Basic examples

Basic examples of the instruction `WZEnable` are illustrated.

Example 1

```
VAR wztemporary wzone;
...
PROC ...
  WZLimSup \Temp, wzone, volume;
  MoveL p_pick, v500, z40, tool1;
  WZDisable wzone;
  MoveL p_place, v200, z30, tool1;
  WZEnable wzone;
  MoveL p_home, v200, z30, tool1;
ENDPROC
```

When moving to `p_pick`, the position of the robot's TCP is checked so that it will not go inside the specified volume `wzone`. This supervision is not performed when going to `p_place` but is reactivated before going to `p_home`.

Arguments

```
WZEnable WorldZone
```

`WorldZone`

Data type: `wztemporary`

Variable or persistent variable of the type `wztemporary`, which contains the identity of the world zone to be activated.

Program execution

The temporary world zone is re-activated. Please note that a world zone is automatically activated when it is created. It need only be re-activated when it has previously been deactivated by `WZDisable`.

Limitations

Only a temporary world zone can be deactivated and reactivated. A stationary world zone is always active.

Syntax

```
WZEnable
  [WorldZone':=']<variable or persistent (INOUT) of
       wztemporary>';'
```


Continues on next page

Related information

For information about	See
World Zones	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - World zones*
World zone shape	*shapedata - World zone shape data on page 1179*
Temporary world zone data	*wztemporary - Temporary world zone data on page 1230*
Activate world zone limit supervision	*WZLimSup - Activate world zone limit supervision on page 753*
Activate world zone set digital output	*WZDOSet - Activate world zone to set digital output on page 738*
Deactivate world zone	*WZDisable - Deactivate temporary world zone supervision on page 736*
Erase world zone	*WZFree - Erase temporary world zone supervision on page 744*

1.255. WZFree - Erase temporary world zone supervision

Usage

`WZFree` (*World Zone Free*) is used to erase the definition of a temporary world zone, previously defined either to stop the movement or to set an output.

Basic examples

Basic examples of the instruction `WZFree` are illustrated below.

Example 1

```
VAR wztemporary wzone;
...
PROC ...
  WZLimSup \Temp, wzone, volume;
  MoveL p_pick, v500, z40, tool1;
  WZDisable wzone;
  MoveL p_place, v200, z30, tool1;
  WZEnable wzone;
  MoveL p_home, v200, z30, tool1;
  WZFree wzone;
ENDPROC
```

When moving to `p_pick`, the position of the robot's TCP is checked so that it will not go inside a specified volume `wzone`. This supervision is not performed when going to `p_place` but is reactivated before going to `p_home`. When this position is reached then the world zone definition is erased.

Arguments

```
WZFree WorldZone
```

`WorldZone`

Data type: `wztemporary`

Variable or persistent variable of the type `wztemporary`, which contains the identity of the world zone to be erased.

Program execution

The temporary world zone is first deactivated and then its definition is erased.

Once erased, a temporary world zone cannot be re-activated or deactivated.

Limitations

Only a temporary world zone can be deactivated, reactivated, or erased. A stationary world zone is always active.

Syntax

```
WZFree
  [WorldZone':=']<variable or persistent (INOUT) of
      wztemporary>';'
```


Continues on next page

Related information

For information about	See
World Zones	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - World zones*
World zone shape	*shapedata - World zone shape data on page 1179*
Temporary world zone data	*wztemporary - Temporary world zone data on page 1230*
Activate world zone limit supervision	*WZLimSup - Activate world zone limit supervision on page 753*
Activate world zone set digital output	*WZDOSet - Activate world zone to set digital output on page 738*
Deactivate world zone	*WZDisable - Deactivate temporary world zone supervision on page 736*
Activate world zone	*WZEnable - Activate temporary world zone supervision on page 742*

1.256. WZHomeJointDef - Define a world zone for home joints

Usage

`WZHomeJointDef` (*World Zone Home Joint Definition*) is used to define a world zone in joints coordinates for both the robot and external axes to be used as a HOME or SERVICE position.

Basic examples

Basic examples of the instruction `WZHomeJointDef` are illustrated below.

Example 1

```
VAR wzstationary home;
...
PROC power_on()
  VAR shapedata joint_space;
  CONST jointtarget home_pos := [ [ 0, 0, 0, 0, 0, -45], [ 0, 9E9,
        9E9, 9E9, 9E9, 9E9] ];
  CONST jointtarget delta_pos := [ [ 2, 2, 2, 2, 2, 2], [ 5, 9E9,
        9E9, 9E9, 9E9, 9E9] ];
  ...
  WZHomeJointDef \Inside, joint_space, home_pos, delta_pos;
  WZDOSet \Stat, home \Inside, joint_space, do_home, 1;
ENDPROC
```

Definition and activation of stationary world zone `home`, that sets the signal `do_home to 1`, when all robot axes and the external axis `extax.eax_a` are at the joint position `home_pos` (within +/- `delta_pos` for each axis) during program execution and jogging. The variable `joint_space` of data type `shapedata` are used to transfer data from the instruction `WZHomeJointDef` to the instruction `WZDOSet`.

Arguments

```
WZHomeJointDef [\Inside] | [\Outside] Shape  MiddleJointVal
     DeltaJointVal
```

`[\Inside]`

Data type: `switch`

Define the joint space inside the `MiddleJointVal` +/- `DeltaJointVal`.

`[\Outside]`

Data type: `switch`

Define the joint space outside the `MiddleJointVal` +/- `DeltaJointVal` (inverse joint space).

`Shape`

Data type: `shapedata`

Variable for storage of the defined joint space (private data for the system).

Continues on next page

`MiddleJointVal`

Data type: `jointtarget`

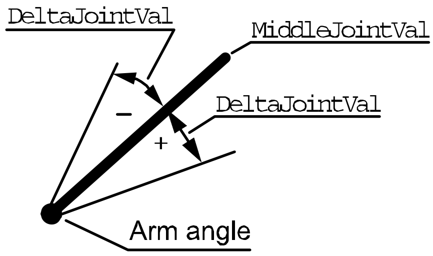
The position in joint coordinates for the center of the joint space to define. Specifies for each robot axis and external axis (degrees for rotational axes and mm for linear axes). Specifies in absolute joints (not in offset coordinate system `EOffsSet-EOffsOn` for external axes). **Value 9E9 for some axis means that the axis should not be supervised.** Non-active external axis also gives 9E9 at programming time.

`DeltaJointVal`

Data type: `jointtarget`

The +/- delta position in joint coordinates from the center of the joint space. The value must be greater than 0 for all axes to supervise.

The following figure shows the definition of joint space for rotational axis.



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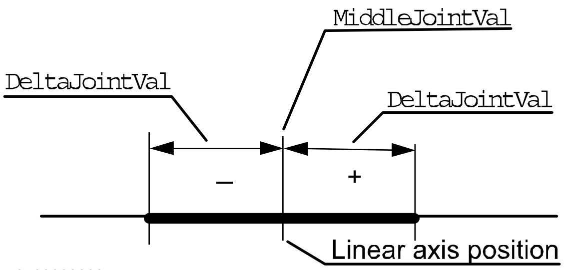
The following figure shows the definition of joint space for linear axis.



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Program execution

The definition of the joint space is stored in the variable of type `shapedata` (argument `Shape`) for future use in `WZLimSup` or `WZDOSet` instructions.

If use of `WZHomeJointDef` together with `WZDOSet` then the digital output signal is set but only if all active axes with joint space supervision are before or inside the joint space.

If use of `WZHomeJointDef` with outside joint space (argument `\Outside`) together with `WZLimSup` then the robot is stopped as soon as one active axes with joint space supervision reach the joint space.

If use of `WZHomeJointDef` with inside joint space (argument `\Inside`) together with `WZLimSup` then the robot is stopped as soon as the last active axes with joint space supervision reach the joint space. That means that one or several axes, but not all active and supervised axes, can be inside the joint space at the same time.

At execution of the instruction `ActUnit` or `DeactUnit` for activation or deactivation of mechanical units, the supervision status for HOME position or work area limitation will be updated.

Continues on next page

Limitations

Only active mechanical units and their active axes at activation time of the world zone (with instruction `WZDOSet` respectively `WZLimSup`), are included in the supervision of the HOME position respectively to the limitation of the working area. Besides that, the mechanical unit and its axes must still be active at the program movement or jogging to be supervised.

For example, if one axis with supervision is outside its HOME joint position but is deactivated then it does not prevent the digital output signal for the HOME joint position to be set if all other active axes with joint space supervision are inside the HOME joint position. At activation of that axis again it will be included in the supervision and the robot system will then be outside the HOME joint position and the digital output will be reset.

Syntax

```
WZHomeJointDef
  [['\'Inside] | ['\'Outside]',']
  [Shape':=']<variable (VAR) of shapedata>','
  [MiddleJointVal' :=']<expression (IN) of jointtarget>','
  [DeltaJointVal' :=']<expression (IN) of jointtarget>';'
```

Related information

For information about	See
World Zones	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - World zones*
World zone shape	*shapedata - World zone shape data on page 1179*
Define box-shaped world zone	*WZBoxDef - Define a box-shaped world zone on page 732*
Define cylinder-shaped world zone	*WZCylDef - Define a cylinder-shaped world zone on page 734*
Define sphere-shaped world zone	*WZSphDef - Define a sphere-shaped world zone on page 756*
Define a world zone for limit joints	*WZLimJointDef - Define a world zone for limitation in joints on page 749*
Activate world zone limit supervision	*WZLimSup - Activate world zone limit supervision on page 753*
Activate world zone digital output set	*WZDOSet - Activate world zone to set digital output on page 738*

1.257. WZLimJointDef - Define a world zone for limitation in joints

Usage

`WZLimJointDef` (*World Zone Limit Joint Definition*) is used to define a world zone in joints coordinates for both the robot and external axes, to be used for limitation of the working area.

With `WZLimJointDef` it is possible to limit the working area for each robot and external axes in the RAPID program, besides the limitation that can be done with system parameters *Motion - Arm - robx_y - Upper Joint Bound ... Lower Joint Bound*.

Basic examples

Basic examples of the instruction `WZLimJointDef` are illustrated below.

Example 1

```
VAR wzstationary work_limit;
  ...
  PROC power_on()
    VAR shapedata joint_space;
    CONST jointtarget low_pos:= [ [ -90, 9E9, 9E9, 9E9, 9E9, 9E9],
          [ -1000, 9E9, 9E9, 9E9, 9E9, 9E9]];
    CONST jointtarget high_pos := [ [ 90, 9E9, 9E9, 9E9,9E9, 9E9],
          [ 9E9, 9E9, 9E9, 9E9, 9E9, 9E9] ];
    ...
    WZLimJointDef \Outside, joint_space, low_pos, high_pos;
    WZLimSup \Stat, work_limit, joint_space;
  ENDPROC
```

Definition and activation of stationary world zone `work_limit`, that limit the working area for robot axis 1 to -90 and +90 degrees and the external axis `extax.eax_a` to -1000 mm during program execution and jogging. The variable `joint_space` of data type `shapedata` are used to transfer data from the instruction `WZLimJointDef` to the instruction `WZLimSup`.

Arguments

```
WZLimJointDef [\Inside] | [\Outside] Shape LowJointVal
      HighJointVal
```

`[\Inside]`

Data type: `switch`

Define the joint space inside the `LowJointVal ... HighJointVal`.

`[\Outside]`

Data type: `switch`

Define the joint space outside the `LowJointVal ... HighJointVal` (inverse joint space).

`Shape`

Data type: `shapedata`

Variable for storage of the defined joint space (private data for the system).

Continues on next page

`LowJointVal`

Data type: `jointtarget`

The position in joint coordinates for the low limit of the joint space to define. Specifies for each robot axes and external axes (degrees for rotational axes and mm for linear axes). Specifies in absolute joints (not in offset coordinate system `EOffsSet` or `EOffsOn` for external axes). Value `9E9` for some axis means that the axis should not be supervised for low limit. Non-active external axis also gives `9E9` at programming time.

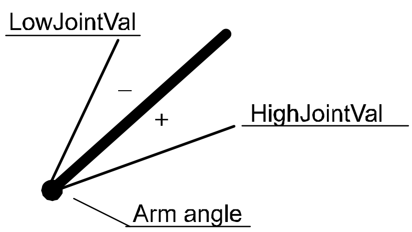
`HighJointVal`

Data type: `jointtarget`

The position in joint coordinates for the high limit of the joint space to define. Specifies for each robot axes and external axes (degrees for rotational axes and mm for linear axes). Specifies in absolute joints (not in offset coordinate system `EOffsSet` or `EOffsOn` for external axes). Value `9E9` for an axis means that the axis should not be supervised for high limit. Non-active external axis also gives `9E9` at programming time.

`HighJointVal` minus `LowJointVal` for each axis must be greater than 0 for all axes to supervise.

The figure below shows definition of joint space for rotating axis.



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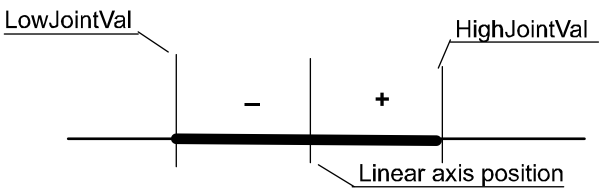
The figure below shows definition of joint space for linear axis.



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Continues on next page

Program execution

The definition of the joint space is stored in the variable of type `shapedata` (argument `Shape`) for future use in `WZLimSup` or `WZDOSet` instructions.

If using `WZLimJointDef` together with `WZDOSet` then the digital output signal is set, only if all active axes with joint space supervision are before or inside the joint space.

If using `WZLimJointDef` with outside joint space (argument `\Outside`) together with `WZLimSup` then the robot is stopped as soon as one active axes with joint space supervision reaches the joint space.

If using `WZLimJointDef` with inside joint space (argument `\Inside`) together with `WZLimSup` then the robot is stopped as soon as the last active axes with joint space supervision reaches the joint space. That means that one or several axes but not all active and supervised axes can be inside the joint space at the same time.

At execution of the instruction `ActUnit` or `DeactUnit` the supervision status will be updated.

Limitations

WARNING!

Only active mechanical units and its active axes at activation time of the world zone (with instruction `WZDOSet` respective to `WZLimSup`), are included in the supervision of the HOME position respectively the limitation of the working area. Besides that, the mechanical unit and its axes must still be active at the program movement or jogging to be supervised.

For example, if one axis with supervision is outside its HOME joint position but is deactivated then it does not prevent the digital output signal for the HOME joint position to be set if all other active axes with joint space supervision are inside the HOME joint position. At activation of that axis again, it will be included in the supervision and the robot system will the be outside the HOME joint position and the digital output will be reset.

Syntax

```
WZLimJointDef
  [['\'Inside] | ['\'Outside]',']
  [Shape':=']<variable (VAR) of shapedata>','
  [LowJointVal':=']<expression (IN) of jointtarget>','
  [HighJointVal':=']<expression (IN) of jointtarget>';'
```


Continues on next page

Related information

For information about	See
World Zones	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - World zones*
World zone shape	*shapedata - World zone shape data on page 1179*
Define box-shaped world zone	*WZBoxDef - Define a box-shaped world zone on page 732*
Define cylinder-shaped world zone	*WZCylDef - Define a cylinder-shaped world zone on page 734*
Define sphere-shaped world zone	*WZSphDef - Define a sphere-shaped world zone on page 756*
Define a world zone for home joints	*WZHomeJointDef - Define a world zone for home joints on page 746*
Activate world zone limit supervision	*WZLimSup - Activate world zone limit supervision on page 753*
Activate world zone digital output set	*WZDOSet - Activate world zone to set digital output on page 738*

1.258. WZLimSup - Activate world zone limit supervision

Usage

`WZLimSup` (*World Zone Limit Supervision*) is used to define the action and to activate a world zone for supervision of the working area of the robot or external axes.

After this instruction is executed, when the robot's TCP reaches the defined world zone or when the robot/external axes reaches the defined world zone in joints, then the movement is stopped both during program execution and when jogging.

Basic examples

Basic examples of the instruction `WZLimSup` are illustrated below.

See also *More examples on page 754*.

Example 1

```
VAR wzstationary max_workarea;
...
PROC POWER_ON()
  VAR shapedata volume;
  ...
  WZBoxDef \Outside, volume, corner1, corner2;
  WZLimSup \Stat, max_workarea, volume;
ENDPROC
```

Definition and activation of stationary world zone `max_workarea`, with the shape of the area outside a box (temporarily stored in `volume`) and the action work-area supervision. The robot stops with an error message before entering the area outside the box.

Arguments

```
WZLimSup [\Temp] | [\Stat] WorldZone Shape
```

`[\Temp]`

Temporary

Data type: `switch`

The world zone to define is a temporary world zone.

`[\Stat]`

Stationary

Data type: `switch`

The world zone to define is a stationary world zone.

One of the arguments `\Temp` or `\Stat` must be specified.

`WorldZone`

Data type: `wztemporary` or `wzstationary`

Variable or persistent variable that will be updated with the identity (numeric value) of the world zone.

If using switch `\Temp`, the data type must be `wztemporary`. If using switch `\Stat`, the data type must be `wzstationary`.

Continues on next page

`Shape`

Data type: `shapedata`

The variable that defines the volume of the world zone.

Program execution

The defined world zone is activated. From this moment the robot's TCP position or the robot/external axes joint position are supervised. If it reaches the defined area then the movement is stopped.

If using `WZLimJointDef` or `WZHomeJointDef` with outside joint space (argument `\Outside`) together with `WZLimSup` then the robot is stopped as soon as one active axes with joint space supervision reaches the joint space.

If using `WZLimJointDef` or `WZHomeJointDef` with inside joint space (argument `\Inside`) together with `WZLimSup` then the robot is stopped as soon as the last active axes with joint space supervision reaches the joint space. That means that one or several axes but not all active and supervised axes can be inside the joint space at the same time.

At execution of the instruction `ActUnit` or `DeactUnit` the supervision status will be updated.

More examples

More examples of how to use the instruction `WZLimSup` are illustrated below.

Example 1

```
VAR wzstationary box1_invers;
VAR wzstationary box2;

PROC wzone_power_on()
  VAR shapedata volume;
  CONST pos box1_c1:=[500,-500,0];
  CONST pos box1_c2:=[-500,500,500];
  CONST pos box2_c1:=[500,-500,0];
  CONST pos box2_c2:=[200,-200,300];
  ...
  WZBoxDef \Outside, volume, box1_c1, box1_c2;
  WZLimSup \Stat, box1_invers, volume;
  WZBoxDef \Inside, volume, box2_c1, box2_c2;
  WZLimSup \Stat, box2, volume;
ENDPROC
```

Limitation of work area for the robot with the following stationary world zones:

- Outside working area when outside `box1_invers`
- Outside working area when inside `box2`

If this routine is connected to the system event POWER ON then these world zones will always be active in the system, both for program movements and manual jogging.

Continues on next page

Limitations

A world zone cannot be redefined using the same variable in argument `WorldZone`.

A stationary world zone cannot be deactivated, activated again, or erased in the RAPID program.

A temporary world zone can be deactivated (`WZDisable`), activated again (`WZEnable`), or erased (`WZFree`) in the RAPID program.

Syntax

```
WZLimSup
  [['\'Temp] | ['\Stat]',']
  [WorldZone´:=´]<variable or persistent (INOUT) of
       wztemporary>´,´
  [Shape´:=´]<variable (VAR) of shapedata>´;´
```

Related information

For information about	See
World Zones	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - World zones*
World zone shape	*shapedata - World zone shape data on page 1179*
Temporary world zone	*wztemporary - Temporary world zone data on page 1230*
Stationary world zone	*wzstationary - Stationary world zone data on page 1228*
Define straight box-shaped world zone	*WZBoxDef - Define a box-shaped world zone on page 732*
Define sphere-shaped world zone	*WZSphDef - Define a sphere-shaped world zone on page 756*
Define cylinder-shaped world zone	*WZCylDef - Define a cylinder-shaped world zone on page 734*
Define a world zone for home joints	*WZHomeJointDef - Define a world zone for home joints on page 746*
Define a world zone for limit joints	*WZLimJointDef - Define a world zone for limitation in joints on page 749*
Activate world zone digital output set	*WZDOSet - Activate world zone to set digital output on page 738*

1.259. WZSphDef - Define a sphere-shaped world zone

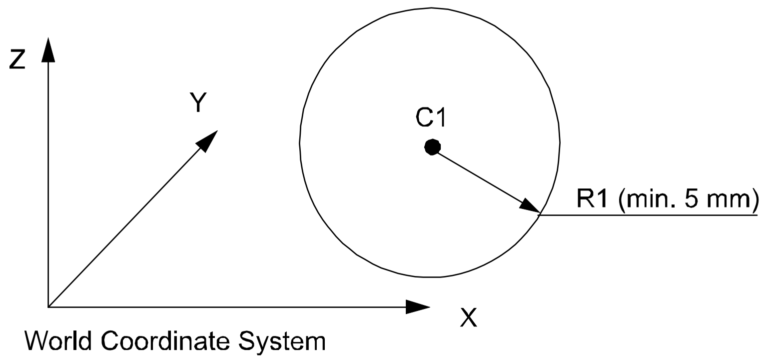
Usage

`WZSphDef` (*World Zone Sphere Definition*) is used to define a world zone that has the shape of a sphere.

Basic examples

Basic examples of the instruction `WZSphDef` are illustrated below.

Example 1



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```
VAR shapedata volume;
CONST pos C1:=[300,300,200];
CONST num R1:=200;
...
WZSphDef \Inside, volume, C1, R1;
```

Define a sphere named `volume` by its center `C1` and its radius `R1`.

Arguments

```
WZSphDef [\Inside] | [\Outside] Shape CentrePoint Radius
```

`[\Inside]`

Data type: `switch`

Define the volume inside the sphere.

`[\Outside]`

Data type: `switch`

Define the volume outside the sphere (inverse volume).

One of the arguments `\Inside` or `\Outside` must be specified.

`Shape`

Data type: `shapedata`

Variable for storage of the defined volume (private data for the system).

`CentrePoint`

Data type: `pos`

Position (x,y,z) in mm defining the center of the sphere.

Continues on next page

`Radius`

Data type: `num`

The radius of the sphere in mm.

Program execution

The definition of the sphere is stored in the variable of type `shapedata` (argument `Shape`), for future use in `WZLimSup` or `WZDOSet` instructions.

Limitations

If the robot is used to point out the `CentrePoint` then the work object `wobj0` must be active (use of component `trans` in `robtarget` e.g. `p1.trans` as argument).

Syntax

```
WZSphDef
  [['\'Inside] | ['\'Outside]',']
  [Shape':=']<variable (VAR) of shapedata>','
  [CentrePoint':=']<expression (IN) of pos>','
  [Radius':=']<expression (IN) of num>';'
```

Related information

For information about	See
World Zones	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - World zones*
World zone shape	*shapedata - World zone shape data on page 1179*
Define box-shaped world zone	*WZBoxDef - Define a box-shaped world zone on page 732*
Define cylinder-shaped world zone	*WZCylDef - Define a cylinder-shaped world zone on page 734*
Define a world zone for home joints	*WZHomeJointDef - Define a world zone for home joints on page 746*
Define a world zone for limit joints	*WZLimJointDef - Define a world zone for limitation in joints on page 749*
Activate world zone limit supervision	*WZLimSup - Activate world zone limit supervision on page 753*
Activate world zone digital output set	*WZDOSet - Activate world zone to set digital output on page 738*

2 Functions

2.1. Abs - Gets the absolute value

Usage

`Abs` is used to get the absolute value, i.e. a positive value of numeric data.

Basic examples

Basic examples of the function `Abs` are illustrated below.

See also *More examples on page 759*.

Example 1

```
reg1 := Abs(reg2);
```

`Reg1` is assigned the absolute value of `reg2`.

Return value

Data type: `num`

The absolute value, i.e. a positive numeric value, e.g.:

Input value	Returned value
3	3
-3	3
-2.53	2.53

Arguments

```
Abs (Value)
```

`Value`

Data type: `num`

The input value.

More examples

More examples of the function `Abs` are illustrated below.

Example 1

```
TPReadNum no_of_parts, "How many parts should be produced? ";
no_of_parts := Abs(no_of_parts);
```

The operator is asked to input the number of parts to be produced. To ensure that the value is greater than zero, the value given by the operator is made positive.

Syntax

```
Abs '('
  [ Value ':=' ] < expression (IN) of num >')'
```

A function with a return value of the data type `num`.

Continues on next page

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*

2.2. ACos - Calculates the arc cosine value

Usage

`ACos` (*Arc Cosine*) is used to calculate the arc cosine value.

Basic examples

Basic examples of the function `ACos` are illustrated below.

Example 1

```
VAR num angle;
VAR num value;
...
...
angle := ACos(value);
```

`angle` will get the arc cosine value of `value`.

Return value

Data type: `num`

The arc cosine value, expressed in degrees, range [0, 180].

Arguments

```
ACos (Value)
```

`Value`

Data type: `num`

The argument value must be in range [-1, 1].

Limitations

The execution of the function `Acos(x)` will give an error if `x` is outside the range [-1, 1].

Syntax

```
Acos'('
  [Value ':='] <expression (IN) of num>
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Mathematics*

2.3. AOutput - Reads the value of an analog output signal

Usage

`AOutput` is used to read the current value of an analog output signal.

Basic examples

Basic examples of the function `AOutput` are illustrated below.

Example 1

```
IF AOutput(ao4) > 5 THEN ...
```

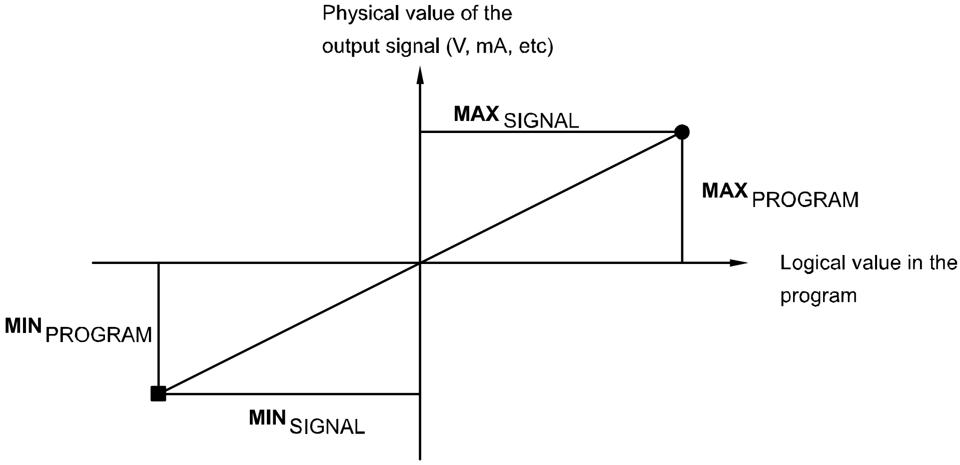
If the current value of the signal `ao4` is greater than `5`, then `...`

Return value

Data type: `num`

The current value of the signal.

The current value is scaled (in accordance with the system parameters) before it is read by the RAPID program. A diagram of how analog signal values are scaled is shown in the figure below.



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Arguments

```
AOutput (Signal)
```

`Signal`

Data type: `signalao`

The name of the analog output to be read.

Error handling

The following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT` if there is no contact with the unit.

Continues on next page

Syntax

```
AOutput '('
  [ Signal ':=' ] < variable (VAR) of signalao > ')'
```

A function with a return value of data type `num`.

Related information

For information about	See
Set an analog output signal	*SetAO - Changes the value of an analog output signal on page 431*
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and Output Signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - I/O principles*
Configuration of I/O	*Technical reference manual - System parameters*

2.4. ArgName - Gets argument name

Usage

`ArgName` (*Argument Name*) is used to get the name of the original data object for the current argument or the current data.

Basic examples

Basic examples of the function `ArgName` are illustrated below.

See also *More examples on page 765*.

Example 1

```
VAR num chales :=5;
...
proc1 chales;

PROC proc1 (num par1)
  VAR string name;
  ...
  name:=ArgName(par1);
  TPWrite "Argument name "+name+" with value "\Num:=par1;
ENDPROC
```

The variable `name` is assigned the string value "`chales`" and on FlexPendant the following string is written: "Argument name chales with value 5".

Return value

Data type: `string`

The original data object name.

Arguments

```
ArgName (Parameter)
```

`Parameter`

Data type: `anytype`

The formal parameter identifier (for the routine in which `ArgName` is located) or the data identity.

All types of data with structure atomic, record, record component, array, or array element can be used.

Program execution

The function returns the original data object name for an entire object of the type constant, variable, or persistent. The original data object can be global, local in the program module, or local in a routine (normal RAPID scope rules).

If it is a part of a data object then the name of the whole data object is returned.

Continues on next page

More examples

More examples of the function `ArgName` are illustrated below.

Convert from identifier to string

This function can also be used to convert from identifier to `string`, by specifying the identifier in the argument `Parameter` for any data object with global, local in module, or local in routine scope:

```
VAR num chales :=5;
...
proc1;

PROC proc1 ()
  VAR string name;
  ...
  name:=ArgName(chales);
  TPWrite "Global data object "+name+" has value "\Num:=chales;
ENDPROC
```

The variable `name` is assigned the string value "`chales`" and on FlexPendant the following string is written: "Global data object chales has value 5".

Routine call in several steps

Note that the function returns the **original** data object name:

```
VAR num chales :=5;
...
proc1 chales;
...
PROC proc1 (num parameter1)
  ...
  proc2 parameter1;
  ...
ENDPROC

PROC proc2 (num par1)
  VAR string name;
  ...
  name:=ArgName(par1);
  TPWrite "Original data object name "+name+" with value"
        \Num:=par1;
ENDPROC
```

The variable `name` is assigned the string value "`chales`" and on FlexPendant the following string is written: "Original data object name chales with value 5".

Continues on next page

Error handling

If one of the following errors occurs then the system variable `ERRNO` is set to `ERR_ARGNAME`:

- Argument is expression value
- Argument is not present
- Argument is of type switch

This error can then be handled in the error handler.

Syntax

```
ArgName '('
[ Parameter':=' ] < reference (REF) of any type> ')'
```

A function with a return value of the data type `string`.

Related information

For information about	See
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics -Basic elements*

2.5. ASin - Calculates the arc sine value

Usage

`ASin` (*Arc Sine*) is used to calculate the arc sine value.

Basic examples

Basic examples of the function `ASin` are illustrated below.

Example 1

```
VAR num angle;
VAR num value;
...
...
angle := ASin(value);
```

`angle will get the arc sine value of value`

Return value

Data type: `num`

The arc sine value, expressed in degrees, range [-90, 90].

Arguments

```
ASin (Value)
```

`Value`

Data type: `num`

The argument value must be in range [-1, 1].

Limitations

The execution of the function `ASin(x)` will give an error if x is outside the range [1, -1].

Syntax

```
ASin'('
  [Value ':='] <expression (IN) of num>
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Mathematics*

2.6. ATan - Calculates the arc tangent value

Usage

`ATan` (*Arc Tangent*) is used to calculate the arc tangent value.

Basic examples

Basic examples of the function `ATan` are illustrated below.

Example 1

```
VAR num angle;
VAR num value;
...
...
angle := ATan(value);
```

`angle` will get the arc tangent value of `value`.

Return value

Data type: `num`

The arc tangent value, expressed in degrees, range [-90, 90].

Arguments

```
ATan (Value)
```

`Value`

Data type: `num`

The argument value.

Syntax

```
ATan'('
  [Value ':='] <expression (IN) of num>
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*
Arc tangent with a return value in the range [-180, 180]	*ATan2 - Calculates the arc tangent2 value on page 769*

2.7. ATan2 - Calculates the arc tangent2 value

Usage

`ATan2` (*Arc Tangent2*) is used to calculate the arc tangent2 value.

Basic examples

Basic examples of the function `ATan2` are illustrated below.

Example 1

```
VAR num angle;
VAR num x_value;
VAR num y_value;
...
...
angle := ATan2(y_value, x_value);
```

`angle` will get the arc tangent value of `y_value/x_value`.

Return value

Data type: `num`

The arc tangent value, expressed in degrees, range [-180, 180]. The value will be equal to ATan(y/x) but in the range of [-180, 180] since the function uses the sign of both arguments to determine the quadrant of the return value.

Arguments

```
ATan2 (Y X)
```

`Y`

Data type: `num`

The numerator argument value.

`X`

Data type: `num`

The denominator argument value.

Syntax

```
ATan2'('
  [Y ':='] <expression (IN) of num> ','
  [X ':='] <expression (IN) of num>
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Mathematics*
Arc tangent with only one argument	*ATan - Calculates the arc tangent value on page 768*

2.8. BitAnd - Logical bitwise AND - operation on byte data

Usage

`BitAnd` is used to execute a logical bitwise `AND` - operation on data types byte.

Basic examples

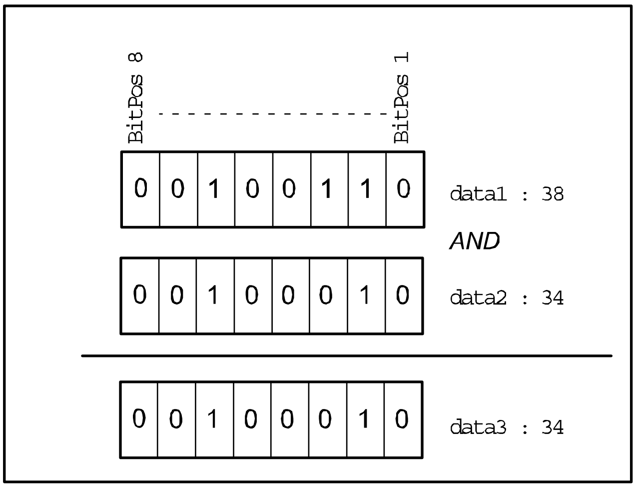
Basic examples of the function `BitAnd` are illustrated below.

Example 1

```
VAR byte data1 := 38;
VAR byte data2 := 34;
VAR byte data3;

data3 := BitAnd(data1, data2);
```

The logical bitwise AND - operation (see figure below) will be executed on the `data1` and `data2`. The result will be returned to `data3` (integer representation).



xx0500002454

Return value

Data type: `byte`

The result of the logical bitwise `AND` - operation in integer representation.

Arguments

```
BitAnd (BitData1 BitData2)
```

`BitData1`

Data type: `byte`

The bit data 1, in integer representation.

`BitData2`

Data type: `byte`

The bit data 2, in integer representation.

Limitations

The range for a data type `byte` is 0 - 255.

Continues on next page

Syntax

```
BitAnd'('
  [BitData1 ':='] <expression (IN) of byte>' ,'
  [BitData2 ':='] <expression (IN) of byte>
  ')'
```

A function with a return value of the data type `byte`.

Related information

For information about	See
Logical bitwise OR - operation on byte data	*BitOr - Logical bitwise OR - operation on byte data on page 778*
Logical bitwise XOR - operation on byte data	*BitXOr - Logical bitwise XOR - operation on byte data on page 782*
Logical bitwise NEGATION - operation on byte data	*BitNeg - Logical bitwise NEGATION - operation on byte data on page 776*
Other bit functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Bit Functions*

2.9. BitCheck - Check if a specified bit in a byte data is set

Usage

`BitCheck` is used to check if a specified bit in a defined `byte` data is set to 1.

Basic examples

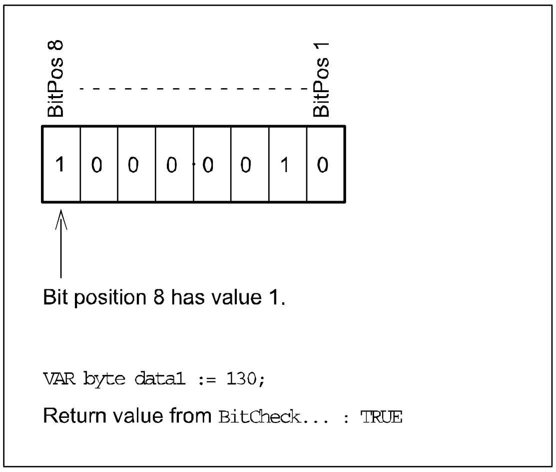
Basic examples of the function `BitCheck` are illustrated below.

Example 1

```
CONST num parity_bit := 8;
VAR byte data1 := 130;

IF BitCheck(data1, parity_bit) = TRUE THEN
   ...
ELSE
  ...
ENDIF
```

Bit number `8` (`parity_bit`) in the variable `data1` will be checked, e.g. if the specified bit is set to 1 in the variable `data1` then this function will return to `TRUE`. Bit check of data type `byte` is illustrated in the figure below.



xx0500002442

Return value

Data type: `bool`

`TRUE` if the specified bit is set to 1, `FALSE` if the specified bit is set to 0.

Continues on next page

Arguments

```
BitCheck (BitData BitPos)
```

`BitData`

Data type: `byte`

The bit data, in integer representation, to be checked.

`BitPos`

Bit Position

Data type: `num`

The bit position (1-8) in the `BitData` to be checked.

Limitations

The range for a data type `byte` is 0 - 255 decimal.

The bit position is valid from 1 - 8.

Syntax

```
BitCheck'('
  [BitData ':='] <expression (IN) of byte> ´,'
  [BitPos ':='] <expression (IN) of num>
  ')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Set a specified bit in a byte data	*BitSet - Set a specified bit in a byte data on page 28*
Clear a specified bit in a byte data	*BitClear - Clear a specified bit in a byte data on page 26*
Other bit functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Bit Functions*

2.10. BitLSh - Logical bitwise LEFT SHIFT - operation on byte

Usage

`BitLSh` (*Bit Left Shift*) is used to execute a logical bitwise LEFT SHIFT-operation on data types `byte`.

Basic examples

Basic examples of the function `BitLSh` are illustrated below.

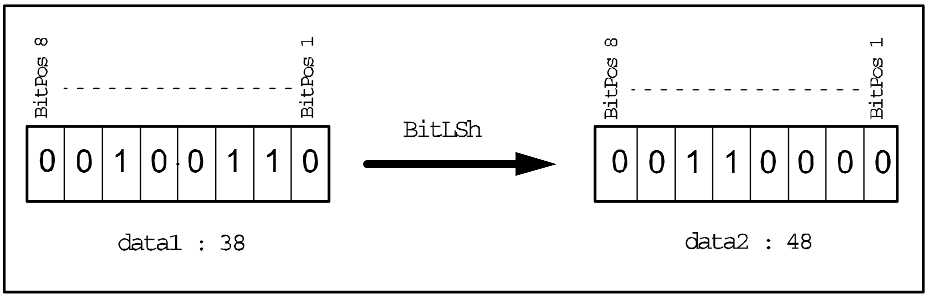
Example 1

```
VAR num left_shift := 3;
VAR byte data1 := 38;
VAR byte data2;

data2 := BitLSh(data1, left_shift);
```

The logical bitwise LEFT SHIFT- operation will be executed on the `data1` with `3` (`left_shift`) steps of left shift, and the result will be returned to `data2` (integer representation).

The following figure shows logical bitwise LEFT SHIFT-operation.



xx0500002457

Return value

Data type: `byte`

The result of the logical bitwise LEFT SHIFT-operation in integer representation.

The right bit cells will be filled up with 0-bits.

Arguments

```
BitLSh (BitData ShiftSteps)
```

`BitData`

Data type: `byte`

The bit data, in integer representation, to be shifted.

`ShiftSteps`

Data type: `num`

Number of the logical shifts (1 - 8) to be executed.

Limitations

The range for a data type `byte` is 0 - 255.

The `ShiftSteps` argument is valid from 1 - 8 according to one byte.

Continues on next page

Syntax

```
BitLSh'('
  [BitData ':='] <expression (IN) of byte>' ,'
  [ShiftSteps' :='] <expression (IN) of num>
  ')'
```

A function with a return value of the data type `byte`.

Related information

For information about	See
Logical bitwise RIGHT SHIFT-operation on byte data	*BitRSh - Logical bitwise RIGHT SHIFT - operation on byte on page 780*
Other bit functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics - Bit functions*

2.11. BitNeg - Logical bitwise NEGATION - operation on byte data

Usage

`BitNeg` (*Bit Negation*) is used to execute a logical bitwise `NEGATION` - operation (one's complement) on data types `byte`.

Basic examples

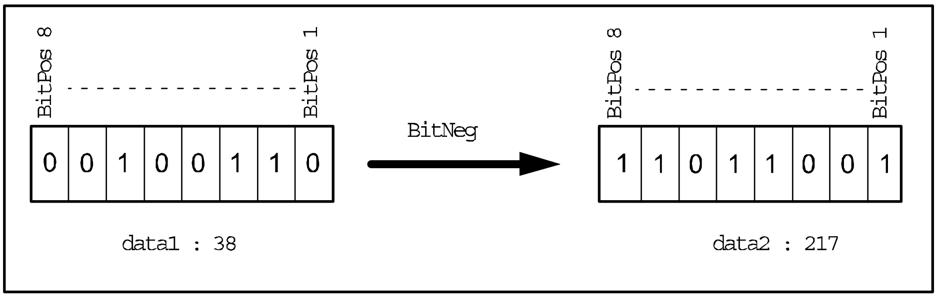
Basic examples of the function `BitNeg` are illustrated below.

Example 1

```
VAR byte data1 := 38;
VAR byte data2;

data2 := BitNeg(data1);
```

The logical bitwise `NEGATION` - operation (see figure below) will be executed on the `data1`, and the result will be returned to `data2` (integer representation).



xx0500002456

Return value

Data type: `byte`

The result of the logical bitwise `NEGATION` - operation in integer representation.

Arguments

```
BitNeg (BitData)
```

`BitData`

Data type: `byte`

The byte data, in integer representation.

Limitations

The range for a data type `byte` is 0 - 255.

Syntax

```
BitNeg'('
  [BitData ':='] <expression (IN) of byte>
  ')'
```

A function with a return value of the data type `byte`.

Continues on next page

Related information

For information about	See
Logical bitwise AND - operation on byte data	*BitAnd - Logical bitwise AND - operation on byte data on page 770*
Logical bitwise OR - operation on byte data	*BitOr - Logical bitwise OR - operation on byte data on page 778*
Logical bitwise XOR - operation on byte data	*BitXOr - Logical bitwise XOR - operation on byte data on page 782*
Other bit functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Bit functions*

2.12. BitOr - Logical bitwise OR - operation on byte data

Usage

`BitOr` (*Bit inclusive Or*) is used to execute a logical bitwise `OR`-operation on data types `byte`.

Basic examples

Basic examples of the function `BitOr` are illustrated below.

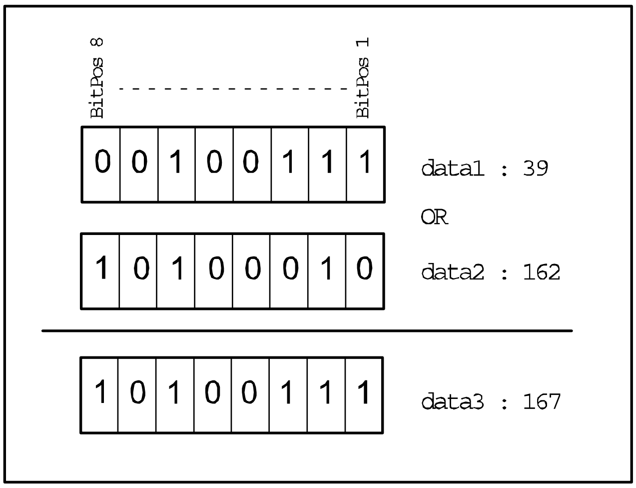
Example 1

```
VAR byte data1 := 39;
VAR byte data2 := 162;
VAR byte data3;

data3 := BitOr(data1, data2);
```

The logical bitwise OR-operation will be executed on the `data1` and `data2`, and the result will be returned to `data3` (integer representation).

The following figure shows logical bitwise OR-operation.



xx0500002458

Return value

Data type: `byte`

The result of the logical bitwise OR-operation in integer representation.

Arguments

```
BitOr (BitData1 BitData2)
```

`BitData1`

Data type: `byte`

The bit data 1, in integer representation.

`BitData2`

Data type: `byte`

The bit data 2, in integer representation.

Continues on next page

Limitations

The range for a data type `byte` is 0 - 255.

Syntax

```
BitOr'('
  [BitData1 ':='] <expression (IN) of byte>' ,'
  [BitData2 ':='] <expression (IN) of byte>
  ')'
```

A function with a return value of the data type `byte`.

Related information

For information about	See
Logical bitwise AND - operation on byte data	*BitAnd - Logical bitwise AND - operation on byte data on page 770*
Logical bitwise XOR - operation on byte data	*BitXOr - Logical bitwise XOR - operation on byte data on page 782*
Logical bitwise NEGATION - operation on byte data	*BitNeg - Logical bitwise NEGATION - operation on byte data on page 776*
Other bit functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics - Bit functions*

2.13. BitRSh - Logical bitwise RIGHT SHIFT - operation on byte

Usage

`BitRSh` (*Bit Right Shift*) is used to execute a logical bitwise RIGHT SHIFT-operation on data types `byte`.

Basic examples

Basic example of the function `BitRSh` are illustrated below.

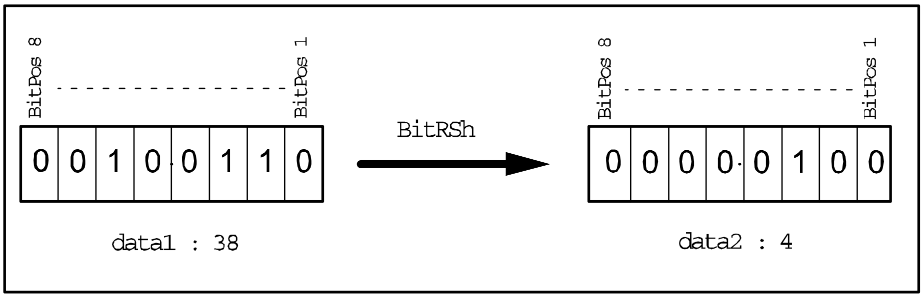
Example 1

```
VAR num right_shift := 3;
VAR byte data1 := 38;
VAR byte data2;

data2 := BitRSh(data1, right_shift);
```

The logical bitwise RIGHT SHIFT-operation will be executed on the `data1` with `3` (`right_shift`) steps of right shift, and the result will be returned to `data2` (integer representation)

The following figure shows logical bitwise RIGHT SHIFT-operation.



xx0500002455

Return value

Data type: `byte`

The result of the logical bitwise RIGHT SHIFT-operation in integer representation.

The left bit cells will be filled up with 0-bits.

Arguments

```
BitRSh (BitData ShiftSteps)
```

`BitData`

Data type: `byte`

The bit data, in integer representation, to be shifted.

`ShiftSteps`

Data type: `num`

Number of the logical shifts (1 - 8) to be executed.

Limitations

The range for a data type `byte` is 0 - 255.

The `ShiftSteps` argument is valid from 1 - 8 according to one byte.

Continues on next page

Syntax

```
BitRSh'('
  [BitData ':='] <expression (IN) of byte>','
  [ShiftSteps':='] <expression (IN) of num>
  ')'
```

A function with a return value of the data type byte.

Related information

For information about	See
Logical bitwise LEFT SHIFT-operation on byte data	*BitLSh - Logical bitwise LEFT SHIFT - operation on byte on page 774*
Other bit functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics - Bit functions*

2.14. BitXOr - Logical bitwise XOR - operation on byte data

Usage

`BitXOr` (*Bit eXclusive Or*) is used to execute a logical bitwise XOR-operation on data types `byte`.

Basic examples

Basic examples of the function `BitXOr` are illustrated below.

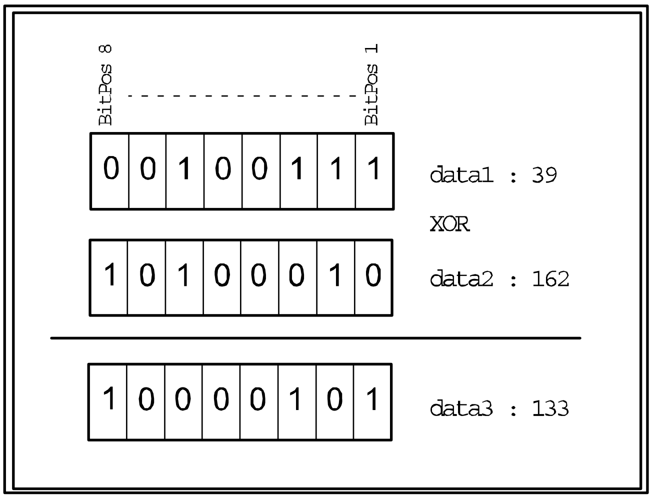
Example 1

```
VAR byte data1 := 39;
VAR byte data2 := 162;
VAR byte data3;

data3 := BitXOr(data1, data2);
```

The logical bitwise XOR -operation will be executed on the `data1` and `data2`, and the result will be returned to `data3` (integer representation).

The following figure shows logical bitwise XOR-operation.



xx0500002459

Return value

Data type: `byte`

The result of the logical bitwise XOR-operation in integer representation.

Arguments

```
BitXOr (BitData1 BitData2)
```

`BitData1`

Data type: `byte`

The bit data 1, in integer representation.

`BitData2`

Data type: `byte`

The bit data 2, in integer representation.

Continues on next page

Limitations

The range for a data type `byte` is 0 - 255.

Syntax

```
BitXOr'('
  [BitData1 ':='] <expression (IN) of byte>' ,'
  [BitData2 ':='] <expression (IN) of byte>
  ')'
```

A function with a return value of the data type `byte`.

Related information

For information about	See
Logical bitwise AND - operation on byte data	*BitAnd - Logical bitwise AND - operation on byte data on page 770*
Logical bitwise OR - operation on byte data	*BitOr - Logical bitwise OR - operation on byte data on page 778*
Logical bitwise NEGATION - operation on byte data	*BitNeg - Logical bitwise NEGATION - operation on byte data on page 776*
Other bit functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics - Bit functions*

2.15. ByteToStr - Converts a byte to a string data

Usage

`ByteToStr` (*Byte To String*) is used to convert a byte into a string data with a defined byte data format.

Basic examples

Basic examples of the function `ByteToStr` are illustrated below.

Example 1

```
VAR string con_data_buffer{5};
VAR byte data1 := 122;

con_data_buffer{1} := ByteToStr(data1);
```

The content of the array component `con_data_buffer{1}` will be "122" after the `ByteToStr ...` function.

```
con_data_buffer{2} := ByteToStr(data1\Hex);
```

The content of the array component `con_data_buffer{2}` will be "7A" after the `ByteToStr ...` function.

```
con_data_buffer{3} := ByteToStr(data1\Okt);
```

The content of the array component `con_data_buffer{3}` will be "172" after the `ByteToStr ...` function.

```
con_data_buffer{4} := ByteToStr(data1\Bin);
```

The content of the array component `con_data_buffer{4}` will be "01111010"after the `ByteToStr ...` function.

```
con_data_buffer{5} := ByteToStr(data1\Char);
```

The content of the array component `con_data_buffer{5}` will be "z" after the `ByteToStr ...` function.

Return value

Data type: `string`

The result of the conversion operation with the following format:

Format	Characters	String length	Range
Dec .....:	’0’ -’ 9’	1-3	"0" - "255"
Hex .....:	’0’ -’ 9’, ’A’ -’F’	2	"00" - "FF"
Okt ......:	’0’ - ’7’	3	"000" - "377"
Bin ......:	’0’ - ’1’	8	"00000000" - "11111111"
Char ....:	Any ASCII char (*)	1	One ASCII char

(*) If it is a non-writable ASCII character then the return format will be RAPID character code format (e.g.“ \07” for BEL control character).

Continues on next page

Arguments

```
ByteToStr (BitData [\Hex] | [\Okt] | [\Bin] | [\Char])
```

`BitData`

Data type: `byte`

The bit data to be converted.

If the optional switch argument is omitted then the data will be converted in `decimal` (Dec) format.

`[\Hex]`

Hexadecimal

Data type: `switch`

The data will be converted in `hexadecimal` format.

`[\Okt]`

Octal

Data type: `switch`

The data will be converted in `octal` format.

`[\Bin]`

Binary

Data type: `switch`

The data will be converted in `binary` format.

`[\Char]`

Character

Data type: `switch`

The data will be converted in `ASCII` character format.

Limitations

The range for a data type `byte` is 0 to 255 decimal.

Syntax

```
ByteToStr'('
  [BitData ':='] <expression (IN) of byte>
  ['\' Hex ] | ['\' Okt] | ['\' Bin] | ['\' Char]
  ')'
```

A function with a return value of the data type `string`.

Related information

For information about	See
Convert a string to a byte data	*StrToByte - Converts a string to a byte data on page 1007*
Other bit (byte) functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics - Bit functions*
Other string functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*

2.16. CalcJointT - Calculates joint angles from robtarget

Usage

`CalcJointT` (*Calculate Joint Target*) is used to calculate joint angles of the robot axes and external axes from a specified `robtarget` data.

The input `robtarget` data should be specified in the same coordinate system as specified in argument for `Tool`, `WObj`, and at execution time active program displacement (`ProgDisp`) and external axes offset (`EOffs`). The returned `jointtarget` data is expressed in the calibration coordinate system.

If MultiMove application type semicoordinated or synchronized coordinated mode with the coordinated workobject is moved by some mechanical unit located in another program task then the function `CalcJointT` can be used if:

- It is appropriate that the current position of the coordinated work object moved by the mechanical unit is used in the calculation (current user frame). All other data will be fetched from the RAPID program.
- The mechanical unit located in another program task is standing still.
- The argument `\UseCurWObjPos` is used.

Basic examples

Basic examples of the function `CalcJointT` are illustrated below.

Example 1

```
VAR jointtarget jointpos1;
CONST robtarget p1 := [...];
jointpos1 := CalcJointT(p1, tool1 \WObj:=wobj1);
```

The `jointtarget` value corresponding to the `robtarget` value `p1` is stored in `jointpos1`. The tool `tool1` and work object `wobj1` are used for calculating the joint angles `jointpos1`.

Example 2

```
VAR jointtarget jointpos2;
CONST robtarget p2 := [...];
jointpos2 := CalcJointT(\UseCurWObjPos, p2, tool2 \WObj:=orb1);
```

The `jointtarget` value corresponding to the `robtarget` value `p2` is stored in `jointpos2`. The tool `tool2` and work object `orb1` are used for calculating the joint angles `jointpos2`. The current position of the standing still manipulator `orb1` is not located in the same program task as the TCP robot but is used for the calculation.

Return value

Data type: `jointtarget`

The angles in degrees for the axes of the robot on the arm side.

The values for the external axes, in mm for linear axes, in degrees for rotational axes.

The returned values are always related to the calibration position.

Continues on next page

Arguments

```
CalcJointT ( [\UseCurWObjPos] Rob_target Tool [\WObj] )
```

`[\UseCurWObjPos]`

Data type: `switch`

Use current position of the coordinated work object moved by the mechanical unit in another task for the calculation (current user frame). All other data is fetched from the RAPID program.

`Rob_target`

Data type: `robtarget`

The position of the robot and external axes in the outermost coordinate system, related to the specified tool and work object and at execution time active program displacement (`ProgDisp`) and/or external axes offset (`EOffs`).

`Tool`

Data type: `tooldata`

The tool used for calculation of the robot joint angles.

`[\WObj]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot position is related.

If this argument is omitted then the work object `wobj0` is used. This argument must be specified when using stationary tool, coordinated external axes, or conveyor.

Program execution

The returned `jointtarget` is calculated from the input `robtarget`. If use of the argument `\UseCurWObjPos` also the current position of the mechanical unit that controls the user frame is used. To calculate the robot joint angles, the specified `Tool`, `WObj` (including coordinated user frame), and the `ProgDisp` active at execution time are taken into consideration. To calculate the external axes position at the execution time, active `EOffs` is taken into consideration.

The calculation always selects the robot configuration according to the specified configuration data in the input `robtarget` data. Instructions `ConfL` and `ConfJ` do not affect this calculation principle. When wrist singularity is used, robot axis 4 will be set to 0 degrees.

If there is any active program displacement (`ProgDisp`) and/or external axis offset (`EOffs`) at the time the robtarget is stored then the same program displacement and/or external axis offset must be active when `CalcJointT` is executed.

Continues on next page

Limitation

If a coordinate frame is used then the coordinated unit has to be activated before using `CalcJointT`.

The mechanical unit that controls the user frame in the work object must normally be available in the same program task as the TCP robot which executes `CalcJointT`.

Normally `CalcJointT` uses `robtarget`, `tooldata`, and `wobjdata` from the RAPID program to calculate `jointtarget`. For coordinated workobjects, the position of the mechanical unit is given as external axes position in the `robtarget`. That is not the case if the mechanical unit is controlled by another program task (MultiMove system) or the mechanical unit is not controlled by the control system (Conveyor). For the MultiMove System but not for the conveyor it is possible to use the argument `\UseCurWObjPos` if the mechanical unit is standing still at the execution time of `CalCJointT`.

Error handling

If at least one axis is outside the working area or the limits are exceeded for at least one coupled joint then the system variable `ERRNO` is set to `ERR_ROBLIMIT` and the execution continues in the error handler.

If the mechanical unit that controls the work object (user frame) isn't standing still at execution time of `CalJointT \UseCurWobjPos` then the system variable `ERRNO` is set to `ERR_WOBJ_MOVING` and the execution continues in the error handler.

The error handler can then deal with the situations.

Syntax

```
CalcJointT'('
  ['\'UseCurWObjPos ',']
  [Rob_target' :='] <expression (IN) of robtarget>','
  [Tool ':=' ] <persistent (PERS) of tooldata>
  ['\'WObj ':=' <persistent (PERS) of wobjdata>] ')'
```

A function with a return value of the data type jointtarget.

Related information

For information about	See
Calculate robtarget from jointtarget	*CalcRobT - Calculates robtarget from jointtarget on page 789*
Definition of position	*robtarget - Position data on page 1176*
Definition of joint position	*jointtarget - Joint position data on page 1129*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
Program displacement coordinate system	*PDispOn - Activates program displacement on page 317*
External axis offset coordinate system	*EOffsOn - Activates an offset for external axes on page 88*

2.17. CalcRobT - Calculates robtarget from jointtarget

Usage

`CalcRobT` (*Calculate Robot Target*) is used to calculate a `robtarget` data from a given `jointtarget` data.

This function returns a `robtarget` value with position (x, y, z), orientation (q1 ... q4), robot axes configuration, and external axes position.

The input `jointtarget` data should be specified in the calibration coordinate system.

The returned `robtarget` data is expressed in the outermost coordinate system. It takes the specified tool, work object, and at execution time active program displacement (`ProgDisp`) and external axis offset (`EOffs`) into consideration.

Basic examples

Basic examples of the function `CalcRobT` are illustrated below.

Example 1

```
VAR robtarget p1;
CONST jointtarget jointpos1 := [...];

p1 := CalcRobT(jointpos1, tool1 \WObj:=wobj1);
```

The `robtarget` value corresponding to the `jointtarget` value `jointpos1` is stored in `p1`. The tool `tool1` and work object `wobj1` are used for calculating the position of `p1`.

Return value

Data type: `robtarget`

The robot and external axes position is returned in data type `robtarget` and expressed in the outermost coordinate system. It takes the specified tool, work object, and at execution time active program displacement (`ProgDisp`) and external axes offset (`EOffs`) into consideration.

If there is no active `ProgDisp` then the robot position is expressed in the object coordinate system. If there are no active `EOffs` then the external axis position is expressed in the calibration coordinate system.

Arguments

```
CalcRobT   ( Joint_target Tool  [\WObj] )
```

`Joint_target`

Data type: `jointtarget`

The joint position for the robot axes and external axes related to the calibration coordinate system.

`Tool`

Data type: `tooldata`

The tool used for calculation of the robot position.

Continues on next page

`[\WObj]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the robot position returned by the function is related.

If this argument is omitted the work object `wobj0` is used. This argument must be specified when using stationary tool, coordinated external axes, or conveyor.

Program execution

The returned `robtarget` is calculated from the input `jointtarget`. To calculate the cartesian robot position the specified `Tool`, `WObj` (including coordinated user frame), and at the execution time active `ProgDisp`, are taken into consideration.

To calculate the external axes position, the `EOffs` active at execution time is also taken into consideration.

Limitation

If a coordinate frame is used then the coordinated unit has to be activated before using `CalcRobT`. The coordinated unit also has to be situated in the same task as the robot.

Syntax

```
CalcRobT'('
  [Joint_target ':=' ] <expression (IN) of jointtarget>','
  [Tool ':=' ] <persistent (PERS) of tooldata>
  ['\'WObj ':=' <persistent (PERS) of wobjdata>] ')'
```

A function with a return value of the data type `robtarget`.

Related information

For information about	See
Calculate jointtarget from robtarget	*CalcJointT - Calculates joint angles from robtarget on page 786*
Definition of position	*robtarget - Position data on page 1176*
Definition of joint position	*jointtarget - Joint position data on page 1129*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - Coordinate Systems*
Program displacement coordinate system	*PDispOn - Activates program displacement on page 317*
External axes offset coordinate system	*EOffsOn - Activates an offset for external axes on page 88*

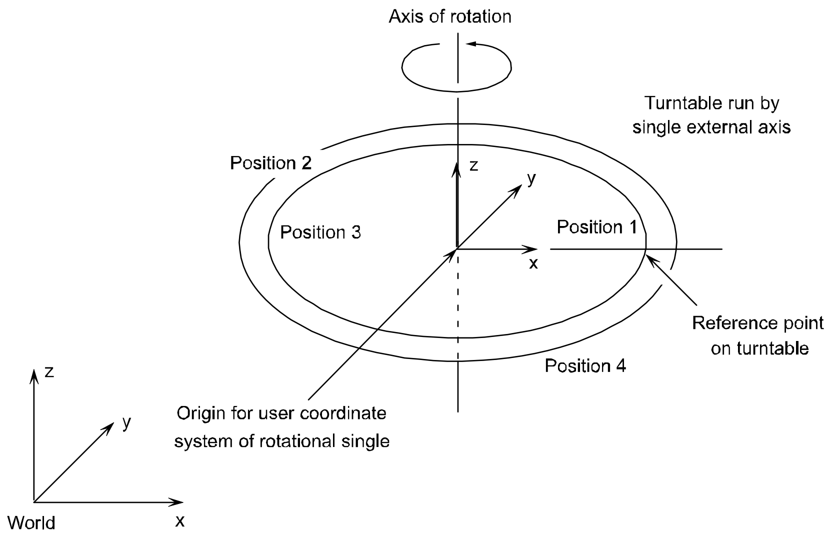
2.18. CalcRotAxFrameZ - Calculate a rotational axis frame

Usage

`CalcRotAxFrameZ` (*Calculate Rotational Axis Frame with positive Z-point*) is used to calculate the user coordinate system of a rotational axis type mechanical unit. This function is to be used when the master robot and the external axis are located in different RAPID tasks. If they are in the same task then the function `CalcRotAxisFrame` should be used.

Description

The definition of a user frame for a rotational external axis requires that the turntable (or similar mechanical structure) on the external axis has a marked reference point. Moreover, the TCP robot's base frame and TCP must be calibrated. The calibration procedure consists of a number of positions for the robot's TCP on the reference point when the turntable is rotated to different angles. A positioning of the robots TCP in the positive z direction is also needed. For definition of points for a rotational axis, see the figure below.



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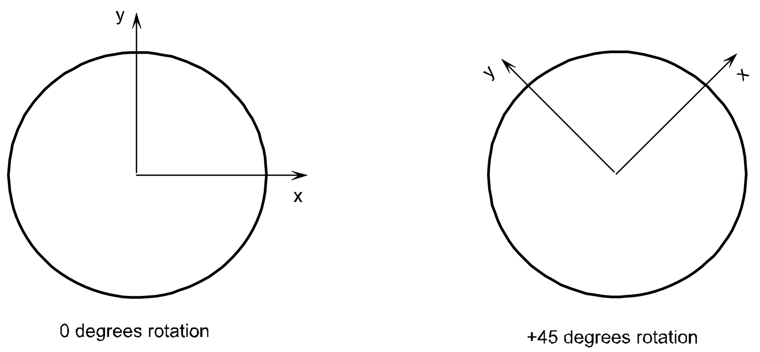
The user coordinate system for the rotational axis has its origin in the center of the turntable. The z direction coincides with the axis of rotation and the x axis goes through the reference point.

The figure below shows the user coordinate system for two different positions of the turntable (turntable seen from above).



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Basic examples

Basic examples of the function `CalcRotAxFrameZ` are illustrated below.

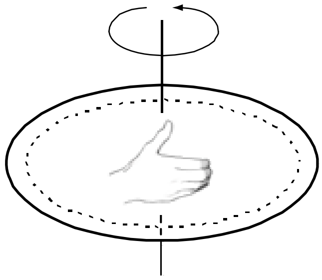
Example 1

```
CONST robtarget pos1 := [...];
CONST robtarget pos2 := [...];
CONST robtarget pos3 := [...];
CONST robtarget pos4 := [...];
CONST robtarget zpos;
VAR robtarget targetlist{10};
VAR num max_err := 0;
VAR num mean_err := 0;
VAR pose resFr:=[...];
PERS tooldata tMyTool:= [...];

! Instructions for creating/ModPos pos1 - pos4 with TCP pointing
     at the turntable.
MoveJ pos1, v10, fine, tMyTool;
MoveJ pos2, v10, fine, tMyTool;
MoveJ pos3, v10, fine, tMyTool;
MoveJ pos4, v10, fine, tMyTool;

!Instruction for creating/ModPos zpos with TCP pointing at a point
     in positive z direction
MoveJ zpos, v10, fine, tMyTool;

! Add the targets to the array
targetlist{1}:= pos1;
targetlist{2}:= pos2;
targetlist{3}:= pos3;
targetlist{4}:= pos4;

resFr:=CalcRotAxFrameZ(targetlist, 4, zpos, max_err, mean_err);

! Update the system parameters.
IF (max_err < 1.0) AND (mean_err < 0.5) THEN
  WriteCfgData "/MOC/SINGLE/STN_1",
        "base_frame_pos_x",resFr.trans.x/1000;
  WriteCfgData "/MOC/SINGLE/STN_1",
        "base_frame_pos_y",resFr.trans.y/1000;
  WriteCfgData "/MOC/SINGLE/STN_1",
        "base_frame_pos_z",resFr.trans.z/1000;
  WriteCfgData "/MOC/SINGLE/STN_1",
        "base_frame_orient_u0",resFr.rot.q1;
  WriteCfgData "/MOC/SINGLE/STN_1",
        "base_frame_orient_u1",resFr.rot.q2;
  WriteCfgData "/MOC/SINGLE/STN_1",
        "base_frame_orient_u2",resFr.rot.q3;
```


Continues on next page

```
    WriteCfgData "/MOC/SINGLE/STN_1",
         "base_frame_orient_u3",resFr.rot.q4;
    TPReadFK reg1,"Warmstart required for calibration to take
         effect."
       ,stEmpty,stEmpty,stEmpty, stEmpty,"OK";
    WarmStart;
  ENDIF
```

Four positions, `pos1` - `pos4`, are created/modposed so that the robot's tool `tMyTool` points to the same reference point on the external axis `STN_1` but with different external axis rotations. Position, `zpos`, is created/modposed so that the robot's tool `tMyTool` points in the positive z direction according to the definition of the positive z-direction of an external rotational mechanical unit. Using the definition of the positive z-direction of an external rotational mechanical unit, see *Description on page 791*. The points are then used for calculating the external axis base frame, `resFr`, in relation to the world coordinate system. Finally, the frame is written to the configuration file and a warmstart is made to let the change take effect.



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NOTE!

Definition of the positive z-direction of an external rotational mechanical unit:

Let the right hand's fingers coincide with the positive rotation axis of the rotational axis. The direction of the thumb then defines the positive z-direction. See the figure above.

Return value

Data type: `pose`

The calculated frame.

Arguments

```
CalcRotAxFrameZ (TargetList TargetsInList PositiveZPoint
     MaxErr MeanErr)
```

`TargetList`

Data type: `robtarget`

Array of robtargets holding the positions defined by pointing out the turntable. Minimum number of robtargets is 4, maximum 10.

`TargetsInList`

Data type: `num`

Number of robtargets in an array.

`PositiveZPoint`

Data type: `robtarget`

`robtarget` holding the position defined by pointing out a point in the positive z direction. Using the definition of the positive z-direction of an external rotational mechanical unit, see *Description on page 791*.

`MaxErr`

Maximum Error

Data type: `num`

The estimated maximum error in mm.

`MeanErr`

Mean Error

Data type: `num`

The estimated mean error in mm.

Error handling

If the positions don't have the required relation or are not specified with enough accuracy then the system variable `ERRNO` is set to `ERR_FRAME`. This error can then be handled in an error handler.

Syntax

```
CalcRotAxFrameZ'('
  [TargetList ':='] <array {*} (IN) of robtarget>' ,'
  [TargetsInList' :='] <expression (IN) of num> ','
  [PositiveZPoint' :='] <expression (IN) of robtarget> ','
  [MaxErr ':='] <variable (VAR) of num> ','
  [MeanErr ':='] <variable (VAR) of num>')'
```

A function with a return value of the data type `pose`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*

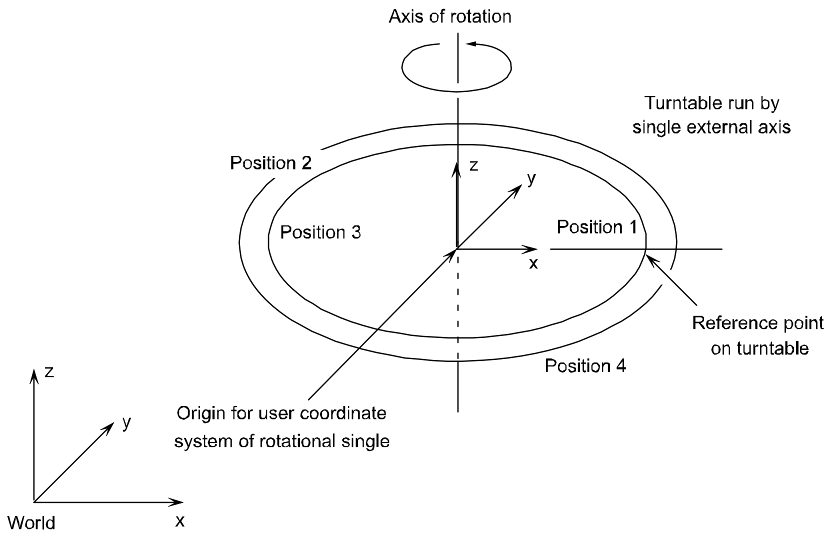
2.19. CalcRotAxisFrame - Calculate a rotational axis frame

Usage

`CalcRotAxisFrame` (*Calculate Rotational Axis Frame*) is used to calculate the user coordinate system of a rotational axis type mechanical unit. This function is to be used when the master robot and the external axis are located in the same RAPID task. If they are in different tasks the function `CalcRotAxFrameZ` should be used.

Description

The definition of a user frame for a rotational external axis requires that the turntable (or similar mechanical structure) on the external axis has a marked reference point. Moreover, the master robot's base frame and TCP must be calibrated. The calibration procedure consists of a number of positions for the robot's TCP on the reference point when the turntable is rotated to different angles. Definition of points for a rotational axis is illustrated in the figure below.



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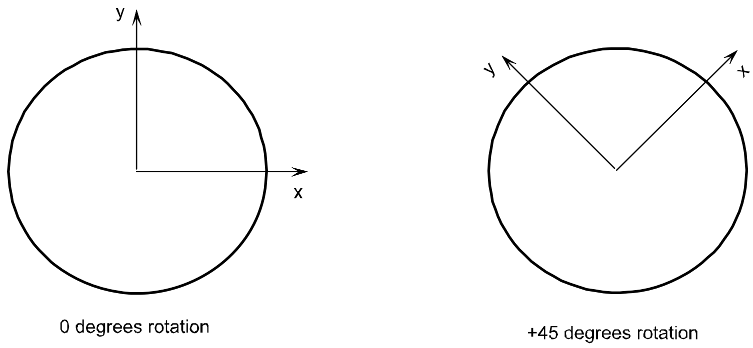
The user coordinate system for the rotational axis has its origin in the center of the turntable. The z direction coincides with the axis of rotation and the x axis goes through the reference point.

The figure below shows the user coordinate system for two different positions of the turntable (turntable seen from above).



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Basic examples

Basic examples of the function `CalcRotAxisFrame` are illustrated below.

Example 1

```
CONST robtarget pos1 := [...];
CONST robtarget pos2 := [...];
CONST robtarget pos3 := [...];
CONST robtarget pos4 := [...];
VAR robtarget targetlist{10};
VAR num max_err := 0;
VAR num mean_err := 0;
VAR pose resFr:=[...];
PERS tooldata tMyTool:= [...];

! Instructions needed for creating/ModPos pos1 - pos4 with TCP
     pointing at the turntable.
MoveJ pos1, v10, fine, tMyTool;
MoveJ pos2, v10, fine, tMyTool;
MoveJ pos3, v10, fine, tMyTool;
MoveJ pos4, v10, fine, tMyTool;

! Add the targets to the array
targetlist{1}:= pos1;
targetlist{2}:= pos2;
targetlist{3}:= pos3;
targetlist{4}:= pos4;

resFr:=CalcRotAxisFrame(STN_1 , targetlist, 4, max_err, mean_err);

! Update the system parameters.
IF (max_err < 1.0) AND (mean_err < 0.5) THEN
  WriteCfgData "/MOC/SINGLE/STN_1",
       "base_frame_pos_x",resFr.trans.x/1000;
  WriteCfgData "/MOC/SINGLE/STN_1",
       "base_frame_pos_y",resFr.trans.y/1000;
  WriteCfgData "/MOC/SINGLE/STN_1",
       "base_frame_pos_z",resFr.trans.z/1000;
  WriteCfgData "/MOC/SINGLE/STN_1",
       "base_frame_orient_u0",resFr.rot.q1;
  WriteCfgData "/MOC/SINGLE/STN_1",
       "base_frame_orient_u1",resFr.rot.q2;
  WriteCfgData "/MOC/SINGLE/STN_1",
       "base_frame_orient_u2",resFr.rot.q3;
  WriteCfgData "/MOC/SINGLE/STN_1",
       "base_frame_orient_u3",resFr.rot.q4;
  TPReadFK reg1,"Warmstart required for calibration to take
       effect.",stEmpty,stEmpty,stEmpty,stEmpty,"OK";
  WarmStart;
ENDIF
```


Continues on next page

Four positions, `pos1` - `pos4`, are created/modposed so that the robot's tool `tMyTool` points to the same reference point on the external axis `STN_1` but with different external axis rotations. The points are then used for calculating the external axis base frame, `resFr`, in relation to the world coordinate system. Finally, the frame is written to the configuration file and a warmstart is made to let the change take effect.

Return value

Data type: `pose`

The calculated frame.

Arguments

```
CalcRotAxisFrame (MechUnit [\AxisNo] TargetList TargetsInList
     MaxErr MeanErr)
```

`MechUnit`

Mechanical Unit

Data type: `mecunit`

Name of the mechanical unit to be calibrated.

`[\AxisNo]`

Data type: `num`

Optional argument defining the axis number for which a frame should be determined. Default value is 1 applying to single rotational axis. For mechanical units with several axes, the axis number should be supplied with this argument.

`TargetList`

Data type: `robtarget`

Array of robtargets holding the positions defined by pointing out the turntable. Minimum number of robtargets is 4, maximum is 10.

`TargetsInList`

Data type: `num`

Number of robtargets in an array.

`MaxErr`

Maximum Error

Data type: `num`

The estimated maximum error in mm.

`MeanErr`

Mean Error

Data type: `num`

The estimated mean error in mm.

Error handling

If the positions don't have the required relation or are not specified with enough accuracy then the system variable `ERRNO` is set to `ERR_FRAME`. This error can then be handled in an error handler.

Continues on next page

Syntax

```
CalcRotAxisFrame'('
  [MechUnit ':='] <variable (VAR) of mecunit>
  [\AxisNo ':=' <expression (IN) of num> ]','
  [TargetList':='] <array {*} (IN) of robtarget> ','
  [TargetsInList':='] <expression (IN) of num> ','
  [MaxErr ':='] <variable (VAR) of num> ','
  [MeanErr ':='] <variable (VAR) of num>')'
```

A function with a return value of the data type `pose`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*

2.20. CDate - Reads the current date as a string

Usage

`CDate` (*Current Date*) is used to read the current system date.

This function can be used to present the current date to the operator on the FlexPendant display or to paste the current date into a text file that the program writes to.

Basic examples

Basic examples of the function `CDate` are illustrated below.

See also *on page 799*.

Example 1

```
VAR string date;
date := CDate();
```

The current date is stored in the variable `date`.

Return value

Data type: `string`

The current date in a string.

The standard date format is "year-month-day", e.g. "1998-01-29".

More examples

More examples of the function `CDate` are illustrated below.

Example 1

```
VAR string date;
date := CDate();
TPWrite "The current date is: "+date;
Write logfile, date;
```

The current date is written to the FlexPendant display and into a text file.

Syntax

```
CDate '(' ')'
```

A function with a return value of the type `string`.

Related information

For information about	See
Time instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - System & time*
Setting the system clock	*Operating manual - IRC5 with FlexPendant*, section *Changing FlexPendant settings*

2.21. CJointT - Reads the current joint angles

Usage

`CJointT` (*Current Joint Target*) is used to read the current angles of the robot axes and external axes.

Basic examples

Basic examples of the function `CJointT` are illustrated below.

See also *More examples on page 801*.

Example 1

```
VAR jointtarget joints;
joints := CJointT();
```

The current angles of the axes for a robot and external axes are stored in `joints`.

Return value

Data type: `jointtarget`

The current angles in degrees for the axes of the robot on the arm side.

The current values for the external axes, in mm for linear axes, in degrees for rotational axes.

The returned values are related to the calibration position.

Arguments

```
CJointT ([\TaskRef]|[\TaskName])
```

`[\TaskRef]`

Task Reference

Data type: `taskid`

The program task identity from which the `jointtarget` should be read.

For all program tasks in the system, predefined variables of the data type `taskid` will be available. The variable identity will be "taskname"+"Id", e.g. for the `T_ROB1` task, and the variable identity will be `T_ROB1Id`.

`[\TaskName]`

Data type: `string`

The program task name from which the `jointtarget` should be read.

If none of the arguments `\TaskRef` or `\TaskName` are specified then the current task is used.

Continues on next page

More examples

More examples of the function `CJointT` are illustrated below.

Example 1

```
! In task T_ROB1
VAR jointtarget joints;
joints := CJointT(\TaskRef:=T_ROB2Id);
```

The current position of the robot and external axes in task `T_ROB2` are stored in `joints` in task `T_ROB1`.

Note that the robot in task `T_ROB2` may be moving when the position is read. To make sure the robot stands still, a stop point `fine` in the preceding movement instruction in task `T_ROB2` could be programmed and instruction `WaitSyncTask` could be used to synchronize the instructions in task `T_ROB1`.

Example 2

```
! In task T_ROB1
VAR jointtarget joints;
joints := CJointT(\TaskName:="T_ROB2");
```

The same effect as Example 1 above.

Error handling

If argument `\TaskRef` or `\TaskName` specify some non-motion task then the system `ERRNO` is set to `ERR_NOT_MOVETASK`. This error can be handled in the error handler.

But no error will be generated if argument `\TaskRef` or `\TaskName` specifies the non-motion task that executes this function `CJointT` (reference to my own non-motion task). The position will then be fetched from the connected motion task.

Syntax

```
CJointT'('
['\' TaskRef' :=' <variable (VAR) of taskid>]
|['\' TaskName' :=' <expression (IN) of string>]')'
```

A function with a return value of the data type `jointtarget`.

Related information

For information about	See
Definition of joint	*jointtarget - Joint position data on page 1129*
Reading the current motor angle	*ReadMotor - Reads the current motor angles on page 947*

2.22. ClkRead - Reads a clock used for timing

Usage

`ClkRead` is used to read a clock that functions as a stop-watch used for timing.

Basic examples

Basic examples of the instruction `ClkRead` are illustrated below.

Example 1

```
reg1:=ClkRead(clock1);
```

The clock `clock1` is read and the time in seconds is stored in the variable `reg1`.

Return value

Data type: `num`

The time in seconds stored in the clock. Resolution 0.01 seconds.

Argument

```
ClkRead (Clock)
```

`Clock`

Data type: `clock`

The name of the clock to read.

Program execution

A clock can be read when it is stopped or running.

Once a clock is read it can be read again, started again, stopped, or reset.

Error handling

If the clock runs for 4,294,967 seconds (49 days 17 hours 2 minutes 47 seconds) then it becomes overflowed and the system variable ERRNO is set to ERR_OVERFLOW.

The error can be handled in the error handler.

Syntax

```
ClkRead '('
[ Clock ':=' ] < variable (VAR) of clock > ')'
```

A function with a return value of the type `num`.

Related information

For information about	See
Clock instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - System & Time*
More examples	*ClkStart - Starts a clock used for timing on page 52*

2.23. CorrRead - Reads the current total offsets

Usage

`CorrRead` is used to read the total corrections delivered by all connected correction generators.

`CorrRead` can be used to:

- find out how much the current path differs from the original path.
- take actions to reduce the difference.

Basic examples

Basic examples of the function `CorrRead` are illustrated below.

See also *More examples on page 803*.

Example 1

```
VAR pos offset;
...
offset := CorrRead();
```

The current offsets delivered by all connected correction generators are available in the variable offset.

Return value

Data type: `pos`

The total absolute offsets delivered from all connected correction generators so far.

More examples

For more examples of the function `CorrRead`, see instruction `CorrCon`.

Syntax

```
CorrRead' (' ')'
```

A function with a return value of the data type pos.

Related information

For information about	See
Connects to a correction generator	*CorrCon - Connects to a correction generator on page 71*
Disconnects from a correction generator	*CorrDiscon - Disconnects from a correction generator on page 76*
Writes to a correction generator	*CorrWrite - Writes to a correction generator on page 77*
Removes all correction generators	*CorrClear - Removes all correction generators on page 70*
Correction descriptor	*corrdescr - Correction generator descriptor on page 1099*

2.24. Cos - Calculates the cosine value

Usage

`Cos` (*Cosine*) is used to calculate the cosine value from an angle value.

Basic examples

Basic examples of the function `Cos` are illustrated below.

Example 1

```
VAR num angle;
VAR num value;
...
...
value := Cos(angle);
```

`value` will get the cosine value of `angle`.

Return value

Data type: `num`

The cosine value, range = [-1, 1] .

Arguments

```
Cos (Angle)
```

`Angle`

Data type: `num`

The angle value, expressed in degrees.

Syntax

```
Cos'('
  [Angle ':='] <expression (IN) of num>
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*

2.25. CPos - Reads the current position (pos) data

Usage

`CPos` *(Current Position)* is used to read the current position of the robot.

This function returns the x, y, and z values of the robot TCP as data of type pos. If the complete robot position (`robtarget`) is to be read then use the function `CRobT` instead.

Basic examples

Basic examples of the function `CPos` are illustrated below.

See also *More examples on page 806*.

```
VAR pos pos1;

MoveL *, v500, fine \Inpos := inpos50, tool1;
pos1 := CPos(\Tool:=tool1 \WObj:=wobj0);
```

The current position of the robot TCP is stored in variable `pos1`. The tool `tool1` and work object `wobj0` are used for calculating the position.

Note that the robot is standing still before the position is read and calculated. This is achieved by using the stop point `fine` within position accuracy `inpos50` in the preceding movement instruction.

Return value

Data type: `pos`

The current position (pos) of the robot with x, y, and z in the outermost coordinate system, taking the specified tool, work object, and active ProgDisp coordinate system into consideration.

Arguments

```
CPos ([\Tool] [\WObj])
```

[`\Tool`]

Data type: `tooldata`

The tool used for calculation of the current robot position.

If this argument is omitted then the current active tool is used.

`[\WObj]`

Work Object

Data type: `wobjdata`

The work object (coordinate system) to which the current robot position returned by the function is related.

If this argument is omitted then the current active work object is used.

WARNING!

It is advised to always specify the arguments `\Tool` and `\WObj` during programming. The function will then always return the wanted position even if another tool or work object are activated.

Continues on next page

Program execution

The coordinates returned represent the TCP position in the ProgDisp coordinate system.

More examples

More examples of the function `CPos` are illustrated below.

```
VAR pos pos2;
VAR pos pos3;
VAR pos pos4;

pos2 := CPos(\Tool:=grip3 \WObj:=fixture);
...
pos3 := CPos(\Tool:=grip3 \WObj:=fixture);
pos4 := pos3-pos2;
```

The x, y, and z position of the robot is captured at two places within the program using the `CPos` function. The tool `grip3` and work object `fixture` are used for calculating the position. The x, y, and z distances travelled between these positions are then calculated and stored in variable `pos4`.

Syntax

```
CPos '('
  ['\'Tool ':=' <persistent (PERS) of tooldata>]
  ['\'WObj ':=' <persistent (PERS) of wobjdata>] ')'
```

A function with a return value of the data type `pos`.

Related information

For information about	See
Definition of position	*pos - Positions (only X, Y and Z) on page 1160*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
ProgDisp coordinate system	*PDispOn - Activates program displacement on page 317*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - Coordinate systems*
Reading the current `robtarget`	*CRobT - Reads the current position (robtarget) data on page 807*

2.26. CRobT - Reads the current position (robtarget) data

Usage

`CRobT`*(Current Robot Target)* is used to read the current position of a robot and external axes.

This function returns a `robtarget` value with position (x, y, z), orientation (q1 ... q4), robot axes configuration, and external axes position. If only the x, y, and z values of the robot TCP (`pos`) are to be read then use the function `CPos` instead.

Basic examples

Basic examples of the function `CRobT` are illustrated below.

See also *More examples on page 808*.

Example 1

```
VAR robtarget p1;
MoveL *, v500, fine \Inpos := inpos50, tool1;
p1 := CRobT(\Tool:=tool1 \WObj:=wobj0);
```

The current position of the robot and external axes is stored in `p1`. The tool `tool1` and work object `wobj0` are used for calculating the position.

Note that the robot is standing still before the position is read and calculated. This is achieved by using the stop point `fine` within position accuracy `inpos50` in the preceding movement instruction.

Return value

Data type: `robtarget`

The current position of a robot and external axes in the outermost coordinate system, taking the specified tool, work object, and active `ProgDisp/ExtOffs` coordinate system into consideration.

Arguments

```
CRobT ([\TaskRef]|[\TaskName] [\Tool] [\WObj])
```

`[\TaskRef]`

Task Reference

Data type: `taskid`

The program task identity from which the `robtarget` should be read.

For all program tasks in the system, predefined variables of the data type `taskid` will be available. The variable identity will be "taskname"+"Id", e.g. for the `T_ROB1` task the variable identity will be `T_ROB1Id`.

`[\TaskName]`

Data type: `string`

The program task name from which the `robtarget` should be read.

If none of the arguments `\TaskRef` or `\TaskName` are specified then the current task is used.

Continues on next page

[\Tool]

Data type: tooldata

The persistent variable for the tool used to calculate the current robot position.

If this argument is omitted then the current active tool is used.

[\WObj]

Work Object

Data type: wobjdata

The persistent variable for the work object (coordinate system) to which the current robot position returned by the function is related.

If this argument is omitted then the current active work object is used.

WARNING!

It is advised to always specify the arguments \Tool and \WObj during programming. The function will then always return the wanted position even if another tool or work object are activated.

Program execution

The coordinates returned represent the TCP position in the ProgDisp coordinate system. External axes are represented in the ExtOffs coordinate system.

If one of the arguments \TaskRef or \TaskName are used but arguments Tool and WObj are not used then the current tool and work object in the specified task will be used.

More examples

More examples of the function CRobT are illustrated below.

Example 1

```
VAR robtarget p2;
p2 := ORobT( CRobT(\Tool:=grip3 \WObj:=fixture) );
```

The current position in the object coordinate system (without any ProgDisp or ExtOffs) of the robot and external axes is stored in p2. The tool grip3 and work object fixture are used for calculating the position.

Example 2

```
! In task T_ROB1
VAR robtarget p3;
p3 := CRobT(\TaskRef:=T_ROB2Id \Tool:=tool1 \WObj:=wobj0);
```

The current position of the robot and external axes in task T_ROB2 are stored in p3 in task T_ROB1. The tool tool1 and work object wobj0 are used for calculating the position.

Note that the robot in task T_ROB2 may be moving when the position is read and calculated. To make sure the robot stands still, a stop point fine in the preceding movement instruction in task T_ROB2 could be programmed and instruction WaitSyncTask could be used to synchronize the instructions in task T_ROB1.

Continues on next page

Example 3

```
! In task T_ROB1
VAR robtarget p4;
p4 := CRobT(\TaskName:="T_ROB2");
```

The current position of the robot and external axes in task `T_ROB2` are stored in `p4` in task `T_ROB1`. The current tool and work object in task `T_ROB2` are used for calculating the position.

Error handling

If argument `\TaskRef` or `\TaskName` specify some non-motion task then the system `ERRNO` is set to `ERR_NOT_MOVETASK`. This error can be handled in the error handler.

But no error will be generated if the arguments `\TaskRef` or `\TaskName` specify the non-motion task that executes this function `CRobT` (reference to my own non-motion task). The position will then be fetched from the connected motion task.

Syntax

```
CRobT'('
  ['\' TaskRef ':=' <variable (VAR) of taskid>]
  |['\' TaskName' ':=' <expression (IN) of string>]
  ['\'Tool ':=' <persistent (PERS) of tooldata>]
  ['\'WObj ':=' <persistent (PERS) of wobjdata>] ')'
```

A function with a return value of the data type `robtarget`.

Related information

For information about	See
Definition of position	*robtarget - Position data on page 1176*
Definition of tools	*tooldata - Tool data on page 1207*
Definition of work objects	*wobjdata - Work object data on page 1224*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
ProgDisp coordinate system	*PDispOn - Activates program displacement on page 317*
ExtOffs coordinate system	*EOffsOn - Activates an offset for external axes on page 88*
Reading the current `pos` (x, y, z only)	*CPos - Reads the current position (pos) data on page 805*

2.27. CSpeedOverride - Reads the current override speed

Usage

`CSpeedOverride` is used to read the speed override set by the operator from the FlexPendant. The return value is displayed as a percentage where 100% corresponds to the programmed speed.

In applications with instruction `SpeedRefresh`, this function can also be used to read current speed override value for this or connected motion program tasks.

Note! Must not be mixed up with the argument `Override` in the RAPID instruction `VelSet`.

Basic examples

Basic examples of the function `CSpeedOverride` are illustrated below.

Example 1

```
VAR num myspeed;
myspeed := CSpeedOverride();
```

The current override speed will be stored in the variable `myspeed`. E.g. if the value is 100 then this is equivalent to 100%.

Return value

Data type: `num`

The override speed value in percent of the programmed speed. This will be a numeric value in the range of 0 - 100.

Arguments

```
CSpeedOverride ( [\CTask] )
```

`[\CTask]`

Data type: `switch`

Get current speed override value for this or connected motion program task. Used together with the instruction `SpeedRefresh`.

If this argument is not used then the function returns current speed override for the whole system (all motion program tasks). Meaning the manual speed override, set from Teach Pendant.

Syntax

```
CSpeedOverride'('
  ['\' CTask ] ')'
```

A function with a return value of the data type `num`.

Continues on next page

Related information

For information about	See
Changing the Override Speed	*Operating manual - IRC5 with FlexPendant*, section *Programming and Testing Production Running - Quickset menu, Speed*
Update speed override from RAPID	*SpeedRefresh - Update speed override for ongoing movement on page 476*

2.28. CTime - Reads the current time as a string

Usage

`CTime` is used to read the current system time.

This function can be used to present the current time to the operator on the FlexPendant display or to paste the current time into a text file that the program writes to.

Basic examples

Basic examples of the function `CTime` are illustrated below.

Example 1

```
VAR string time;
time := CTime();
```

The current time is stored in the variable `time`.

Return value

Data type: `string`

The current time in a string.

The standard time format is "hours:minutes:seconds", e.g. "18:20:46".

More example

More examples of the function `CTime` are illustrated below.

Example 1

```
VAR string time;
time := CTime();
TPWrite "The current time is: "+time;
Write logfile, time;
```

The current time is written to the FlexPendant display and written into a text file.

Syntax

```
CTime '(' ')'
```

A function with a return value of the type `string`.

Related information

For information about	See
Time and date instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - System & Time*
Setting the system clock	*Operating manual - IRC5 with FlexPendant*, section *Changing FlexPendant settings*

2.29. CTool - Reads the current tool data

Usage

`CTool` (*Current Tool*) is used to read the data of the current tool.

Basic examples

Basic examples of the function `CTool` are illustrated below:

Example 1

```
PERS tooldata temp_tool:= [ TRUE, [ [0, 0, 0], [1, 0, 0 ,0] ],
     [0.001, [0, 0, 0.001], [1, 0, 0, 0], 0, 0, 0] ];
temp_tool := CTool();
```

The value of the current tool is stored in the variable `temp_tool`.

Return value

Data type: `tooldata`

This function returns a `tooldata` value holding the value of the current tool, i.e. the tool last used in a movement instruction.

The value returned represents the TCP position and orientation in the wrist centre coordinate system. See `tooldata`.

Syntax

```
CTool'(')'
```

A function with a return value of the data type `tooldata`.

Related information

For information about	See
Definition of tools	*tooldata - Tool data on page 1207*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate Systems*

2.30. CWObj - Reads the current work object data

Usage

`CWObj` (*Current Work Object*) is used to read the data of the current work object.

Basic examples

Basic examples of the function `CWObj` are illustrated below.

Example 1

```
PERS wobjdata temp_wobj:= [FALSE, TRUE, "", [[0,0,0], [1,0,0,0]],
      [[0,0,0], [1,0,0,0]]];
temp_wobj := CWObj();
```

The value of the current work object is stored in the variable `temp_wobj`.

Return value

Data type: `wobjdata`

This function returns a `wobjdata` value holding the value of the current work object, i.e. the work object last used in a movement instruction.

The value returned represents the work object position and orientation in the world coordinate system. See `wobjdata`.

Syntax

```
CWObj'('')'
```

A function with a return value of the data type `wobjdata`.

Related information

For information about	See
Definition of work objects	*wobjdata - Work object data on page 1224*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - Coordinate Systems*

2.31. DecToHex - Convert from decimal to hexadecimal

Usage

`DecToHex` is used to convert a number specified in a readable string in the base 10 to the base 16.

The resulting string is constructed from the character set [0-9,A-F,a-f].

This routine handle numbers from 0 up to 9223372036854775807dec or 7FFFFFFFFFFFFFFF hex.

Basic examples

Basic examples of the function `DecToHex` are illustrated below.

Example 1

```
VAR string str;

str := DecToHex("99999999");
```

The variable `str` is given the value `"5F5E0FF"`.

Return value

Data type: `string`

The string converted to a hexadecimal representation of the given number in the inparameter string.

Arguments

```
DecToHex ( Str )
```

`Str`

String

Data type: `string`

The string to convert.

Syntax

```
DecToHex'('
  [ Str ':=' ] <expression (IN) of string>
  ')'
```

A function with a return value of the data type `string`.

Related information

For information about	See
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*

2.32. DefAccFrame - Define an accurate frame

Usage

`DefAccFrame` (*Define Accurate Frame*) is used to define a framed from three to ten original positions and the same number of displaced positions.

Description

A frame can be defined when a set of targets are known at two different locations. Thus, *the same physical positions* are used but expressed differently.

Consider it in two different approaches:

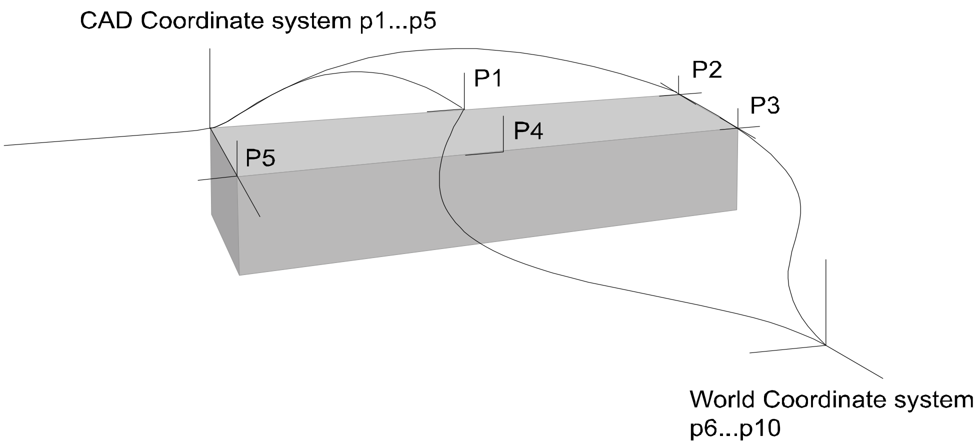
1. The same physical positions are expressed in relation to different coordinate systems. For example, a number of positions are retrieved from a CAD drawing, thus the positions are expressed in a CAD local coordinate system. The same positions are then expressed in robot world coordinate system. From these two sets of positions the frame between CAD coordinate system and robot world coordinate system is calculated.
2. A number of positions are related to an object in an original position. After a displacement of the object, the positions are determined again (often searched for). From these two sets of positions (old positions, new positions) the displacement frame is calculated.

Three targets are enough to define a frame, but to improve accuracy several points should be used.

Basic examples

Basic examples of the function `DefAccFrame` are illustrated below.

Example 1



xx0500002179

```
CONST robtarget p1 := [...];
CONST robtarget p2 := [...];
CONST robtarget p3 := [...];
CONST robtarget p4 := [...];
CONST robtarget p5 := [...];
```

Continues on next page

```
VAR robtarget p6 := [...];
VAR robtarget p7 := [...];
VAR robtarget p8 := [...];
VAR robtarget p9 := [...];
VAR robtarget p10 := [...];
VAR robtarget pWCS{5};
VAR robtarget pCAD{5};

VAR pose frame1;
VAR num max_err;
VAR num mean_err;

! Add positions to robtarget arrays
pCAD{1}:=p1;
...
pCAD{5}:=p5;

pWCS{1}:=p6;
...
pWCS{5}:=p10;

frame1 := DefAccFrame (pCAD, pWCS, 5, max_err, mean_err);
```

Five positions `p1- p5` related to an object have been stored. The five positions are also stored in relation to world coordinate system as `p6-p10`. From these 10 positions the frame, `frame1`, between the object and the world coordinate system is calculated. The frame will be the CAD frame expressed in the world coordinate system. If the input order of the targetlists is exchanged, i.e. `DefAccFrame` (`pWCS, pCAD....`) then the world frame will be expressed in the CAD coordinate system.

Return value

Data type: `pose`

The calculated `TargetListOne` frame expressed in the `TargetListTwo` coordinate system.

Arguments

```
DefAccFrame (TargetListOne TargetListTwo TargetsInList
     MaxErr MeanErr)
```

`TargetListOne`

Data type: `robtarget`

Array of robtargets holding the positions defined in coordinate system one. Minimum number of robtargets is 3, maximum is 10.

`TargetListTwo`

Data type: `robtarget`

Array of robtargets holding the positions defined in coordinate system two. Minimum number of robtargets is 3, maximum is 10.

Continues on next page

`TargetsInList`

Data type: `num`

Number of robtargets in an array.

`MaxErr`

Data type: `num`

The estimated maximum error in mm.

`MeanErr`

Data type: `num`

The estimated mean error in mm.

Error handling

If the positions don't have the required relation or are not specified with enough accuracy then the system variable `ERRNO` is set to `ERR_FRAME`. This error can then be handled in an error handler.

Syntax

```
DefAccFrame'('
  [TargetListOne':='] <array {*} (IN) of robtarget>' ,'
  [TargetListTwo' :='] <array {*} (IN) of robtarget> ','
  [TargetsInList':='] <expression (IN) of num> ','
  [MaxErr':='] <variable (VAR) of num> ','
  [MeanErr':='] <variable (VAR) of num>')'
```

A function with a return value of the data type `pose`.

Related information

For information about	See
Calculating a frame from three positions	*DefFrame - Define a frame on page 822*
Calculate a frame from 6 positions	*DefDFrame - Define a displacement frame on page 819*

2.33. DefDFrame - Define a displacement frame

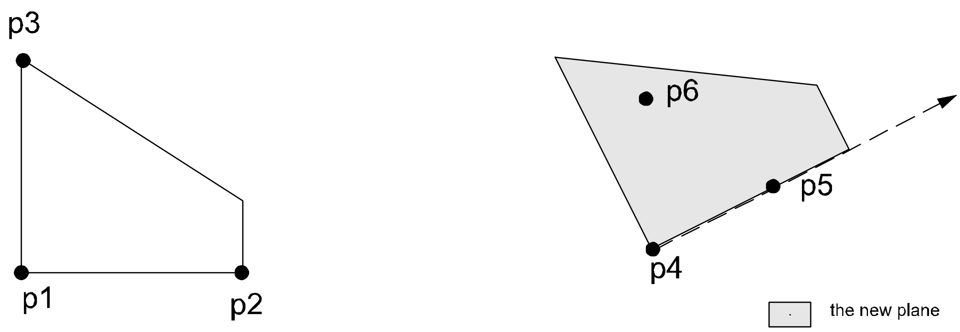
Usage

`DefDFrame` (*Define Displacement Frame*) is used to calculate a displacement frame from three original positions and three displaced positions.

Basic examples

Basic examples of the function `DefDFrame` are illustrated below.

Example 1



xx0500002177

```
CONST robtarget p1 := [...];
CONST robtarget p2 := [...];
CONST robtarget p3 := [...];
VAR robtarget p4;
VAR robtarget p5;
VAR robtarget p6;
VAR pose frame1;
...
!Search for the new positions
SearchL sen1, p4, *, v50, tool1;
...
SearchL sen1, p5, *, v50, tool1;
...
SearchL sen1, p6, *, v50, tool1;
frame1 := DefDframe (p1, p2, p3, p4, p5, p6);
...
!Activation of the displacement defined by frame1
PDispSet frame1;
```

Three positions `p1-p3` related to an object in an original position have been stored. After a displacement of the object, three new positions are searched for and stored as `p4-p6`. The displacement frame is calculated from these six positions. Then the calculated frame is used to displace all the stored positions in the program.

Return value

Data type: `pose`

The displacement frame.

Continues on next page

Arguments

```
DefDFrame (OldP1 OldP2 OldP3 NewP1 NewP2 NewP3)
```

`OldP1`

Data type: `robtarget`

The first original position.

`OldP2`

Data type: `robtarget`

The second original position.

`OldP3`

Data type: `robtarget`

The third original position.

`NewP1`

Data type: `robtarget`

The first displaced position. The difference between `OldP1` and `NewP1` will define the translation part of the frame and must be measured and determined with great accuracy.

`NewP2`

Data type: `robtarget`

The second displaced position. The line `NewP1 ... NewP2` will define the rotation of the old line `OldP1 ... OldP2`.

`NewP3`

Data type: `robtarget`

The third displaced position. This position will define the rotation of the plane, e.g. it should be placed on the new plane of `NewP1`, `NewP2`, and `NewP3`.

Error handling

If it is not possible to calculate the frame because of bad accuracy in the positions then the system variable `ERRNO` is set to `ERR_FRAME`. This error can then be handled in the error handler.

Syntax

```
DefDFrame'('
  [OldP1 ':='] <expression (IN) of robtarget>' ,'
  [OldP2 ':='] <expression (IN) of robtarget> ','
  [OldP3 ':='] <expression (IN) of robtarget> ','
  [NewP1 ':='] <expression (IN) of robtarget> ','
  [NewP2 ':='] <expression (IN) of robtarget> ','
  [NewP3 ':='] <expression (IN) of robtarget> ')'
```

A function with a return value of the data type `pose`.

Continues on next page

Related information

For information about	See
Activation of displacement frame	*PDispSet - Activates program displacement using known frame on page 321*
Manual definition of displacement frame	*Operating manual - IRC5 with FlexPendant*, section *Calibrating*

2.34. DefFrame - Define a frame

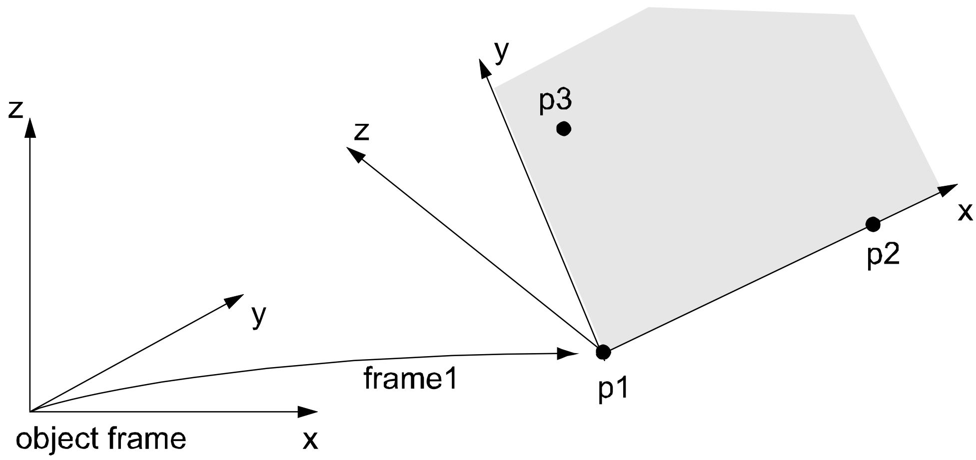
Usage

`DefFrame` (*Define Frame*) is used to calculate a frame, from three positions defining the frame.

Basic examples

Basic examples of the function `DefFrame` are illustrated below.

Example 1



xx0500002181

Three positions, `p1- p3` related to the object coordinate system are used to define the new coordinate system, `frame1`. The first position, `p1`, is defining the origin of the new coordinate system. The second position, `p2`, is defining the direction of the x-axis. The third position, `p3`, is defining the location of the xy-plane. The defined `frame1` may be used as a displacement frame, as shown in the example below:

```
CONST robtarget p1 := [...];
CONST robtarget p2 := [...];
CONST robtarget p3 := [...];
VAR pose frame1;
...
...
frame1 := DefFrame (p1, p2, p3);
...
...
!Activation of the displacement defined by frame1
PDispSet frame1;
```

Return value

Data type: `pose`

The calculated frame.

The calculation is related to the active object coordinate system.

Continues on next page

Arguments

```
DefFrame (NewP1 NewP2 NewP3 [\Origin])
```

`NewP1`

Data type: `robtarget`

The first position, which will define the origin of the new coordinate system.

`NewP2`

Data type: `robtarget`

The second position, which will define the direction of the x-axis of the new coordinate frame.

`NewP3`

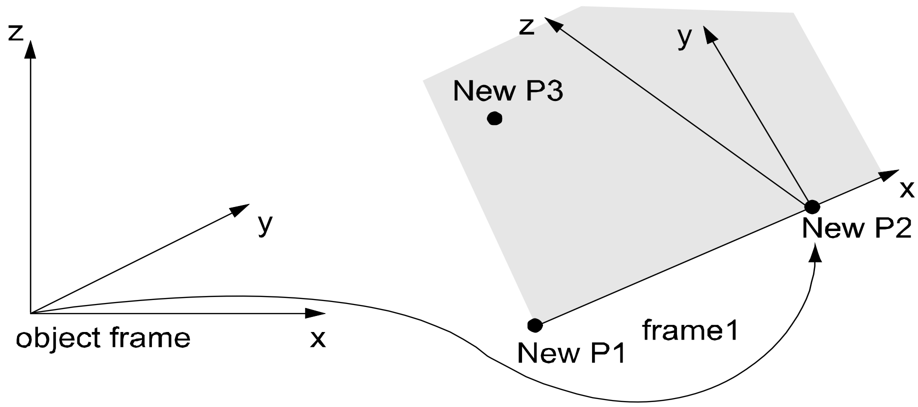
Data type: `robtarget`

The third position, which will define the xy-plane of the new coordinate system. The position of point 3 will be on the positive y side, see the figure above.

`[\Origin]`

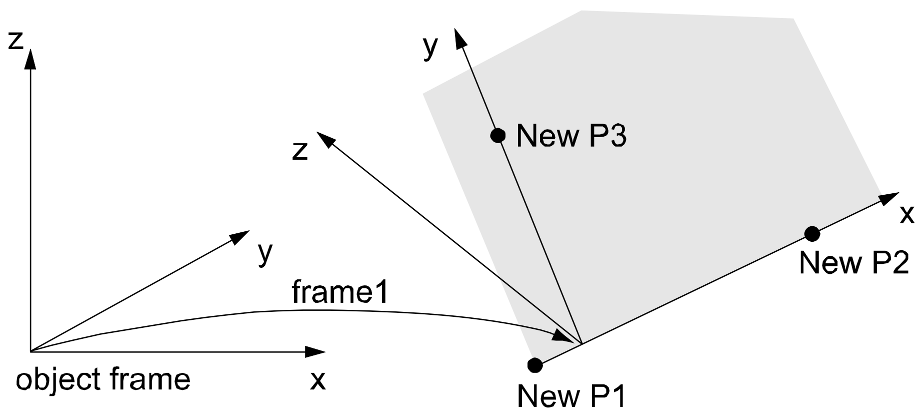
Data type: `num`

Optional argument, which will define how the origin of the new coordinate system will be placed. `Origin` = 1 means that the origin is placed in `NewP1`, i.e. the same as if this argument is omitted. `Origin` = 2 means that the origin is placed in `NewP2`. See the figure below.



xx0500002178

`Origin` = 3 means that the origin is placed on the line going through `NewP1` and `NewP2` and so that `NewP3` will be placed on the y axis. See the figure below.



xx0500002180

Other values, or if `Origin` is omitted, will place the origin in `NewP1`.

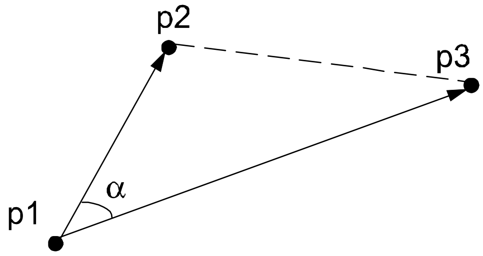
Continues on next page

Error handling

If the frame cannot be calculated because of the below limitations then the system variable `ERRNO` is set to `ERR_FRAME`. This error can then be handled in the error handler.

Limitations

The three positions `p1 - p3`, defining the frame, must define a well shaped triangle. The most well shaped triangle is the one with all sides of equal length.



xx0500002182

The triangle is not considered to be well shaped if the angle α is too small. The angle α is too small if:

$|\cos \alpha| < 1 - 10^{-4}$

The triangle `p1`, `p2`, `p3` must not be too small, i.e. the positions cannot be too close. The distances between the positions `p1 - p2` and `p1 - p3` must not be less than 0.1 mm.

Syntax

```
DefFrame'('
  [NewP1 ':='] <expression (IN) of robtarget>' ,'
  [NewP2 ':='] <expression (IN) of robtarget> ','
  [NewP3 ':='] <expression (IN) of robtarget>
  ['\'Origin':=' <expression (IN) of num >]')'
```

A function with a return value of the data type `pose`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*
Activation of displacement frame	*PDispSet - Activates program displacement using known frame on page 321*

2.35. Dim - Obtains the size of an array

Usage

`Dim` (*Dimension*) is used to obtain the number of elements in an array.

Basic examples

Basic examples of the function `Dim` are illustrated below.

See also *More examples on page 826*.

Example 1

```
PROC arrmul(VAR num array{*}, num factor)

  FOR index FROM 1 TO Dim(array, 1) DO
     array{index} := array{index} * factor;
  ENDFOR

ENDPROC
```

All elements of a num array are multiplied by a factor. This procedure can take any one-dimensional array of data type `num` as an input.

Return value

Data type: `num`

The number of array elements of the specified dimension.

Arguments

```
Dim (ArrPar DimNo)
```

`ArrPar`

Array Parameter

Data type: Any type

The name of the array.

`DimNo`

Dimension Number

Data type: `num`

The desired array dimension:

1 = first dimension

2 = second dimension

3 = third dimension

Continues on next page

More examples

More examples of how to use the function `Dim` are illustrated below.

Example 1

```
PROC add_matrix(VAR num array1{*,*,*}, num array2{*,*,*})

  IF Dim(array1,1) <> Dim(array2,1) OR Dim(array1,2) <>
      Dim(array2,2) OR Dim(array1,3) <> Dim(array2,3) THEN
    TPWrite "The size of the matrices are not the same";
    Stop;
  ELSE
    FOR i1 FROM 1 TO Dim(array1, 1) DO
      FOR i2 FROM 1 TO Dim(array1, 2) DO
        FOR i3 FROM 1 TO Dim(array1, 3) DO
          array1{i1,i2,i3} := array1{i1,i2,i3} +
                array2{i1,i2,i3};
        ENDFOR
      ENDFOR
    ENDFOR
  ENDIF
  RETURN;

ENDPROC
```

Two matrices are added. If the size of the matrices differs then the program stops and an error message appears.

This procedure can take any three-dimensional array of data type `num` as an input.

Syntax

```
Dim '('
  [ArrPar':='] <reference (REF) of any type> ','
  [DimNo':='] <expression (IN) of num> ')'
```

A REF parameter requires that the corresponding argument be either a constant, a variable, or an entire persistent. The argument could also be an IN parameter, a VAR parameter, or an entire PERS parameter.

A function with a return value of the data type `num`.

Related information

For information about	See
Array parameters	*Technical reference manual - RAPID overview*, section *Basic characteristics - Routines*
Array declaration	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data*

2.36. Distance - Distance between two points

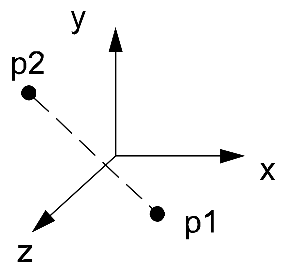
Usage

`Distance` is used to calculate the distance between two points in the space.

Basic examples

Basic examples of the function `Distance` are illustrated below.

Example 1



xx0500002321

```
VAR num dist;
CONST pos p1 := [4,0,4];
CONST pos p2 := [-4,4,4];
...
dist := Distance(p1, p2);
```

The distance in space between the points `p1` and `p2` is calculated and stored in the variable `dist`.

Return value

Data type: `num`

The distance (always positive) in mm between the points.

Arguments

```
Distance (Point1 Point2)
```

`Point1`

Data type: `pos`

The first point described by the `pos` data type.

`Point2`

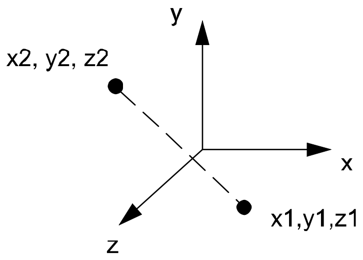
Data type: `pos`

The second point described by the `pos` data type.

Continues on next page

Program execution

Calculation of the distance between the two points:



xx0500002322

$$\text{distance} = \sqrt{\left((x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2\right)}$$

xx0500002323

Syntax

```
Distance'('
[Point1 ':='] <expression (IN) of pos> ','
[Point2 ':='] <expression (IN) of pos> ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Mathematics*
Definition of pos	*pos - Positions (only X, Y and Z) on page 1160*

2.37. DnumToNum - Converts dnum to num

Usage

`DnumToNum` converts a `dnum` to a `num` if possible, otherwise it generates a recoverable error.

Basic examples

A basic example of the function `DnumToNum` is illustrated below.

Example 1

```
VAR num mynum:=0;
VAR dnum mydnum:=8388607;
VAR dnum testFloat:=8388609;
VAR dnum anotherdnum:=4294967295;
! Works OK
mynum:=DnumToNum(mydnum);
! Accept floating point value
mynum:=DnumToNum(testFloat);
! Cause error recovery error
mynum:=DnumToNum(anotherdnum \Integer);
```

The dnum value 8388607 is returned by the function as the num value 8388607.

The dnum value 8388609 is returned by the function as the num value `8.38861E+06`.

The dnum value 4294967295 generates the recoverable error `ERR_ARGVALERR`.

Return value

Data type: `num`

The input dnum value can be in the range -8388607 to 8388608 and return the same value as a `num`. If the `\Integer` switch is not used, the input dnum value can be in the range -3.40282347E+38 to 3.40282347E+38 and the return value might become a floating point value.

Arguments

```
DnumToNum (Value [\Integer])
```

`Value`

Data type: `dnum`

The numeric value to be converted.

`[\Integer]`

Data type: `switch`

Only integer values

If switch `\Integer` is not used, an down cast is made even if the value becomes a floating point value. If it is not used, a check is made whether the value is an integer between -8388607 to 8388608. If it is not, a recoverable error is generated.

Continues on next page

Error handling

The following recoverable errors can be generated. The errors can be handled in an error handler. The system variable `ERRNO` will be set to:

Error code	Description
`ERR_ARGVALERR`	Value is above 8388608 or below -8388607 or not an integer (if optional argument `Integer` is used)
`ERR_NUM_LIMIT`	Value is above 3.40282347E+38 or below -3.40282347E+38
`ERR_INT_NOTVAL`	Value is not an integer

Syntax

```
DnumToNum
  [ Value ':=' ] < expression (IN) of dnum >
  [\ Integer]' ;'
```

A function with a return value of the data type `num`.

Related information

For information about	See
`Dnum` data type	*dnum - Double numeric values on page 1104*.
`Num` data type	*num - Numeric values on page 1146*.

2.38. DotProd - Dot product of two pos vectors

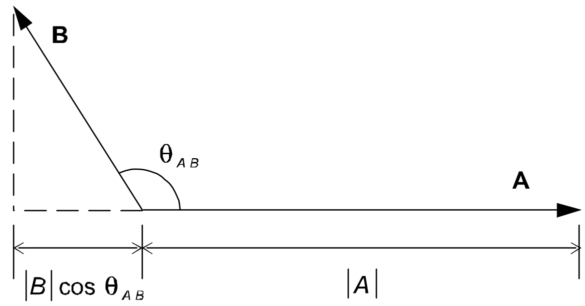
Usage

`DotProd` (*Dot Product*) is used to calculate the dot (or scalar) product of two pos vectors. The typical use is to calculate the projection of one vector upon the other or to calculate the angle between the two vectors.

Basic examples

Basic examples of the function `DotProd` are illustrated below.

Example 1



xx0500002449

The dot or scalar product of two vectors **A** and **B** is a scalar, which equals the products of the magnitudes of **A** and **B** and the cosine of the angle between them.

$$A \cdot B = |A||B|\cos\theta_{AB}$$

.

The dot product:

- is less than or equal to the product of their magnitudes.
- can be either a positive or a negative quantity, depending on whether the angle between them is smaller or larger then 90 degrees.
- is equal to the product of the magnitude of one vector and the projection of the other vector upon the first one.
- is zero when the vectors are perpendicular to each other.

The vectors are described by the data type `pos` and the dot product by the data type `num`:

```
VAR num dotprod;
VAR pos vector1;
VAR pos vector2;
...
...
vector1 := [1,1,1];
vector2 := [1,2,3];
dotprod := DotProd(vector1, vector2);
```

Return value

Data type: `num`

The value of the dot product of the two vectors.

Continues on next page

Arguments

```
DotProd (Vector1 Vector2)
```

`Vector1`

Data type: `pos`

The first vector described by the `pos` data type.

`Vector2`

Data type: `pos`

The second vector described by the `pos` data type.

Syntax

```
DotProd'('
  [Vector1 ':='] <expression (IN) of pos>','
  [Vector2 ':='] <expression (IN) of pos>
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*

2.39. DOutput - Reads the value of a digital output signal

Usage

`DOutput` is used to read the current value of a digital output signal.

Basic examples

Basic examples of the function `DOutput` are illustrated below.

See also *More examples on page 833*.

Example 1

```
IF DOutput(do2) = 1 THEN...
```

If the current value of the signal `do2` is equal to `1`, then...

Return value

Data type: `dionum`

The current value of the signal (0 or 1).

Arguments

```
DOutput (Signal)
```

`Signal`

Data type: `signaldo`

The name of the signal to be read.

Program execution

The value read depends on the configuration of the signal. If the signal is inverted in the system parameters then the value returned by this function is the opposite of the true value of the physical channel.

Error handling

The following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

ERR_NORUNUNIT if there is no contact with the unit.

More examples

More examples of the function `DOutput` are illustrated below.

Example 1

```
IF DOutput(auto_on) <> active THEN . . .
```

If the current value of the system signal `auto_on` is `not active` then ..., i.e. if the robot is in the manual operating mode, then ...

NOTE!

The signal must first be defined as a system output in the system parameters.

Continues on next page

Syntax

```
DOutput '('
  [ Signal ':=' ] < variable (VAR) of signaldo > ')'
```

A function with a return value of the data type `dionum`.

Related information

For information about	See
Set a digital output signal	*SetDO - Changes the value of a digital output signal on page 440*
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and Output Signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section Motion and I/O Principles - I/O Principles
Configuration of I/O	*Technical reference manual - System parameters*

2.40. EulerZYX - Gets euler angles from orient

Usage

`EulerZYX` (*Euler ZYX rotations*) is used to get an Euler angle component from an `orient` type variable.

Basic examples

Basic examples of the function `EulerZYX` are illustrated below.

Example 1

```
VAR num anglex;
VAR num angley;
VAR num anglez;
VAR pose object;
...
...
anglex := EulerZYX(\X, object.rot);
angley := EulerZYX(\Y, object.rot);
anglez := EulerZYX(\Z, object.rot);
```

Return value

Data type: `num`

The corresponding Euler angle, expressed in degrees, range from [-180, 180].

Arguments

```
EulerZYX ([\X] | [\Y] | [\Z] Rotation)
```

`[\X]`

Data type: `switch`

Gets the rotation around the X axis.

`[\Y]`

Data type: `switch`

Gets the rotation around the Y axis.

`[\Z]`

Data type: `switch`

Gets the rotation around the Z axis.

Note!

The arguments `\X`, `\Y`, and `\Z` are mutually exclusive. If none of these are specified then a run-time error is generated.

`Rotation`

Data type: `orient`

The rotation in its quaternion representation.

Continues on next page

Syntax

```
EulerZYX'('
  ['\'X ','] | ['\'Y' ,'] | ['\'Z',']
  [Rotation':='] <expression (IN) of orient>
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*

2.41. EventType - Get current event type inside any event routine

Usage

`EventType` can be used in any event routine and then returns the current executed event type.

If `EventType` is called from any program task routine then `EventType` always returns 0 meaning EVENT_NONE.

Basic examples

Basic examples of the function `EventType` are illustrated below.

Example 1

```
TEST EventType()
CASE EVENT_NONE:
  ! Not executing any event
CASE EVENT_POWERON:
  ! Executing POWER ON event
CASE EVENT_START:
  ! Executing START event
CASE EVENT_STOP:
  ! Executing STOP event
CASE EVENT_QSTOP:
  ! Executing QSTOP event
CASE EVENT_RESTART:
  ! Executing RESTART event
CASE EVENT_RESET:
  ! Executing RESET event
CASE EVENT_STEP:
  ! Executing STEP event
ENDTEST
```

Use of function `EventType` inside any event routine to find out which system event, if any, is executing now.

Return value

Data type: `event_type`

The current executed event type 1 ... 7, or 0 if no event routine is executed.

Predefined data

The following predefined symbolic constants of type `event_type` can be used to check the return value:

```
CONST event_type EVENT_NONE := 0;
CONST event_type EVENT_POWERON := 1;
CONST event_type EVENT_START := 2;
CONST event_type EVENT_STOP := 3;
CONST event_type EVENT_QSTOP:= 4;
CONST event_type EVENT_RESTART := 5;
CONST event_type EVENT_RESET := 6;
CONST event_type EVENT_STEP := 7;
```

Continues on next page

Syntax

```
EventType'(' ')'
```

A function with a return value of the data type `event_type`.

Related information

For information about	See
Event routines in general	*Technical reference manual - System parameters*, section *Controller - Event Routine*
Data type event_type, predefined constants	*event_type - Event routine type on page 1116*

2.42. ExecHandler - Get type of execution handler

Usage

`ExecHandler` can be used to find out if the actual `RAPID` code is executed in any `RAPID` program routine handler.

Basic examples

Basic example of the function `ExecHandler` is illustrated below.

Example 1

```
TEST ExecHandler()
CASE HANDLER_NONE:
  ! Not executing in any routine handler
CASE HANDLER_BWD:
  ! Executing in routine BACKWARD handler
CASE HANDLER_ERR:
  ! Executing in routine ERROR handler
CASE HANDLER_UNDO:
  ! Executing in routine UNDO handler
ENDTEST
```

Use of function `ExecHandler` to find out if the code is executing in some type of routine handler or not.

`HANDLER_ERR` will be returned even if the call is executed in a submethod to the error handler.

Return value

Data type: `handler_type`

The current executed handler type 1 ... 3, or 0 if not executing in any routine handler.

Predefined data

The following predefined symbolic constants of type `handler_type` can be used to check the return value:

```
CONST handler_type HANDLER_NONE := 0;
CONST handler_type HANDLER_BWD  := 1;
CONST handler_type HANDLER_ERR  := 2;
CONST handler_type HANDLER_UNDO := 3;
```

Syntax

```
ExecHandler'(' ')'
```

A function with a return value of the data type `handler_type`.

Related information

For information about	See
Type of execution handler	*handler_type - Type of execution handler on page 1120*

2.43. ExecLevel - Get execution level

Usage

`ExecLevel` can be used to find out current execution level for the RAPID code that currently is executed.

Basic examples

Basic example of the function `ExecLevel` is illustrated below.

Example 1

```
TEST ExecLevel()
CASE LEVEL_NORMAL:
  ! Execute on base level
CASE LEVEL_TRAP:
  ! Execute in TRAP routine
CASE LEVEL_SERVICE:
  ! Execute in service, event or system input interrupt routine
ENDTEST
```

Use of function `ExecLevel` to find out the current execution level.

Return value

Data type: `exec_level`

The current execution level 0... 2.

Predefined data

The following predefined symbolic constants of type `event_level` can be used to check the return value:

```
CONST exec_level LEVEL_NORMAL  := 0;
CONST exec_level LEVEL_TRAP    := 1;
CONST exec_level LEVEL_SERVICE := 2;
```

Syntax

```
ExecLevel'(' ')'
```

A function with a return value of the data type `exec_level`.

Related information

For information about	See
Data type for execution level	*exec_level - Execution level on page 1117*

2.44. Exp - Calculates the exponential value

Usage

`Exp` (*Exponential*) is used to calculate the exponential value, e^x.

Basic examples

Basic examples of the function `Exp` are illustrated below.

Example 1

```
VAR num x;
VAR num value;
...
value:= Exp( x);
```

`value` will get the exponential value of `x`.

Return value

Data type: `num`

The exponential value e^x.

Arguments

```
Exp (Exponent)
```

`Exponent`

Data type: `num`

The exponent argument value.

Syntax

```
Exp'('
  [Exponent ':='] <expression (IN) of num>')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Mathematics*

2.45. FileSize - Retrieve the size of a file

Usage

`FileSize` is used to retrieve the size of the specified file.

Basic examples

Basic examples of the function `FileSize` are illustrated below.

See also *More examples on page 842*.

Example 1

```
PROC listfile(string filename)
    VAR num size;
    size := FileSize(filename);
    TPWrite filename+"  size: "+NumToStr(size,0)+" Bytes";
ENDPROC
```

This procedure prints out the name of specified file together with a size specification.

Return value

Data type: `num`

The size in bytes.

Arguments

```
FileSize (Path)
```

`Path`

Data type: `string`

The file name specified with full or relative path.

Program execution

This function returns a numeric that specifies the size in bytes of the specified file.

It is also possible to get the same information about a directory.

More examples

Basic examples of the function are illustrated below.

Example 1

This example lists all files bigger than `1` KByte under the "`HOME:`" directory structure, including all subdirectories.

```
PROC searchdir(string dirname, string actionproc)
  VAR dir directory;
  VAR string filename;
  IF IsFile(dirname \Directory) THEN
     OpenDir directory, dirname;
      WHILE ReadDir(directory, filename) DO
           ! .. and . is the parent and resp. this directory
           IF filename <> ".." AND  filename <> "." THEN
              searchdir dirname+"/"+filename, actionproc;
```

Continues on next page

```
          ENDIF
      ENDWHILE
      CloseDir directory;
    ELSE
      %actionproc% dirname;
    ENDIF
  ERROR
    RAISE;
  ENDPROC

  PROC listfile(string filename)
    IF FileSize(filename) > 1024 THEN
         TPWrite filename;
    ENDIF
  ENDPROC

  PROC main()
    ! Execute the listfile routine for all files found under the
    ! tree of HOME:
    searchdir "HOME:","listfile";
  ENDPROC
```

This program traverses the directory structure under "`HOME`:" and for each file found it calls the `listfile` procedure. The `searchdir` is a generic part that knows nothing about the start of the search or which routine should be called for each file. It uses `IsFile` to check whether it has found a subdirectory or a file and it uses the late binding mechanism to call the procedure specified in `actionproc` for all files found. The `actionproc` routine `listfile` checks whether the file is bigger than `1`KBytes.

Error handling

If the file does not exist, the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

Syntax

```
FileSize '('
  [ Path ':=' ] < expression (IN) of string> ')'
```

A function with a return value of the data type `num`.

Continues on next page

Related information

For information about	See
Make a directory	*MakeDir - Create a new directory on page 218*
Remove a directory	*RemoveDir - Delete a directory on page 355*
Rename a file	*RenameFile - Rename a file on page 357*
Remove a file	*RemoveFile - Delete a file on page 356*
Copy a file	*CopyFile - Copy a file on page 65*
Check file type	*IsFile - Check the type of a file on page 878*
Check file system size	*FSSize - Retrieve the size of a file system on page 848*

2.46. FileTime - Retrieve time information about a file

Usage

`FileTime` is used to retrieve the last time for modification, access or file status change of a file. The time is measured in seconds since 00:00:00 GMT, Jan. 1 1970. The time is returned as a `num` and optionally also in a `stringdig`.

Basic example

Basic examples of the function `FileTime` are illustrated below.

See also *More examples on page 846*.

Example 1

```
IF FileTime ("HOME:/mymod.mod" \ModifyTime)
  > ModTime ("mymod") THEN
  UnLoad "HOME:mymod.mod";
  Load \Dynamic, "HOME:mymod.mod";
ENDIF
```

This program reloads a module if the source file is newer. It uses the `ModTime` to retrieve the latest modification time for the specified module, and to compare it to the `FileTime\ModifyTime` at the source. Then, if the source is newer, the program unloads and loads the module again.

Limitation in this example: The data type `num` cannot handle positive integers above 8388608 seconds with exact representation. To get better dissolution, see example in function `StrDigCmp`.

Return value

Data type: `num`

The time measured in seconds since 00:00:00 GMT, Jan. 1 1970.

Arguments

```
FileTime ( Path [\ModifyTime] | [\AccessTime] | [\StatCTime]
      [\StrDig])
```

`Path`

Data type: `string`

The file specified with a full or relative path.

`[\ModifyTime]`

Data type: `switch`

Last modification time.

`[\AccessTime]`

Data type: `switch`

Time of last access (read, execute of modify).

`[\StatCTime]`

Data type: `switch`

Last file status (access qualification) change time.

Continues on next page

[\StrDig]

String Digit

Data type: `stringdig`

To get the file time in a `stringdig` representation.

Further use in `StrDigCmp` can handle positive integers above 8388608 with exact representation.

Program execution

This function returns a numeric that specifies the time since the last:

- Modification
- Access
- File status change

of the specified file.

It is also possible to get the same information about a directory.

More examples

More examples of the function `FileTime` are illustrated below.

This is a complete example that implements an alert service for maximum 10 files.

```
LOCAL RECORD falert
  string filename;
  num ftime;
ENDRECORD

LOCAL VAR falert myfiles[10];
LOCAL VAR num currentpos:=0;
LOCAL VAR intnum timeint;

PROC alertInit(num freq)
  currentpos:=0;
  CONNECT timeint WITH mytrap;
  ITimer freq,timeint;
ENDPROC

LOCAL TRAP mytrap
  VAR num pos:=1;
  WHILE pos <= currentpos DO
    IF FileTime(myfiles{pos}.filename \ModifyTime) >
          myfiles{pos}.ftime THEN
      TPWrite "The file "+myfiles{pos}.filename+" is changed";
    ENDIF
    pos := pos+1;
  ENDWHILE
ENDTRAP
```


Continues on next page

```
PROC alertNew(string filename)
  currentpos := currentpos+1;
  IF currentpos <= 10 THEN
    myfiles{currentpos}.filename := filename;
    myfiles{currentpos}.ftime := FileTime (filename \ModifyTime);
  ENDIF
ENDPROC

PROC alertFree()
  IDelete timeint;
ENDPROC
```

Error handling

If the file does not exist, the system variable ERRNO is set to ERR_FILEACC. This error can then be handled in the error handler.

Syntax

```
FileTime '('
[ Path ':=' ] < expression (IN) of string>
[ '\'ModifyTime] |
[ '\'AccessTime] |
[ '\'StatCTime]
[ '\' StrDig' :=' < variable (VAR) of stringdig> ] ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Last modify time of a loaded module	*ModTime - Get file modify time for the loaded module on page 896*
String with only digits	*ModTime - Get file modify time for the loaded module on page 896* *stringdig - String with only digits on page 1197*
Compare two strings with only digits	*ModTime - Get file modify time for the loaded module on page 896* *StrDigCmp - Compare two strings with only digits on page 991*

2.47. FSSize - Retrieve the size of a file system

Usage

`FSSize` (*File System Size*) is used to retrieve the size of the file system in which a specified file resides. The size in bytes, kilo bytes or mega bytes are returned as a `num`.

Basic example

Basic examples of the function `FSSize` are illustrated below.

See also *More examples on page 849*.

Example 1

```
PROC main()
  VAR num totalfsyssize;
  VAR num freefsyssize;
  freefsyssize := FSSize("HOME:/spy.log" \Free);
  totalfsyssize := FSSize("HOME:/spy.log" \Total);
  TPWrite NumToStr(((totalfsyssize - freefsyssize)/
        totalfsyssize)*100,0)
     +" percent used";
ENDPROC
```

This procedure prints out the amount of disk space used on the `HOME`: file system (flash disk `/hd0a/`) as a percentage.

Return value

Data type: `num`

The size in bytes.

Arguments

```
FSSize (Name [\Total] | [\Free] [\Kbyte] [\Mbyte])
```

`Name`

Data type: `string`

The name of a file in the file system, specified with full or relative path.

`[ \Total ]`

Data type: `switch`

Retrieves the total amount of space in the file system.

`[ \Free ]`

Data type: `switch`

Retrieves the amount of free space in the file system.

`[ \Kbyte ]`

Data type: `switch`

Convert the number of bytes read to kilobytes, e.g divide the size with 1024.

Continues on next page

[\Mbyte]

Data type: `switch`

Convert the number of bytes read to megabytes, e.g divide the size with 1048576 (1024*1024).

Program execution

This function returns a numeric that specifies the size of the file system in which the specified file resides.

More examples

More examples of the function `FSSize` are illustrated below.

Example 1

```
LOCAL VAR intnum timeint;

LOCAL TRAP mytrap
  IF FSSize("HOME:/spy.log" \Free)/FSSize("HOME:/spy.log" \Total)
       <= 0.1 THEN
    TPWrite "The disk is almost full";
    alertFree;
  ENDIF
ENDTRAP

PROC alertInit(num freq)
  CONNECT timeint WITH mytrap;
  ITimer freq,timeint;
ENDPROC

PROC alertFree()
  IDelete timeint;
ENDPROC
```

This is a complete example for implementing an alert service that prints a warning on the FlexPendant when the remaining free space in the "`HOME`:" file system is less than 10%.

Error handling

The following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

`ERR_FILEACC`	The file system does not exist
`ERR_FILESIZE`	The size exceeds the max integer value for a num, 8388608

Syntax

```
FSSize'('
  [ Name ':=' ] < expression (IN) of string>
  [ ´\´Total ] | [ ´\´Free ]
  [ ´\´Kbyte ]
  [ ´\´Mbyte ]')'
```

A function with a return value of the data type `num`.

Continues on next page

Related information

For information about	See
Make a directory	*MakeDir - Create a new directory on page 218*
Remove a directory	*RemoveDir - Delete a directory on page 355*
Rename a file	*RenameFile - Rename a file on page 357*
Remove a file	*RemoveFile - Delete a file on page 356*
Copy a file	*CopyFile - Copy a file on page 65*
Check file type	*IsFile - Check the type of a file on page 878*
Check file size	*FileSize - Retrieve the size of a file on page 842*

2.48. GetMecUnitName - Get the name of the mechanical unit

Usage

`GetMecUnitName` is used to get the name of a mechanical unit with one of the installed mechanical units as the argument. This function returns the mechanical units name as a `string`.

Basic examples

Basic examples of the function `GetMecUnitName` are illustrated below.

Example 1

```
VAR string mecname;
mecname:= GetMecUnitName(T_ROB1);
```

`mecname` will get the value `"T_ROB1"`as a `string`. All mechanical units (data type `mecunit`) such as `T_ROB1` are predefined in the system.

Return value

Data type: `string`

The return value will be the mechanical unit name as a `string`.

Arguments

```
GetMecUnitName ( MechUnit )
```

`MechUnit`

Mechanical Unit

Data type: `mecunit`

`MechUnit` takes one of the predefined mechanical units found in the configuration.

Syntax

```
GetMecUnitName'('
  [ MechUnit ':=' ] < variable (VAR) of mecunit > ')'
```

A function with a return value of the data type `string`.

Related information

For information about	See
Mechanical unit	*mecunit - Mechanical unit on page 1139*

2.49. GetNextMechUnit - Get name and data for mechanical units

Usage

`GetNextMechUnit` (*Get Next Mechanical Unit*) is used for retrieving the name of mechanical units in the robot system. Besides the mechanical unit name, several optional properties of the mechanical unit can be retrieved.

Basic examples

Basic examples of the function `GetNextMechUnit` are illustrated below.

See also *More examples on page 853*.

Example 1

```
VAR num listno := 0;
VAR string name := "";

TPWrite "List of mechanical units:";
WHILE GetNextMechUnit(listno, name) DO
  TPWrite name;
  ! listno := listno + 1 is done by GetNextMechUnit
ENDWHILE
```

The name of all mechanical units available in the system, will be displayed on the FlexPendant.

Return Value

Data type: `bool`

`TRUE` if a mechanical unit was found, otherwise `FALSE`.

Arguments

```
GetNextMechUnit    ( ListNumber  UnitName [\MecRef] [\TCPRob]
      [\NoOfAxes] [\MecTaskNo] [\MotPlanNo] [\Active]
      [\DriveModule] [\OKToDeact])
```

`ListNumber`

Data type: `num`

This specifies which items in the system internal list of mechanical units are to be retrieved. At return, this variable is always incremented by one by the system to make it easy to access the next unit in the list. The first mechanical unit in the list has index 0.

`UnitName`

Data type: `string`

The name of the mechanical unit.

`[\MecRef]`

Data type: `mecunit`

The system reference to the mechanical unit.

Continues on next page

[\TCPRob]

Data type: `bool`

TRUE if the mechanical unit is a TCP robot, otherwise FALSE.

[\NoOfAxes]

Data type: `num`

Number of axes for the mechanical unit. Integer value.

[\MecTaskNo]

Data type: `num`

The program task number that controls the mechanical unit. Integer value in range 1-20. If not controlling by any program task, -1 is returned.

This actual connection is defined in the system parameters domain controller (can in some application be redefined at runtime).

[\MotPlanNo]

Data type: `num`

The motion planner number that controls the mechanical unit. Integer value in range 1-6. If not controlling by any motion planner, -1 is returned.

This connection is defined in the system parameters domain controller.

[\Active]

Data type: `bool`

TRUE if the mechanical unit is active, otherwise FALSE.

[\DriveModule]

Data type: `num`

The Drive Module number 1 - 4 used by this mechanical unit.

[\OKToDeact]

Data type: `bool`

Return TRUE, if allowed to deactivate the mechanical unit from RAPID program.

More examples

More examples of the instruction `GetNextMechUnit` are illustrated below.

Example 1

```
VAR num listno := 4;
VAR string name := "";
VAR bool found := FALSE;

found := GetNextMechUnit (listno, name);
```

If `found` is set to `TRUE`, the name of mechanical unit number `4` will be in the variable `name`, else `name` contains only an empty string.

Continues on next page

Syntax

```
GetNextMechUnit '('
  [ ListNumber ':=' ] < variable (VAR) of num>' ,'
  [ UnitName' :=' ] < variable (VAR) of string> ','
  [ '\' MecRef' :=' < variable (VAR) of mecunit> ]
  [ '\' TCPRob' :=' < variable (VAR) of bool> ]
  [ '\' NoOfAxes' :=' < variable (VAR) of num> ]
  [ '\' MecTaskNo' :=' < variable (VAR) of num> ]
  [ '\' MotPlanNo' :=' < variable (VAR) of num> ]
  [ '\' Active' :=' < variable (VAR) of bool>]
  [ '\' DriveModule' :=' < variable (VAR) of num>]
  [ '\' OKToDeact' :=' < variable (VAR) of bool>] ';'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Mechanical unit	*mecunit - Mechanical unit on page 1139*
Activating/Deactivating mechanical units	*ActUnit - Activates a mechanical unit on page 17* *DeactUnit - Deactivates a mechanical unit on page 79*
Characteristics of non-value data types	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Data types*

2.50. GetNextSym - Get next matching symbol

Usage

`GetNextSym` (*Get Next Symbol*) is used together with `SetDataSearch` to retrieve data objects from the system.

Basic examples

Basic examples of the function `GetNextSym` are illustrated below.

Example 1

```
VAR datapos block;
VAR string name;
VAR bool truevar:=TRUE;
...
SetDataSearch "bool" \Object:="my.*" \InMod:="mymod"\LocalSym;
WHILE GetNextSym(name,block) DO
  SetDataVal name\Block:=block,truevar;
ENDWHILE
```

This session will set all local `bool` data objects that begin with `my` in the module `mymod` to `TRUE`.

Return value

Data type: `bool`

`TRUE` if a new object has been retrieved, the object name and its enclosed block is then returned in its arguments.

`FALSE` if no more objects match.

Arguments

```
GetNextSym (Object Block [\Recursive])
```

`Object`

Data type: `string`

Variable (`VAR` or `PERS`) to store the name of the data object that will be retrieved.

`Block`

Data type: `datapos`

The enclosed block to the object.

`[ \Recursive ]`

Data type: `switch`

This will force the search to enter the block below, e.g. if the search session has begun at the task level, it will also search modules and routines below the task.

Continues on next page

Syntax

```
GetNextSym '('
  [ Object ':=' ] < variable or persistent (INOUT) of string > ','
  [ Block ':='] <variable (VAR) of datapos>
  ['\'Recursive ] ')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Define a symbol set in a search session	*SetDataSearch - Define the symbol set in a search sequence on page 433*
Get the value of a data object	*GetDataVal - Get the value of a data object on page 110*
Set the value of a data object	*SetDataVal - Set the value of a data object on page 437*
Set the value of many data objects	*SetAllDataVal - Set a value to all data objects in a defined set on page 429*
The related data type datapos	*datapos - Enclosing block for a data object on page 1101*

2.51. GetSysInfo - Get information about the system

Usage

`GetSysInfo` is used to read information about the system. Available information includes Serial Number, SoftWare Version, Robot Type, Controller ID or Lan ip address.

Basic examples

Basic examples of the function `GetSysInfo` are illustrated below.

Example 1

```
VAR string serial;
VAR string version;
VAR string rtype;
VAR string cid;
VAR string lanip;
VAR string clang;
serial := GetSysInfo(\SerialNo);
version := GetSysInfo(\SWVersion);
rtype := GetSysInfo(\RobotType);
cid := GetSysInfo(\CtrlId);
lanip := GetSysInfo(\LanIp);
clang := GetSysInfo(\CtrlLang);
```

The serial number will be stored in the variable `serial`, the version number will be stored in the variable `version`, the robot number will be stored in the variable `rtype,` the controller ID number will be stored in the variable `cid`, the LAN ip address will be stored in the variable `lanip` and the controller language will be stored in the variable `clang`.

Examples of returned strings:

Serial Number: `14-21858`

Software Version: `ROBOTWARE_5.08.134`

Robot Type: 2400/16 Type A

Controller ID: `44-1267`

LAN ip address: `192.168.8.103`

Language: en

Return value

Data type: `string`

One of Serial Number, SoftWare Version, Robot Type, Controller ID, LAN ip address or Controller Language. Read more about the return values in *Arguments* below.

Continues on next page

Arguments

```
GetSysInfo ([\SerialNo] | [\SWVersion] | [\RobotType] | [\CtrlId]
    | [\LanIp] | [\CtrlLang])
```

One of the arguments `SerialNo`, `SWVersion`, `RobotType` , `CtrlId`, `LanIp` or `CtrlLang` must be present.

[\SerialNo]

Serial Number

Data type: `switch`

Returns the serial number.

[\SWVersion]

Software Version

Data type: `switch`

Returns the software version.

`[ \RobotType ]`

Data type: `switch`

Returns the robot type in the current or connected task. If the mechanical unit is not a TCP-robot, a "-" is returned.

`[ \CtrlId ]`

Controller ID

Data type: `switch`

Returns the controller ID. Returns an empty string if no Controller ID is specified. A string with "`VC`" is returned if this option is used in the Virtual Controller.

`[ \LanIp ]`

Lan Ip address

Data type: `switch`

Returns the LAN ip address for the controller. A string with "`VC`" is returned if this option is used in the Virtual Controller. An empty string is returned if no LAN ip address is configured in the system.

`[ \CtrlLang ]`

Controller Language

Data type: `switch`

Returns the language used on the controller.

Return value	Language
cs	Czech
zh	Chinese (simplified Chinese, mainland Chinese)
da	Danish
nl	Dutch
en	English
fi	Finnish
fr	French

Continues on next page

Return value	Language
de	German
hu	Hungarian
it	Italian
ja	Japanese
ko	Korean
pt	Portuguese (Brazilian Portuguese)
ru	Russian
es	Spanish
sv	Swedish
tr	Turkish

Syntax

```
GetSysInfo'('
  ['\'SerialNo]
  | ['\'SWVersion]
  | ['\'RobotType]
  | ['\'CtrlId]
  | ['\'LanIp]
  | ['\'CtrlLang]')'
```

A function with a return value of the data type `string`.

Related information

For information about	See
Test the identity of the system	*IsSysId - Test system identity on page 890*

2.52. GetTaskName - Gets the name and number of current task

Usage

`GetTaskName` is used to get the identity of the current program task, with its name and number.

It is also possible from some *Non Motion Task* to get the name and number of its connected *Motion Task*. For *MultiMove System* the system parameter *Controller/Tasks/Use Mechanical Unit Group* define the connected *Motion Task* and in a base system the main task is always the connected *Motion Task* from any other task.

Basic examples

Basic examples of the function `GetTaskName` are illustrated below.

Example 1

```
VAR string taskname;
...
taskname := GetTaskName();
```

The current task name is returned in the variable `taskname`.

Example 2

```
VAR string taskname;
VAR num taskno;
...
taskname := GetTaskName(\TaskNo:=taskno);
```

The current task name is returned in the variable `taskname`. The integer identity of the task is stored in the variable `taskno`.

Example 3

```
VAR string taskname;
VAR num taskno;
...
taskname := GetTaskName(\MecTaskNo:=taskno);
```

If current task is a *Non Motion Task* task, the name of the connected motion task is returned in the variable `taskname`. The numerical identity of the connected motion task is stored in the variable `taskno`.

If current task controls some mechanical units, current task name is returned in the variable `taskname`. The numerical identity of the task is stored in the variable `taskno`.

Return value

Data type: `string`

The name of the task in which the function is executed or the name of the connected motion task.

Continues on next page

Arguments

```
GetTaskName ( [\TaskNo] | [\MecTaskNo] )
```

`[\TaskNo]`

Data type: `num`

Return current task name (same functionality if none of the switch `\TaskNo` or `\MecTaskNo` is used). Also get the identity of the current task represented as a integer value. The numbers returned will be in the range 1-20.

`[\MecTaskNo]`

Data type: `num`

Return connected motion task name or current motion task name. Also get the identity of connected or current motion task represented as a integer value. The numbers returned will be in the range 1-20.

Syntax

```
GetTaskName'('
  [ \TaskNo ':=' ] < variable (VAR) of num >
  [ \MecTaskNo':=' ] < variable (VAR) of num > ')'
```

A function with a return value of the data type `string`.

Related information

For information about	See
Multitasking	*Technical reference manual - RAPID overview*, section *RAPID Overview - RAPID summary Multitasking* *Technical reference manual - RAPID overview*, section *Basic characteristics - Multitasking*

2.53. GetTime - Reads the current time as a numeric value

Usage

`GetTime` is used to read a specified component of the current system time as a numeric value.

`GetTime` can be used to:

- have the program perform an action at a certain time
- perform certain activities on a weekday
- abstain from performing certain activities on the weekend
- respond to errors differently depending on the time of day.

Basic examples

Basic examples of the function `GetTime` are illustrated below.

Example 1

```
hour := GetTime(\Hour);
```

The current hour is stored in the variable `hour`.

Return value

Data type: `num`

One of the four time components specified below.

Argument

```
GetTime ( [\WDay] | [\Hour] | [\Min] | [\Sec] )
```

[\`WDay`]

Data type: `switch`

Return the current weekday. Range: 1 to 7 (Monday to Sunday).

[\Hour]

Data type: `switch`

Return the current hour. Range: 0 to 23.

[\`Min`]

Data type: `switch`

Return the current minute. Range: 0 to 59.

[\`Sec`]

Data type: `switch`

Return the current second. Range: 0 to 59.

One of the arguments must be specified, otherwise program execution stops with an error message.

Continues on next page

More examples

More examples of the function `GetTime` are illustrated below.

Example 1

```
weekday := GetTime(\WDay);
hour := GetTime(\Hour);
IF weekday < 6 AND hour >6 AND hour < 16 THEN
  production;
ELSE
  maintenance;
ENDIF
```

If it is a weekday and the time is between 7:00 and 15:59 the robot performs production. At all other times, the robot is in the maintenance mode.

Syntax

```
GetTime '('
['\' WDay ]
| [ '\' Hour ]
| [ '\' Min ]
| [ '\' Sec ] ')'
```

A function with a return value of the type `num`.

Related information

For information about	See
Time and date instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - System & time*
Setting the system clock	*Operating manual - IRC5 with FlexPendant*, section *Changing FlexPendant settings*

2.54. GInputDnum - Read value of group input signal

Usage

`GInputDnum` is used to read the current value of a group of digital input signals.

Basic examples

Basic examples of the function `GInputDnum` are illustrated below.

Example 1

```
IF GInputDnum(gi2) = 55 THEN ...
```

If the current value of the signal `gi2` is equal to `55`, then `...`

Example 2

```
IF GInputDnum(gi2) = 4294967295 THEN ...
```

If the current value of the signal `gi2` is equal to `4294967295`, then `...`

Return value

Data type: `dnum`

The current value of the signal (a positive integer).

The values of each signal in the group are read and interpreted as an unsigned binary number. This binary number is then converted to an integer.

The value returned lies within a range that is dependent on the number of signals in the group.

Number of signals	Allowed value
1	0-1
2	0-3
3	0-7
4	0-15
5	0-31
6	0-63
7	0-127
8	0-255
9	0-511
10	0-1023
11	0-2047
12	0-4095
13	0-8191
14	0-16383
15	0-32767
16	0-65535
17	0-131071
18	0-262143
19	0-524287
20	0-1048575
21	0-2097151

Continues on next page

Number of signals	Allowed value
22	0-4194303
23	0-8388607
24	0-16777215
25	0-33554431
26	0-67108863
27	0-134217727
28	0-268435455
29	0-536870911
30	0-1073741823
31	0-2147483647
32	0-4294967295

Arguments

```
GInputDnum (Signal)
```

`Signal`

Data type: `signalgi`

The name of the signal group to be read.

Error handling

The following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

Error code	Description
`ERR_NORUNUNIT`	No contact with the unit.

Syntax

```
GInputDnum '('
  [ Signal ':=' ] < variable (VAR) of signalgi > ')'
```

A function with a return value of data type `dnum`.

Related information

For information about	See
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and Output Signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles*
Configuration of I/O	*Technical reference manual - System parameters*

2.55. GOutput - Reads the value of a group of digital output signals

Usage

`GOutput` is used to read the current value of a group of digital output signals.

Basic examples

Basic example of the function `GOutput` is illustrated below.

Example 1

```
IF GOutput(go2) = 5 THEN ...
```

If the current value of the signal `go2` is equal to `5`, then `...`

Return value

Data type: `num`

The current value of the signal (a positive integer).

The values of each signal in the group are read and interpreted as an unsigned binary number. This binary number is then converted to an integer.

The value returned lies within a range that is dependent on the number of signals in the group.

No. of signals	Permitted value
1	0-1
2	0-3
3	0-7
4	0-15
5	0-31
6	0-63
7	0-127
8	0-255
9	0-511
10	0-1023
11	0-2047
12	0-4095
13	0-8191
14	0-16383
15	0-32767
16	0-65535
17	0-131071
18	0-262143
19	0-524287
20	0-1048575
21	0-2097151
22	0-4194303
23	0-8388607

Continues on next page

Arguments

```
GOutput (Signal)
```

`Signal`

Data type: `signalgo`

The name of the signal group to be read.

Error handling

Following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT`

if there is no contact with the unit.

Syntax

```
GOutput '('
  [ Signal ':=' ] < variable (VAR) of signalgo > ')'
```

A function with a return value of data type `num`.

Related information

For information about	See
Set an output signal group	*SetGO - Changes the value of a group of digital output signals on page 442*
Read a group of output signals	*GOutputDnum - Read value of group output signal on page 868*
Read a group of input signals	*GInputDnum - Read value of group input signal on page 864*
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and Output Signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - I/O Principles*
Configuration of I/O	*Technical reference manual - System parameters*

2.56. GOutputDnum - Read value of group output signal

Usage

`GOutputDnum` is used to read the current value of a group of digital output signals.

Basic examples

Basic examples of the function `GOutputDnum` are illustrated below.

Example 1

```
IF GOutputDnum(go2) = 55 THEN ...
```

If the current value of the signal `go2` is equal to `55`, then `...`

Example 2

```
IF GOutputDnum(go2) = 4294967295 THEN ...
```

If the current value of the signal `go2` is equal to `4294967295`, then `...`

Return value

Data type: `dnum`

The current value of the signal (a positive integer).

The values of each signal in the group are read and interpreted as an unsigned binary number. This binary number is then converted to an integer.

The value returned lies within a range that is dependent on the number of signals in the group.

Number of signals	Allowed value
1	0-1
2	0-3
3	0-7
4	0-15
5	0-31
6	0-63
7	0-127
8	0-255
9	0-511
10	0-1023
11	0-2047
12	0-4095
13	0-8191
14	0-16383
15	0-32767
16	0-65535
17	0-131071
18	0-262143
19	0-524287
20	0-1048575
21	0-2097151

Continues on next page

Number of signals	Allowed value
22	0-4194303
23	0-8388607
24	0-16777215
25	0-33554431
26	0-67108863
27	0-134217727
28	0-268435455
29	0-536870911
30	0-1073741823
31	0-2147483647
32	0-4294967295

Arguments

```
GOutputDnum (Signal)
```

`Signal`

Data type: `signalgo`

The name of the signal group to be read.

Error handling

The following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

Error code	Description
`ERR_NORUNUNIT`	No contact with the unit

Syntax

```
GOutputDnum '('
  [ Signal ':=' ] < variable (VAR) of signalgo > ')'
```

A function with a return value of data type `dnum`.

Related information

For information about	See
Set an output signal group	*SetGO - Changes the value of a group of digital output signals on page 442*
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and Output Signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles*
Configuration of I/O	*Technical reference manual - System parameters*

2.57. HexToDec - Convert from hexadecimal to decimal

Usage

`HexToDec` is used to convert a number specified in a readable string in the base 16 to the base 10.

The input string should be constructed from the character set [0-9,A-F,a-f].

This routine handle numbers from 0 up to 9223372036854775807dec or 7FFFFFFFFFFFFFFF hex.

Basic examples

Basic examples of the function `HexToDec` are illustrated below.

Example 1

```
VAR string str;

str := HexToDec("5F5E0FF");
```

The variable `str` is given the value "99999999".

Return value

Data type: `string`

The string converted to a decimal representation of the given number in the inparameter string.

Arguments

```
HexToDec ( Str )
```

`Str`

String

Data type: `string`

The string to convert.

Syntax

```
HexToDec'('
  [ Str ':=' ] <expression (IN) of string>
  ')'
```

A function with a return value of the data type `string`.

Related information

For information about	See
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*

2.58. IndInpos - Independent axis in position status

Usage

`IndInpos` is used to test whether an independent axis has reached the selected position.

Basic examples

Basic examples of the function `IndInpos` are illustrated below

Example 1

```
IndAMove Station_A,1\ToAbsNum:=90,20;
WaitUntil IndInpos(Station_A,1) = TRUE;
WaitTime 0.2;
```

Wait until axis `1` of `Station_A` is in the 90 degrees position.

Return value

Data type: `bool`

The table describes the return values from `IndInpos`:

Return value	Axis status
`TRUE`	In position and has zero speed.
`FALSE`	Not in position and/or has not zero speed.

Arguments

```
IndInpos ( MecUnit Axis )
```

`MecUnit`

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit.

`Axis`

Data type: `num`

The number of the current axis for the mechanical unit (1-6).

Limitations

An independent axis executed with the instruction `IndCMove` always returns the value `FALSE`, even when the speed is set to zero.

A wait period of 0.2 seconds should be added after the instruction, to ensure that the correct status has been achieved. This time period should be longer for external axes with poor performance.

Error handling

If the axis is not activated, the system variable `ERRNO` is set to `ERR_AXIS_ACT`.

If the axis is not in independent mode, the system variable ERRNO will be set to ERR_AXIS_IND.

These errors can then be handled in the error handler.

Continues on next page

Syntax

```
IndInpos '('
  [ MecUnit':=' ] < variable (VAR) of mecunit>','
  [ Axis':=' ] < expression (IN) of num>')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Independent axes in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - Positioning during program execution*
Other independent instruction and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Check the speed status for independent axes	*IndSpeed - Independent speed status on page 873*
Defining independent joints	*Technical reference manual - System parameters*, section *Motion - Arm*

2.59. IndSpeed - Independent speed status

Usage

`IndSpeed` is used to test whether an independent axis has reached the selected speed.

Basic examples

Basic examples of the function `IndSpeed` are illustrated below.

Example 1

```
IndCMove Station_A, 2, 3.4;
WaitUntil IndSpeed(Station_A,2 \InSpeed) = TRUE;
WaitTime 0.2;
```

Wait until axis `2` of `Station_A` has reached the speed `3.4` degrees/s.

Return value

Data type: `bool`

The table describes the return values from `IndSpeed \IndSpeed`:

Return value	Axis status
`TRUE`	Has reached the selected speed.
`FALSE`	Has not reached the selected speed.

The table describes the return values from `IndSpeed \ZeroSpeed:`

Return value	Axis status
`TRUE`	Zero speed.
`FALSE`	Not zero speed

Arguments

```
IndSpeed ( MecUnit Axis [ \InSpeed ] | [ \ZeroSpeed ] )
```

`MecUnit`

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit.

`Axis`

Data type: `num`

The number of the current axis for the mechanical unit (1-6).

`[ \InSpeed ]`

Data type: `switch`

`IndSpeed` returns value `TRUE` if the axis has reached the selected speed otherwise `FALSE`.

`[ \ZeroSpeed ]`

Data type: `switch`

`IndSpeed` returns value `TRUE` if the axis has zero speed otherwise `FALSE`.

If both the arguments `\InSpeed` and `\ZeroSpeed` are omitted, an error message will be displayed.

Continues on next page

Limitation

The function `IndSpeed\InSpeed` will always return the value `FALSE` in the following situations:

- The robot is in manual mode with reduced speed.
- The speed is reduced using the `VelSet` instruction.
- The speed is reduced from the production window.

A wait period of 0.2 seconds should be added after the instruction to ensure that the correct status is obtained. This time period should be longer for external axes with poor performance.

Error handling

If the axis is not activated, the system variable `ERRNO` is set to `ERR_AXIS_ACT`.

If the axis is not in independent mode, the system variable ERRNO will be set to ERR_AXIS_IND.

These errors can then be handled in the error handler.

Syntax

```
IndSpeed '('
  [ MecUnit':=' ] < variable (VAR) of mecunit>','
  [ Axis':=' ] < expression (IN) of num>
  [ '\' InSpeed ] | [ '\' ZeroSpeed ] ')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Independent axes in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution*
Other independent instruction and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
More examples	*IndCMove - Independent continuous movement on page 137*
Check the position status for independent axes	*IndInpos - Independent axis in position status on page 871*
Defining independent joints	*Technical reference manual - System parameters*, section *Motion - Arm*

2.60. IOUnitState - Get current state of I/O unit

Usage

`IOUnitState` is used to find out the current state of an I/O unit. It is physical state and logical state define the status for an I/O unit.

Basic examples

Basic examples of the instruction `IOUnitState` are illustrated below.

Example 1

```
IF (IOUnitState("UNIT1" \Phys)=IOUNIT_PHYS_STATE_RUNNING) THEN
  ! Possible to access some signal on the I/O unit
ELSE
  ! Read/Write some signal on the I/O unit result in error
ENDIF
```

Test is done to see if the I/O unit `UNIT1` is up and running.

Example 2

```
IF (IOUnitState("UNIT1" \Logic)=IOUNIT_LOG_STATE_DISABLED) THEN
  ! Unit is disabled by user from RAPID or FlexPendant
ELSE
  ! Unit is enabled.
ENDIF
```

Test is done to see if the I/O unit `UNIT1` is disabled.

Return value

Data type: `iounit_state`

The return value has different values depending on if the optional arguments `\Logic` or `\Phys` or no optional argument at all is used.

The I/O unit logical states describes the state a user can order the unit into.The state of the I/O unit as defined in the table below when using optional argument `\Logic`.

Return value	Symbolic constant	Comment
10	IOUNIT_LOG_STATE_DISABLED	Unit is disabled by user from RAPID, FlexPendant or System Parameters.
11	IOUNIT_LOG_STATE_ENABLED	Unit is enabled by user from RAPID, FlexPendant or System Parameters. Default after startup.

Continues on next page

When the unit is logically enabled by the user and the fieldbus driver intends to take a unit into physical state `IOUNIT_PHYS_STATE_RUNNING`, the unit could get into other states for various reasons (see table below).

The state of the I/O unit as defined in the table below when using optional argument `\Phys`.

Return value	Symbolic constant	Comment
20	IOUNIT_PHYS_STATE_DEACTIVATED	Unit is not running, disabled by user
21	IOUNIT_PHYS_STATE_RUNNING	Unit is running
22	IOUNIT_PHYS_STATE_ERROR	Unit is not working because of some runtime error
23	IOUNIT_PHYS_STATE_UNCONNECTED	Unit is configured but not connected to the bus or the bus is stopped
24	IOUNIT_PHYS_STATE_UNCONFIGURED	Unit is not configured but connected to the bus. [1)]
25	IOUNIT_PHYS_STATE_STARTUP	Unit is in start up mode. [1)]
26	IOUNIT_PHYS_STATE_INIT	Unit is created. [1)]

-

NOTE!

For RobotWare 5.08 and earlier versions it is not possible to use the instruction `IOUnitState` with optional arguments `\Phys` or `\Logic`. From RobotWare 5.09 it is recommended to use the optional arguments `\Phys` or `\Logic`.

The state of the I/O unit is defined in the table below when not using any of the optional arguments `\Phys` or `\Logic`.

Return value	Symbolic constant	Comment
1	IOUNIT_RUNNING	Unit is up and running
2	IOUNIT_RUNERROR	Unit is not working because of some runtime error
3	IOUNIT_DISABLE	Unit is disabled by user from RAPID or FlexPendant
4	IOUNIT_OTHERERR	Other configuration or startup errors

[1)] Not possible to get this state in the RAPID program with current version of RobotWare - OS.

Continues on next page

Arguments

```
IOUnitState (UnitName [\Phys] | [\Logic])
```

`UnitName`

Data type: `string`

The name of the I/O unit to be checked (with same name as configured).

`[\Phys]`

Physical

Data type: `switch`

If using this parameter the physical state of the I/O unit is read.

`[\Logic]`

Logical

Data type: `switch`

If using this parameter the logical state of the I/O unit is read.

Syntax

```
IOUnitState ´(´
  [ UnitName ':=' ] < expression (IN) of string >
  [ '\' Phys] | [ '\' Logic] ´)´
```

A function with a return value of the data type `iounit_state`.

Related information

For information about	See
State of I/O unit	*IOEnable - Enable I/O unit on page 162* *iounit_state - State of I/O unit on page 1128*
Enable an I/O unit	*IOEnable - Enable I/O unit on page 162*
Disabling an I/O unit	*IODisable - Disable I/O unit on page 159*
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and Output Signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - I/O Principles*
Configuration of I/O	*Technical reference manual - System parameters*

2.61. IsFile - Check the type of a file

Usage

The `IsFile` function obtains information about the named file or directory and checks whether it is the same as the specified type. If no type is specified, only an existence check is performed.

The path argument specifies the file. Read, write or execute permission for the named file is not required, but all directories listed in the path name leading to the file must be searchable.

Basic examples

Basic examples of the function `IsFile` are illustrated below.

See also *More examples on page 879*.

Example 1

```
PROC printFT(string filename)
  IF IsFile(filename \Directory) THEN
    TPWrite filename+" is a directory";
    RETURN;
  ENDIF
  IF IsFile(filename \Fifo) THEN
    TPWrite filename+" is a fifo file";
    RETURN;
  ENDIF
  IF IsFile(filename \RegFile) THEN
    TPWrite filename+" is a regular file";
    RETURN;
  ENDIF
  IF IsFile(filename \BlockSpec) THEN
    TPWrite filename+" is a block special file";
    RETURN;
  ENDIF
  IF IsFile(filename \CharSpec) THEN
    TPWrite filename+" is a character special file";
    RETURN;
  ENDIF
ENDPROC
```

This example prints out the `filename` and the type of the specified file on the FlexPendant.

Return value

Data type: `bool`

The function will return `TRUE` if the specified type and actual type match, otherwise `FALSE`. When no type is specified, it returns `TRUE` if the file exists and otherwise `FALSE`.

Continues on next page

Arguments

```
IsFile (Path [\Directory] [\Fifo] [\RegFile] [\BlockSpec]
     [\CharSpec])
```

`Path`

Data type: `string`

The file specified with a full or relative path.

`[ \Directory ]`

Data type: `switch`

Is the file a directory.

`[ \Fifo ]`

Data type: `switch`

Is the file a fifo file.

`[ \RegFile ]`

Data type: `switch`

Is the file a regular file, i.e. a normal binary or ASCII file.

`[ \BlockSpec ]`

Data type: `switch`

Is the file a block special file.

`[ \CharSpec ]`

Data type: `switch`

Is the file a character special file.

Program execution

This function returns a `bool` that specifies match or not.

More examples

More examples of the function `IsFile` are illustrated below.

Example 1

This example implements a generic traverse of a directory structure function.

```
PROC searchdir(string dirname, string actionproc)
  VAR dir directory;
  VAR string filename;
  IF IsFile(dirname \Directory) THEN
     OpenDir directory, dirname;
     WHILE ReadDir(directory, filename) DO
           ! .. and . is the parent and resp. this directory
           IF filename <> ".." AND  filename <> "." THEN
              searchdir dirname+"/"+filename, actionproc;
           ENDIF
     ENDWHILE
     CloseDir directory;
```


Continues on next page

```
    ELSE
      %actionproc% dirname;
    ENDIF
  ERROR
    RAISE;
  ENDPROC

  PROC listfile(string filename)
     TPWrite filename;
  ENDPROC

  PROC main()
    ! Execute the listfile routine for all files found under the
    ! tree of HOME:
    searchdir "HOME:","listfile";
  ENDPROC
```

This program traverses the directory structure under the "`HOME:`" and for each file found, it calls the `listfile` procedure. The `searchdir` is the generic part that knows nothing about the start of the search or which routine should be called for each file. It uses `IsFile` to check whether it has found a subdirectory or a file and it uses the late binding mechanism to call the procedure specified in `actionproc` for all files found. The `actionproc` routine should be a procedure with one parameter of the type `string`.

Error handling

If the file does not exist and there is a type specified, the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

Limitations

This function is not possible to use against serial channels or field buses.

If using against `FTP` or `NFS` mounted discs, the file existance or type information is not always updated. To get correct information an explicit order may be needed against the search path (with instruction `Open`) before using `IsFile`.

Syntax

```
Isfile '('
  [ Path':=' ] < expression (IN) of string>
   [ ´\´Directory ]
  | [ ´\´Fifo ]
  | [ ´\´RegFile ]
  | [ ´\´BlockSpec ]
  | [ ´\´CharSpec ]
  ')'
```

A function with a return value of the data type `bool`.

Continues on next page

Related information

For information about	See
Directory	*dir - File directory structure on page 1103*
Open a directory	*OpenDir - Open a directory on page 285*
Close a directory	*CloseDir - Close a directory on page 56*
Read a directory	*ReadDir - Read next entry in a directory on page 944*
Make a directory	*MakeDir - Create a new directory on page 218*
Remove a directory	*RemoveDir - Delete a directory on page 355*
Rename a file	*RenameFile - Rename a file on page 357*
Remove a file	*RemoveFile - Delete a file on page 356*
Copy a file	*CopyFile - Copy a file on page 65*
Check file size	*FileSize - Retrieve the size of a file on page 842*
Check file system size	*FSSize - Retrieve the size of a file system on page 848*

2.62. IsMechUnitActive - Is mechanical unit active

Usage

`IsMechUnitActive` (*Is Mechanical Unit Active*) is used to check whether a mechanical unit is activated or not.

Basic examples

Basic examples of the function `IsMechUnitActive` are illustrated below.

Example 1

```
IF IsMechUnitActive(SpotWeldGun) CloseGun SpotWeldGun;
```

If the mechanical unit `SpotWeldGun` is active, the routine `CloseGun` will be invoked in which the gun is closed.

Return value

Data type: `bool`

The function returns:

- `TRUE`, if the mechanical unit is active
- `FALSE`, if the mechanical unit is deactive

Arguments

```
IsMechUnitActive ( MechUnit )
```

`MechUnit`

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit.

Syntax

```
IsMechUnitActive '('
  [MechUnit':='] < variable (VAR) of mecunit> ´,´
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Activating mechanical units	*ActUnit - Activates a mechanical unit on page 17*
Deactivating mechanical units	*DeactUnit - Deactivates a mechanical unit on page 79*
Mechanical units	*mecunit - Mechanical unit on page 1139*

2.63. IsPers - Is persistent

Usage

`IsPers` is used to test if a data object is a persistent variable or not.

Basic examples

Basic examples of the function `IsPers` are illustrated below.

Example 1

```
PROC procedure1 (INOUT num parameter1)
  IF IsVar(parameter1) THEN
     ! For this call reference to a variable
     ...
  ELSEIF IsPers(parameter1) THEN
     ! For this call reference to a persistent variable
     ...
  ELSE
     ! Should not happen
     EXIT;
  ENDIF
ENDPROC
```

The procedure `procedure1` will take different actions depending on whether the actual parameter `parameter1` is a variable or a persistent variable.

Return value

Data type: `bool`

TRUE if the tested actual `INOUT` parameter is a persistent variable. FALSE if the tested actual `INOUT` parameter is not a persistent variable.

Arguments

```
IsPers (DatObj)
```

`DatObj`()

Data Object

Data type: any type

The name of the formal INOUT parameter.

Syntax

```
IsPers'('
  [ DatObj' :=' ] < var or pers (INOUT) of any type > ')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Test if variable	*IsVar - Is variable on page 891*
Types of parameters (access modes)	*Technical reference manual - RAPID overview*, section *Basic characteristics - Routines*

2.64. IsStopMoveAct - Is stop move flags active

Usage

`IsStopMoveAct` is used to get the status of the stop move flags for a current or connected motion task.

Basic examples

Basic examples of the function `IsStopMoveAct` are illustrated below.

Example 1

```
stopflag2:= IsStopMoveAct(\FromNonMoveTask);
```

`stopflag2` will be TRUE if the stop move flag from non-motion tasks is set in current or connected motion task, else it will be FALSE.

Example 2

```
IF IsStopMoveAct(\FromMoveTask) THEN
 StartMove;
ENDIF
```

If the stop move flag from motion task is set in the current motion task, it will be reset by the `StartMove` instruction.

Return value

Data type: `bool`

The return value will be TRUE if the selected stop move flag is set, else the return value will be FALSE.

Arguments

```
IsStopMoveAct ( [\FromMoveTask] | [\FromNonMoveTask] )
```

`[\FromMoveTask]`

Data type: `switch`

`FromMoveTask` is used to get the status of the stop move flag of type private motion task.

This type of stop move flag can only be set by:

- The motion task itself with instruction `StopMove`
- After leaving the `RestoPath` level in the program
- At execution in an asynchronous error handler for process- or motion errors before any `StorePath` and after any `RestoPath`

`[\FromNonMoveTask]`

Data type: `switch`

`FromNonMoveTask` is used to get the status of the stop move flag of type any non-motion tasks. This type of stop move flag can only be set by any non-motion task in connected or all motion tasks with the instruction `StopMove`.

Continues on next page

Syntax

```
IsStopMoveAct'('
  ['\' FromMoveTask]
  | ['\' FromNonMoveTask]' )'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Stop robot movement	*StopMove - Stops robot movement on page 515*
Restart robot movement	*StartMove - Restarts robot movement on page 486*

2.65. IsStopStateEvent - Test whether moved program pointer

Usage

`IsStopStateEvent` returns information about the movement of the Program Pointer (PP) in current program task.

Basic examples

Basic examples of the function `IsStopStateEvent` are illustrated below.

Example 1

```
IF IsStopStateEvent (\PPMoved) = TRUE THEN
  ! PP has been moved during the last program stop
ELSE
  ! PP has not been moved during the last program stop
ENDIF

IF IsStopStateEvent  (\PPToMain) THEN
  ! PP has been moved to main routine during the last program stop
ENDIF
```

Return value

Data type: `bool`

Status if and how PP has been moved during the last stop state.

`TRUE` if PP has been moved during the last stop.

`FALSE` if PP has not been moved during the last stop.

If PP has been moved to the main routine, both `\PPMoved` and `\PPToMain` will return `TRUE`.

If PP has been moved to a routine, both `\PPMoved` and `\PPToMain` will return `TRUE`.

If PP has been moved within a list of a routine, `\PPMoved` will return `TRUE` and `\PPToMain` will return `FALSE`.

After calling a service routine (keep execution context in main program sequence) `\PPMove` will return `FALSE` and `\PPToMain` will return `FALSE`.

Arguments

```
IsStopStateEvent ([\PPMoved] | [\PPToMain])
```

`[ \PPMoved ]`

Data type: `switch`

Test whether PP has been moved.

`[ \PPToMain ]`

Data type: `switch`

Test whether PP has been moved to main or to a routine.

Limitations

This function in most cases cannot be used during forward or backward execution because the system is in stop state between every single step.

Continues on next page

Syntax

```
IsStopStateEvent'('
  ['\' PPMoved] | ['\' PPToMain] ´)´
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Making own instructions	*Technical reference manual - RAPID overview*, section - *Programming off-line - Making your own instructions*

2.66. IsSyncMoveOn - Test if in synchronized movement mode

Usage

`IsSyncMoveOn` is used to test if the current program task of type `Motion Task` is in synchronized movement mode or not.

It is also possible from some `Non Motion Task` to test if the connected `Motion Task` is in synchronized movement mode or not. The system parameter *Controller/Tasks/Use Mechanical Unit Group* define the connected `Motion Task`.

When the `Motion Task` is executing at `StorePath` level `IsSyncMoveOn` will test if the task is in synchronized mode on that level, independently of the synchronized mode on the original level.

The instruction `IsSyncMoveOn` is usually used in a *MultiMove* system with option *Coordinated Robots* but can be used in any system and in any program task.

Basic examples

Basic examples of the function `IsSyncMoveOn` are illustrated below.

Example 1

Program example in task `T_ROB1`

```
PERS tasks task_list{2} := [ ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;
VAR syncident sync2;
VAR syncident sync3;

PROC main()
  ...
  MoveL p_zone, vmax, z50, tcp1;
  WaitSyncTask sync1, task_list;
  MoveL p_fine, v1000, fine, tcp1;
  syncmove;
  ...
ENDPROC

PROC syncmove()
  SyncMoveOn sync2, task_list;
  MoveL * \ID:=10, v100, z10, tcp1 \WOBJ:= rob2_obj;
  MoveL * \ID:=20, v100, fine, tcp1 \WOBJ:= rob2_obj;
  SyncMoveOff sync3;
  UNDO
     SyncMoveUndo;
ENDPROC
```


Continues on next page

Program example in task `BCK1`

```
PROC main()
  ...
  IF IsSyncMoveOn() THEN
     ! Connected Motion Task is in synchronized movement mode
  ELSE
     ! Connected Motion Task is in independent mode
  ENDIF
  ...
ENDPROC
```

At the execution time of `IsSyncMoveOn`, in the background task `BCK1`, we test if the connected motion task at that moment is in synchronized movement mode or not.

Return value

Data type: `bool`

`TRUE` if current or connected program task is in synchronized movement mode at the moment, otherwise `FALSE`.

Program execution

Test if current or connected program task is in synchronized movement mode at the moment or not. If the `MotionTask` is executing at `StorePath level`, the `SyncMoveOn` will test if the task is in synchronized movement on the `StorePath level`, not on the original level.

Syntax

```
IsSyncMoveOn '(' ')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Specify cooperated program tasks	*tasks - RAPID program tasks on page 1204*
Identity for synchronization point	*syncident - Identity for synchronization point on page 1200*
Start coordinated synchronized movements	*SyncMoveOn - Start coordinated synchronized movements on page 534*
End coordinated synchronized movements	*SyncMoveOff - End coordinated synchronized movements on page 528*
Set independent movements	*SyncMoveUndo - Set independent movements on page 545*
Store path and execute on new level	*StorePath - Stores the path when an interrupt occurs on page 521*

2.67. IsSysId - Test system identity

Usage

`IsSysId` (*System Identity*) can be used to test the system identity using the system serial number.

Basic examples

Basic examples of the function `IsSysId` are illustrated below.

Example 1

```
IF NOT IsSysId("6400-1234") THEN
  ErrWrite "System identity fault","Faulty system identity for
        this program";
  EXIT;
ENDIF
```

The program is made for a special robot system with serial number `6400-1234` and cannot be used by another robot system.

Return value

Data type: `bool`

`TRUE` = The robot system serial number is the same as specified in the test.

`FALSE` = The robot system serial number is not the same as specified in the test.

Arguments

```
IsSysId ( SystemId)
```

`SystemId`

Data type: `string`

The robot system serial number, marking the system identity.

Syntax

```
IsSysId '('
  [ SystemId':=' ] < expression (IN) of string> ´)´
```

A function with a return value of the data type `bool` .

Related information

For information about	See
Read system information	*GetSysInfo - Get information about the system on page 857*

2.68. IsVar - Is variable

Usage

`IsVar` is used to test whether a data object is a variable or not.

Basic examples

Basic examples of the function `IsVar` are illustrated below.

Example 1

```
PROC procedure1 (INOUT num parameter1)
  IF IsVAR(parameter1) THEN
    ! For this call reference to a variable
    ...
  ELSEIF IsPers(parameter1) THEN
    ! For this call reference to a persistent variable
    ...
  ELSE
    ! Should not happen
    EXIT;
  ENDIF
ENDPROC
```

The procedure `procedure1` will take different actions, depending on whether the actual parameter `parameter1` is a variable or a persistent variable.

Return value

Data type: `bool`

TRUE if the tested actual INOUT parameter is a variable. FALSE if the tested actual INOUT parameter is not a variable.

Arguments

```
IsVar (DatObj)
```

`DatObj`

Data Object

Data type: any type

The name of the formal `INOUT` parameter.

Syntax

```
IsVar'('
  [ DatObj' :=' ] < var or pers (INOUT) of any type > ')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Test if persistent	*IsPers - Is persistent on page 883*
Types of parameters (access modes)	*Technical reference manual - RAPID overview*, section *Basic characteristics - Routines*

2.69. MaxRobSpeed - Maximum robot speed

Usage

`MaxRobSpeed` (*Maximum Robot Speed*) returns the maximum TCP speed for the used robot type.

Basic examples

Basic examples of the function `MaxRobSpeed` are illustrated below.

Example 1

```
TPWrite "Max. TCP speed in mm/s for my robot="\Num:=MaxRobSpeed();
```

The message `Max. TCP speed in mm/s for my robot = 5000` is written on the FlexPendant.

Return value

Data type: `num`

Return the max. TCP speed in mm/s for the used robot type and normal practical TCP values.

If extremely large TCP values are used in the tool frame, one should create his own speeddata with bigger TCP speed than returned by `MaxRobSpeed`.

Syntax

```
MaxRobSpeed '(' ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Definition of velocity	*speeddata - Speed data on page 1185*
Definition of maximum velocity	*VelSet - Changes the programmed velocity on page 662*

2.70. MirPos - Mirroring of a position

Usage

`MirPos` (*Mirror Position*) is used to mirror the translation and rotation parts of a position.

Basic examples

Basic examples of the function `MirPos` are illustrated below.

```
CONST robtarget p1:= [...];
VAR robtarget p2;
PERS wobjdata mirror:= [...];
...
p2 := MirPos(p1, mirror);
```

`p1` is a robtarget storing a position of the robot and an orientation of the tool. This position is mirrored in the xy-plane of the frame defined by `mirror`, relative to the world coordinate system. The result is new robtarget data, which is stored in `p2`.

Return value

Data type: `robtarget`

The new position which is the mirrored position of the input position.

Arguments

```
MirPos (Point MirPlane [\WObj] [\MirY])
```

`Point`

Data type: `robtarget`

The input robot position. The orientation part of this position defines the current orientation of the tool coordinate system.

`MirPlane`

Mirror Plane

Data type: `wobjdata`

The work object data defining the mirror plane. The mirror plane is the xy-plane of the object frame defined in `MirPlane`. The location of the object frame is defined relative to the user frame (also defined in `MirPlane`) which in turn is defined relative to the world frame.

`[\WObj]`

Work Object

Data type: `wobjdata`

The work object data defining the object frame and user frame relative to which the input position *Point* is defined. If this argument is left out the position is defined relative to the World coordinate system.

NOTE!

If the position is created with an active work object, this work object must be referred to in the argument.

Continues on next page

`[\MirY]`

Mirror Y

Data type: `switch`

If this switch is left out, which is the default behavior, the tool frame will be mirrored with regards to the x-axis and the z-axis. If the switch is specified the tool frame will be mirrored with regards to the y-axis and the z-axis.

Limitations

No recalculation is done of the robot configuration part of the input robtarget data.

If a coordinate frame is used, the coordinated unit has to be situated in the same task as the robot.

Syntax

```
MirPos'('
  [ Point ':=' ] < expression (IN) of robtarget>','
  [MirPlane' :='] <expression (IN) of wobjdata>','
  ['\'WObj ':=' <expression (IN) of wobjdata> ]
  ['\'MirY ]')'
```

A function with a return value of the data type `robtarget`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Mathematics*
Position data	*robtarget - Position data on page 1176*
Work object data	*wobjdata - Work object data on page 1224*

2.71. ModExist - Check if program module exist

Usage

`ModExist` (*Module Exist*) is used to check whether a given module exists or not in the program task.

Searching is first done for loaded modules and afterward, if none is found, for installed modules.

Basic examples

Basic examples of the function `ModExist` are illustrated below.

Example 1

```
VAR bool mod_exist;
mod_exist:=ModExist ("MyModule");
```

If module `MyModule` exists within the task, the function will return `TRUE`. If not, the function will return `FALSE`.

Return value

Data type: `bool`

TRUE if the module was found, FALSE if not.

Arguments

```
ModExist (ModuleName)
```

`ModuleName`

Data type: `string`

Name of the module to search for.

Syntax

```
ModExist '('
  [ ModuleName ':=' ] < expression (IN) of string > ')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Find modify time for loaded module	*ModTime - Get file modify time for the loaded module on page 896*

2.72. ModTime - Get file modify time for the loaded module

Usage

`ModTime` (*Modify Time*) is used to retrieve the last file modification time for the loaded module. The module is specified by its name and must be in the task memory. The time is measured in seconds since 00:00:00 GMT, Jan. 1 1970. The time is returned as a `num` and optionally also as a `stringdig`.

Basic examples

Basic examples of the function `ModTime` are illustrated below.

See also *More examples on page 897*.

Example 1

```
MODULE mymod
  VAR num mytime;
  PROC printMyTime()
    mytime := ModTime("mymod");
    TPWrite "My time is "+NumToStr(mytime,0);
  ENDPROC
ENDMODULE
```

Return value

Data type: `num`

The time measured in seconds since 00:00:00 GMT, Jan. 1 1970.

Arguments

```
ModTime ( Object [\StrDig] )
```

`Object`

Data type: `string`

The name of the module.

`[\StrDig]`

String Digit

Data type: `stringdig`

To get the mod loading time in a `stringdig` representation.

Further use in `StrDigCmp` can handle positive integers above 8388608 with exact representation.

Program execution

This function returns a numeric value that specifies the last time a file was modified before it was loaded as a program module in the system.

Continues on next page

More examples

More examples of the function `ModTime` are illustrated below.

Example 1

```
IF FileTime ("HOME:/mymod.mod" \ModifyTime)
  > ModTime ("mymod") THEN
  UnLoad "HOME:/mymod.mod";
  Load \Dynamic, "HOME:/mymod.mod";
ENDIF
```

This program reloads a module if the source file is newer. It uses the `ModTime` to retrieve the latest modify time for the specified module, and compares it to the `FileTime\ModifyTime` at the source. Then, if the source is newer, the program unloads and loads the module again.

Limitation in this example: The data type `num` can't handle positive integers above 8388608 seconds with exact representation. To get better dissolution, see example in function `StrDigCmp`.

Error handling

If no module with specified name is in the program task, the system variable ERRNO is set to ERR_MOD_NOT_LOADED. This error can then be handled in the error handler.

Limitations

This function will always return `0` if used on a module that is encoded or installed shared.

Syntax

```
ModTime '('
  [ Object ':=' ] < expression (IN) of string>
  [ '\' StrDig' :=' < variable (VAR) of stringdig> ] ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Retrieve time information about a file	*FileTime - Retrieve time information about a file on page 845*
String with only digits	*stringdig - String with only digits on page 1197*
Compare two strings with only digits	*StrDigCmp - Compare two strings with only digits on page 991*

2.73. MotionPlannerNo - Get connected motion planner number

Usage

`MotionPlannerNo` returns the connected motion planner number. If executing `MotionPlannerNo` in a motion task, it returns its planner number. Else if executing `MotionPlannerNo` in a non-motion task it returns the connected motion planner number according to the setup in the system parameters.

Basic examples

Basic examples of the function `MotionPlannerNo` are illustrated below.

Example 1

```
!Motion task T_ROB1
PERS string buffer{6} := [stEmpty, stEmpty, stEmpty, stEmpty,
     stEmpty, stEmpty];
VAR num motion_planner;

PROC main()
   ...
  MoveL point, v1000, fine, tcp1;
  motion_planner := MotionPlannerNo();
  buffer[motion_planner] := "READY";
  ...
ENDPROC
!Background task BCK1
PERS string buffer{6};
VAR num motion_planner;
VAR string status;

PROC main()
  ...
  motion_planner := MotionPlannerNo();
  status := buffer[motion_planner];
  ...
ENDPROC
!Motion T_ROB2
PERS string buffer{6};
VAR num motion_planner;

PROC main()
  ...
  MoveL point, v1000, fine, tcp1;
  motion_planner := MotionPlannerNo();
  buffer[motion_planner] := "READY";
  ...
ENDPROC
```


Continues on next page

```
!Background task BCK2
PERS string buffer{6};
VAR num motion_planner;
VAR string status;

PROC main()
  ...
  motion_planner := MotionPlannerNo();
  status := buffer[motion_planner];
  ...
ENDPROC
```

Use the function `MotionPlannerNo` to find out which motion planner number is connected to the task. The exact same code can by implemented in all motion tasks and background tasks. Then each background task can check the status for their connected motion task.

Return value

Data type: `num`

The number of the connected motion planner. For non-motion tasks, the motion planner number of the associated mechanical unit will be returned.

The return value range is 1 ... 6.

Syntax

```
MotionPlannerNo'(' ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Specify cooperated program tasks	*Technical reference manual - System parameters*, section *Controller - Task*

2.74. NonMotionMode - Read the Non-Motion execution mode

Usage

`NonMotionMode` (*Non-Motion Execution Mode*) is used to read the current Non-Motion execution mode of the program task. Non-motion execution mode is selected or removed from the FlexPendant under the menu *ABB\Control Panel\Supervision*.

Basic examples

Basic examples of the function `NonMotionMode` are illustrated below.

Example 1

```
IF NonMotionMode() =TRUE THEN
...
ENDIF
```

The program section is executed only if the robot is in Non-Motion execution mode.

Return value

Data type: `bool`

The current Non-motion mode as defined in the table below.

Return value	Symbolic constant	Comment
0	FALSE	Non-Motion execution is not used
1	TRUE	Non-Motion execution is used

Arguments

```
NonMotionMode ( [ \Main] )
```

`[ \Main ]`

Data type: `switch`

Return current running mode for connected motion task. Used in a multi-tasking system to get the current running mode for the actual task, if it is a motion task or connected motion task, if function `NonMotionMode` is executed in a nonmotion task.

If this argument is omitted, the return value always mirrors the current running mode for the program task that executes the function `NonMotionMode`.

Note that the execution mode is connected to the system and not any task. This means that all tasks in a system will give the same return value from `NonMotionMode`.

Syntax

```
NonMotionMode '(' ['\'Main]')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Reading operating mode	*OpMode - Read the operating mode on page 908*

2.75. NOrient - Normalize orientation

Usage

`NOrient` (*Normalize Orientation*) is used to normalize un-normalized orientation (quaternion).

Description

An orientation must be normalized, i.e. the sum of the squares must equal 1:

$$q_1^2 + q_2^2 + q_3^2 + q_4^2 = 1$$

.

If the orientation is slightly un-normalized, it is possible to normalize it. The normalization error is the absolute value of the sum of the squares of the orientation components. The orientation is considered to be slightly un-normalized if the normalization error is greater then 0.00001 and less then 0.1. If the normalization error is greater then 0.1 the orient is unusable.

$$ABS(\sqrt{q_1^2 + q_2^2 + q_3^2 + q_4^2} - 1) = normerr$$

.

normerr > 0.1	Unusable
normerr > 0.00001 AND normerr <= 0.1	Slightly un-normalized
normerr <= 0.00001	Normalized

Basic examples

Basic examples of the function `NOrient` are illustrated below.

Example 1

We have a slightly un-normalized position (0.707170, 0, 0, 0.707170)

$$ABS(\sqrt{0,707170^2 + 0^2 + 0^2 + 0,707170^2} - 1) = 0,0000894$$

$$0,0000894 > 0,00001 \Rightarrow unnormalized$$

.

```
VAR orient unnormorient := [0.707170, 0, 0, 0.707170];
VAR orient normorient;
...
...
normorient := NOrient(unnormorient);
```

The normalization of the orientation (0.707170, 0, 0, 0.707170) becomes (0.707107, 0, 0, 0.707107).

Return value

Data type: `orient`

The normalized orientation.

Continues on next page

Arguments

```
NOrient (Rotation)
```

Rotation

Data type: `orient`

The orientation to be normalized.

Syntax

```
NOrient'('
  [Rotation ':='] <expression (IN) of orient>
  ')'
```

A function with a return value of the data type `orient`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*

2.76. NumToDnum - Converts num to dnum

Usage

`NumToDnum` converts a `num` to a `dnum`.

Basic examples

A basic example of the function `NumToDnum` is illustrated below.

Example 1

```
VAR num mynum:=55;
VAR dnum mydnum:=0;
mydnum:=NumToDnum(mynum);
```

The num value 55 is returned by the function as the `dnum` value 55.

Return value

Data type: `dnum`

The return value of type `dnum` will have the same value as the input value of type `num`.

Arguments

```
NumToDnum (Value)
```

`Value`

Data type: `num`

The numeric value to be converted.

Syntax

```
NumToDnum
  [ Value ':=' ] < expression (IN) of num > ';'
```

A function with a return value of the data type `dnum`.

Related information

For information about	See
`Num` data type	*num - Numeric values on page 1146*
`Dnum` data type	*dnum - Double numeric values on page 1104*

2.77. NumToStr - Converts numeric value to string

Usage

`NumToStr` (*Numeric To String*) is used to convert a numeric value to a string.

Basic examples

Basic examples of the function `NumToStr` are illustrated below.

Example 1

```
VAR string str;
str := NumToStr(0.38521,3);
```

The variable `str` is given the value `"0.385"`.

Example 2

```
reg1 := 0.38521;
str := NumToStr(reg1, 2\Exp);
```

The variable `str` is given the value `"3.85E-01"`.

Example 3

```
VAR dnum ex3 := 1234567890.123456;
str := NumToStr(ex3, 15\Exp);
```

The variable `str` is given the value `"1.234567890123456E+09"`.

Return value

Data type: `string`

The numeric value converted to a string with the specified number of decimals, with exponent if so requested. The numeric value is rounded if necessary. The decimal point is suppressed if no decimals are included.

Arguments

```
NumToStr (Val | Dval Dec [\Exp])
```

`Val`

Value

Data type: `num`

The numeric value to be converted.

`Dval`

Value

Data type: `dnum`

The numeric value to be converted.

`Dec`

Decimals

Data type: `num`

Number of decimals. The number of decimals must not be negative or greater than the available precision for numeric values.

Continues on next page

`[\Exp]`

Exponent

Data type: `switch`

To use exponent in return value.

Syntax

```
NumToStr'('
  [ Val ':=' ] <expression (IN) of num>
  | [ Dval ':=' ] <expression (IN) of dnum> ','
  [ Dec ':=' ] <expression (IN) of num>
  [ \Exp ]
  ')'
```

A function with a return value of the data type `string`.

Related information

For information about	See
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*

2.78. Offs - Displaces a robot position

Usage

`Offs` is used to add an offset in the object coordinate system to a robot position.

Basic examples

Basic examples of the function `Offs` are illustrated below.

See also *More examples on page 907*.

```
MoveL Offs(p2, 0, 0, 10), v1000, z50, tool1;
```

The robot is moved to a point `10` mm from the position `p2` (in the z-direction).

```
p1 := Offs (p1, 5, 10, 15);
```

The robot position `p1` is displaced `5` mm in the x-direction, `10` mm in the y-direction and `15` mm in the z-direction.

Return value

Data type: `robtarget`

The displaced position data.

Arguments

```
Offs (Point XOffset YOffset ZOffset)
```

`Point`

Data type: `robtarget`

The position data to be displaced.

`XOffset`

Data type: `num`

The displacement in the x-direction, in the object coordinate system.

`YOffset`

Data type: `num`

The displacement in the y-direction, in the object coordinate system.

`ZOffset`

Data type: `num`

The displacement in the z-direction, in the object coordinate system.

Continues on next page

More examples

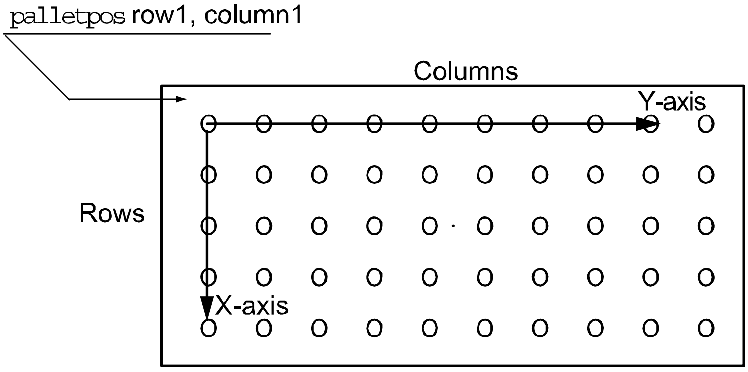
More examples of the function `Offs` are illustrated below.

Example 1

```
PROC pallet (num row, num column, num distance, PERS tooldata tool,
     PERS wobjdata wobj)
VAR robtarget palletpos:=[[0, 0, 0], [1, 0, 0, 0], [0, 0, 0, 0],
     [9E9, 9E9, 9E9, 9E9, 9E9, 9E9]];
palettpos := Offs (palettpos, (row-1)*distance, (column-
     1)*distance, 0);
MoveL palettpos, v100, fine, tool\WObj:=wobj;
ENDPROC
```

A routine for picking parts from a pallet is made. Each pallet is defined as a work object (see figure below). The part to be picked (row and column) and the distance between the parts are given as input parameters. Incrementing the row and column index is performed outside the routine.

The figure shows the position and orientation of the pallet is specified by defining a work object.



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Syntax

```
Offs '('
  [Point ':='] <expression (IN) of robtarget>' ,'
  [XOffset ':='] <expression (IN) of num> ','
  [YOffset ':='] <expression (IN) of num> ','
  [ZOffset ':='] <expression (IN) of num> ')'
```

A function with a return value of the data type `robtarget`.

Related information

For information about	See
Position data	*robtarget - Position data on page 1176*
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Mathematics*
Positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*

2.79. OpMode - Read the operating mode

Usage

`OpMode`(*Operating Mode*) is used to read the current operating mode of the system.

Basic examples

Basic examples of the function `OpMode` are illustrated below.

Example 1

```
TEST OpMode()
CASE OP_AUTO:
  ...
CASE OP_MAN_PROG:
  ...
CASE OP_MAN_TEST:
  ...
DEFAULT:
  ...
ENDTEST
```

Different program sections are executed depending on the current operating mode.

Return value

Data type: `symnum`

The current operating mode as defined in the table below.

Return value	Symbolic constant	Comment
0	`OP_UNDEF`	Undefined operating mode
1	`OP_AUTO`	Automatic operating mode
2	`OP_MAN_PROG`	Manual operating mode max. 250 mm/s
3	`OP_MAN_TEST`	Manual operating mode full speed, 100 %

Syntax

```
OpMode'(' ')'
```

A function with a return value of the data type `symnum`.

Related information

For information about	See
Different operating modes	*Operating manual - IRC5 with FlexPendant*
Reading running mode	*RunMode - Read the running mode on page 971*

2.80. OrientZYX - Builds an orient from euler angles

Usage

`OrientZYX` (*Orient from Euler ZYX angles*) is used to build an orient type variable out of Euler angles.

Basic examples

Basic examples of the function `OrientZYX` are illustrated below.

Example 1

```
VAR num anglex;
VAR num angley;
VAR num anglez;
VAR pose object;
...
object.rot := OrientZYX(anglez, angley, anglex)
```

Return value

Data type: `orient`

The orientation made from the Euler angles.

The rotations will be performed in the following order:

- rotation around the z axis,
- rotation around the new y axis,
- rotation around the new x axis.

Arguments

```
OrientZYX (ZAngle YAngle XAngle)
```

`ZAngle`

Data type: `num`

The rotation, in degrees, around the Z axis.

`YAngle`

Data type: `num`

The rotation, in degrees, around the Y axis.

`XAngle`

Data type: `num`

The rotation, in degrees, around the X axis.

The rotations will be performed in the following order:

- rotation around the z axis,
- rotation around the new y axis,
- rotation around the new x axis.

Continues on next page

Syntax

```
OrientZYX'('
  [ZAngle':='] <expression (IN) of num>' ,'
  [YAngle ':='] <expression (IN) of num> ','
  [XAngle':='] <expression (IN) of num>
  ')'
```

A function with a return value of the data type `orient`.

Related information

For information about	See
Mathematical instructions and functions	*Operating manual - IRC5 with FlexPendant*, section *RAPID summary - Mathematics*

2.81. ORobT - Removes the program displacement from a position

Usage

`ORobT` (*Object Robot Target*) is used to transform a robot position from the program displacement coordinate system to the object coordinate system and/or to remove an offset for the external axes.

Basic examples

Basic examples of the function `ORobT` are illustrated below.

See also *More examples on page 912*.

Example 1

```
VAR robtarget p10;
VAR robtarget p11;
VAR num wobj_diameter;

p10 := CRobT(\Tool:=tool1 \WObj:=wobj_diameter);
p11 := ORobT(p10);
```

The current positions of the robot and the external axes are stored in `p10` and `p11`. The values stored in `p10` are related to the ProgDisp/ExtOffs coordinate system. The values stored in `p11` are related to the object coordinate system without any program displacement and any offset on the external axes.

Return value

Data type: `robtarget`

The transformed position data.

Arguments

```
ORobT (OrgPoint [\InPDisp] | [\InEOffs])
```

`OrgPoint`

Original Point

Data type: `robtarget`

The original point to be transformed.

`[\InPDisp]`

In Program Displacement

Data type: `switch`

Returns the TCP position in the `ProgDisp` coordinate system, i.e. removes external axes offset only.

`[\InEOffs]`

In External Offset

Data type: `switch`

Returns the external axes in the offset coordinate system, i.e. removes program displacement for the robot only.

Continues on next page

More examples

More examples of how to use the function `ORobT` are illustrated below.

Example 1

```
p10 := ORobT(p10 \InEOffs );
```

The `ORobT` function will remove any program displacement that is active, leaving the TCP position relative to the object coordinate system. The external axes will remain in the offset coordinate system.

Example 2

```
p10 := ORobT(p10 \InPDisp );
```

The `ORobT` function will remove any offset of the external axes. The TCP position will remain in the `ProgDisp` coordinate system.

Syntax

```
ORobT '('
  [ OrgPoint ':=' ] < expression (IN) of robtarget>
  ['\'InPDisp] | ['\'InEOffs]')'
```

A function with a return value of the data type `robtarget`.

Related information

For information about	See
Definition of program displacement for the robot	*PDispOn - Activates program displacement on page 317* *PDispSet - Activates program displacement using known frame on page 321*
Definition of offset for external axes	*EOffsOn - Activates an offset for external axes on page 88* *EOffsSet - Activates an offset for external axes using known values on page 90*
Coordinate systems	*Operating manual - IRC5 with FlexPendant*, section *Motion and I/O principles - Coordinate systems*

2.82. ParIdPosValid - Valid robot position for parameter identification

Usage

`ParIdPosValid` (*Parameter Identification Position Valid*) checks whether the robot position is valid for the current parameter identification, such as load identification of tool or payload.

This instruction can only be used in the `main` task or, if in a *MultiMove* system, in motion tasks.

Basic examples

Basic examples of the function `ParIdPosValid` are illustrated below.

Example 1

```
VAR jointtarget joints;
VAR bool valid_joints{12};

! Read the current joint angles
joints := CJointT();
! Check if valid robot position
IF ParIdPosValid (TOOL_LOAD_ID, joints, valid_joints) = TRUE THEN
  ! Valid position for load identification
  ! Continue with LoadId
  ...
ELSE
  ! Not valid position for one or several axes for load
  ! identification
  ! Move the robot to the output data given in variable joints
  ! and do ParIdPosValid once again
  ...
ENDIF
```

Check whether robot position is valid before doing load identification of tool.

Return value

Data type: `bool`

`TRUE` if robot position is valid for current parameter identification.

`FALSE` if robot position is not valid for current parameter identification.

Continues on next page

Arguments

`ParIdPosValid (ParIdType Pos AxValid [\ConfAngle])`

`ParIdType`

Data type: `paridnum`

Type of parameter identification as defined in table below

Value	Symbolic constant	Comment
1	`TOOL_LOAD_ID`	Identify tool load
2	`PAY_LOAD_ID`	Identify payload (Ref. instruction GripLoad)
3	`IRBP_K`	Identify External Manipulator IRBP K load
4	`IRBP_L`	Identify External Manipulator IRBP L load
4	`IRBP_C`	Identify External Manipulator IRBP C load
4	`IRBP_C_INDEX`	Identify External Manipulator IRBP C_INDEX load
4	`IRBP_T`	Identify External Manipulator IRBP T load
5	`IRBP_R`	Identify External Manipulator IRBP R load
6	`IRBP_A`	Identify External Manipulator IRBP A load
6	`IRBP_B`	Identify External Manipulator IRBP B load
6	`IRBP_D`	Identify External Manipulator IRBP D load

`Pos`

Data type: `jointtarget`

Variable specifies the actual joint angles for all robot and external axes. The variable is updated by `ParIdPosValid` according to the table below.

Input axis joint value	Output axis joint value
Valid	Not changed
Not valid	Changed to suitable value

`AxValid`

Data type: `bool`

Array variable with 12 elements corresponding to 6 robot and 6 external axes. The variable is updated by `ParIdPosValid` according to the table below.

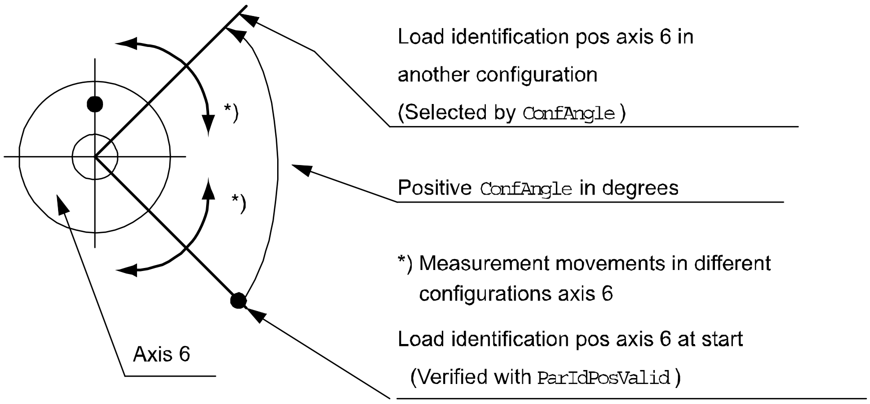
Input axis joint value in Pos	Output status in AxValid
Valid	`TRUE`
Not valid	`FALSE`

Continues on next page

`[ \ConfAngle ]`

Data type: `num`

Option argument for specification of specific configuration angle +/- degrees to be used for parameter identification.



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Default + 90 degrees if this argument is not specified.

Min. + or - 30 degrees. Optimum + or - 90 degrees.

Error handling

If an error occurs, the system variable `ERRNO` is set to `ERR_PID_RAISE_PP`. This error can then be handled in the error handler.

Syntax

```
ParIdPosValid'('
  [ ParIdType ´:=´ ] <expression (IN) of paridnum> ´,´
  [ Pos ´:=´ ] <variable (VAR) of jointtarget> ´,´
  [ AxValid ´:=´ ] <array variable {*} (VAR) of bool>
  [ ´\´ ConfAngle ´:=´ <expression (IN) of num> ] ´)´
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Type of parameter identification	*paridnum - Type of parameter identification on page 1154*
Valid robot type	*ParIdRobValid - Valid robot type for parameter identification on page 916*
Load identification of tool or payload	*LoadId - Load identification of tool or payload on page 212*
Load identification of positioners (IRBP)	*ManLoadIdProc - Load identification of IRBP manipulators on page 219*

2.83. ParIdRobValid - Valid robot type for parameter identification

Usage

`ParIdRobValid` (*Parameter Identification Robot Valid*) checks whether the robot or manipulator type is valid for the current parameter identification, such as load identification of tool or payload.

This instruction can only be used in the main task `T_ROB1` or, if in a *MultiMove* system, in Motion tasks.

Basic examples

Basic examples of the function `ParIdRobValue` are illustrated below.

Example 1

```
TEST ParIdRobValid (TOOL_LOAD_ID)
  CASE ROB_LOAD_VAL:
     ! Possible to do load identification of tool in actual robot
          type
     ...
  CASE ROB_LM1_LOAD_VAL:
     ! Only possible to do load identification of tool with
     ! IRB 6400FHD if actual load < 200 kg
     ...
  CASE ROB_NOT_LOAD_VAL:
     ! Not possible to do load identification of tool in actual
          robot type
     ...
ENDTEST
```

Return value

Data type: `paridvalidnum`

Whether the specified parameter identification can be performed with the current robot or manipulator type, as defined in the table below.

Value	Symbolic constant	Comment
10	ROB_LOAD_VAL	Valid robot or manipulator type for the actual parameter identification
11	ROB_NOT_LOAD_VAL	Not valid type for the actual parameter identification
12	ROB_LM1_LOAD_VAL	Valid robot type IRB 6400FHD for the actual parameter identification if actual load < 200kg

Continues on next page

Arguments

```
ParIdRobValid(ParIdType [\MechUnit] [\AxisNo])
```

`ParIdType`

Data type: `paridnum`

Type of parameter identification as defined in table below.

Value	Symbolic constant	Comment
1	TOOL_LOAD_ID	Identify robot tool load
2	PAY_LOAD_ID	Identify robot payload (Ref. instruction GripLoad)
3	IRBP_K	Identify External Manipulator IRBP K load
4	IRBP_L	Identify External Manipulator IRBP L load
4	IRBP_C	Identify External Manipulator IRBP C load
4	IRBP_C_INDEX	Identify External Manipulator IRBP C_INDEX load
4	IRBP_T	Identify External Manipulator IRBP T load
5	IRBP_R	Identify External Manipulator IRBP R load
6	IRBP_A	Identify External Manipulator IRBP A load
6	IRBP_B	Identify External Manipulator IRBP B load
6	IRBP_D	Identify External Manipulator IRBP D load

`[ \MechUnit ]`

Mechanical Unit

Data type: `mecunit`

Mechanical Unit used for the load identification. Only to be specified for external manipulator. If this argument is omitted the TCP-robot in the task is used.

`[ \AxisNo ]`

Axis number

Data type: `num`

Axis number within the mechanical unit which holds the load to be identified. Only to be specified for external manipulator.

When the argument `\MechUnit` is used, then `\AxisNo` must be used. The argument `\AxisNo` can not be used without `\MechUnit`.

Error handling

If an error occurs, the system variable `ERRNO` is set to `ERR_PID_RAISE_PP`. This error can then be handled in the error handler.

Syntax

```
ParIdRobValid'('
  [ParIdType ':='] <expression (IN) of paridnum>
  ['\' MechUnit' :=' <variable (VAR) of mecunit>]
  ['\' AxisNo ':=' <expression (IN) of num>] ')'
```

A function with a return value of the data type `paridvalidnum`.

Continues on next page

Related information

For information about	See
Type of parameter identification	*paridnum - Type of parameter identification on page 1154*
Mechanical unit to be identified	*mecunit - Mechanical unit on page 1139*
Result of this function	*paridvalidnum - Result of ParIdRobValid on page 1156*
Valid robot position	*ParIdPosValid - Valid robot position for parameter identification on page 913*
Load identification of robot tool load or payload	*LoadId - Load identification of tool or payload on page 212*
Load identification of positioner loads	*ManLoadIdProc - Load identification of IRBP manipulators on page 219*

2.84. PathLevel - Get current path level

Usage

`PathLevel` is used to get the current path level. This function will show whether the task is executing on the original level or if the original movement path has been stored and a new temporary movement is executing. Read more about Path Recovery in *Application manual - Motion functions and event*.

Basic examples

Basic example of the function `PathLevel` is illustrated below.

See also *More examples on page 919*.

Example 1

```
VAR num level;
level:= PathLevel();
```

Variable `level` will be 1 if executed in an original movement path or 2 if executed in a temporary new movement path.

Return value

Data type: `num`

There are two possible return values.

Return value	Description
1	Executing in original movement path.
2	Executing in StorePath level, a temporary new movement path.

More examples

One more example of how to use the function `PathLevel` is illustrated below.

Example 1

```
...
MoveL p100, v100, z10, tool1;
StopMove;
StorePath;
p:= CRobT(\Tool:=tool1);
!New temporary movement
MoveL p1, v100, fine, tool1;
...
level:= PathLevel();
...
MoveL p, v100, fine, tool1;
RestoPath;
StartMove;
...
```

Variable `level` will be 2.

Continues on next page

Limitations

RobotWare option Path Recovery must be installed to be able to use function `PathLevel` at path level 2

Syntax

```
PathLevel'(')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Path recovery.	*Application manual - Motion functions and events*
Store and restore path.	*StorePath - Stores the path when an interrupt occurs on page 521* *RestoPath - Restores the path after an interrupt on page 362*
Stop and start move.	*StartMove - Restarts robot movement on page 486* *StopMove - Stops robot movement on page 515*

2.85. PathRecValidBwd - Is there a valid backward path recorded

Usage

`PathRecValidBwd` is used to check if the path recorder is active and if a recorded backward path is available.

Basic examples

Basic examples of the function `PathRecValidBwd` are illustrated below.

See also *More examples on page 922*.

Example 1

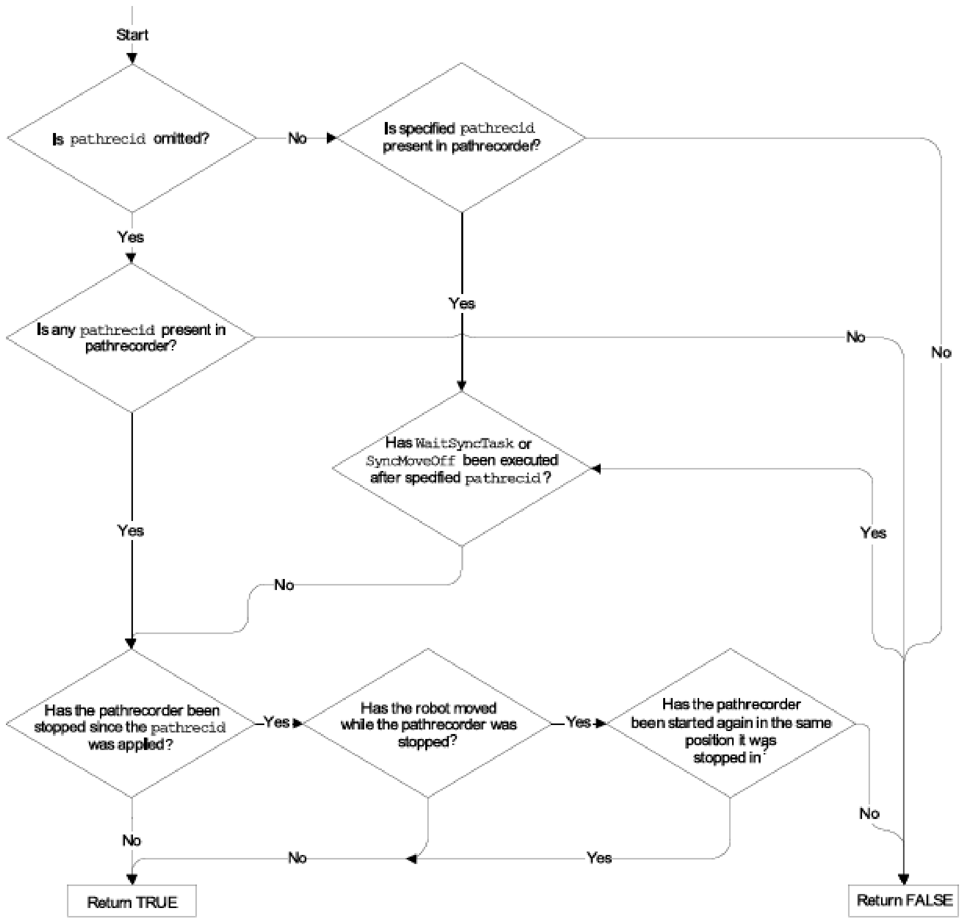
```
VAR bool bwd_path;
VAR pathrecid fixture_id;

bwd_path := PathRecValidBwd (\ID:=fixture_id);
```

The variable `bwd_path` is set to TRUE if it is possible to back-up to the position with identifier `fixture_id`. If not, `bwd_path` is set to FALSE

Return value

Data type: `bool`

The return value of the function can be determined from following flow chart:



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Continues on next page

Arguments

```
PathRecValidBwd ([\ID])
```

`[\ID]`

Identifier

Data type: `pathrecid`

Variable that specifies the name of the recording start position. Data type `pathrecid` is a non-value type, only used as an identifier for naming the recording position.

Program execution

Before the path recorder is ordered to move backwards with `PathRecMoveBwd` it is possible to check whether a valid recorded path is present with `PathRecValidBwd`.

More examples

More examples of how to use the function `PathRecValidBwd` are illustrated below.

Example 1

```
PathRecStart id1;
MoveL p1, vmax, z50, tool1;
MoveL p2, vmax, z50, tool1;
bwd_path := PathRecValidBwd (\ID := id1);
```

The path recorder is started and two move instructions are executed. `PathRecValidBwd` will return TRUE and the available backup path will be:

`p2 -> p1 -> Start postion.`

Example 2

```
PathRecStart id1;
MoveL p1, vmax, z50, tool1;
MoveL p2, vmax, z50, tool1;
PathRecStop \Clear;
bwd_path:= PathRecValidBwd (\ID := id1);
```

The path recorder is started and two move instructions are executed. Then the path recorder is stopped and cleared. `PathRecValidBwd` will return FALSE.

Example 3

```
PathRecStart id1;
MoveL p1, vmax, z50, tool1;
PathRecStart id2;
MoveL p2, vmax, z50, tool1;
bwd_path := PathRecValidBwd ();
```

The path recorder is started and one move instruction is executed. Then, an additional path identifier is started followed by a move instruction. `PathRecValidBwd` will return TRUE and the backup path will be:

`p2 -> p1.`

Continues on next page

Example 4

```
PathRecStart id1;
MoveL p1, vmax, z50, tool1;
WaitSyncTask sync101, tasklist_r1o1;
MoveL p2, vmax, z50, tool1;
bwd_path1 := PathRecValidBwd ();
bwd_path2 := PathRecValidBwd (\ID := id1);
```

Executing above program will result in that the boolean variable `bwd_path1` will be assigned TRUE since a valid backwards path to the `WaitSyncTask` statement exists. The boolean variable `bwd_path2` will be assigned FALSE since it isn't possible to back up above a `WaitSyncTask` statement.

Syntax

```
PathRecValidBwd ´(´
  [´\´ ID' :=' < variable (VAR) of pathrecid >] ')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Path Recorder Identifiers	*pathrecid - Path recorder identifier on page 1158*
Start - stop the path recorder	*PathRecStart - Start the path recorder on page 308* *PathRecStop - Stop the path recorder on page 311*
Play the path recorder backward	*PathRecMoveBwd - Move path recorder backwards on page 298*
Check if a valid forward path exists	*PathRecValidFwd - Is there a valid forward path recorded on page 924*
Play the path recorder forward	*PathRecMoveFwd - Move path recorder forward on page 305*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*

2.86. PathRecValidFwd - Is there a valid forward path recorded

Usage

`PathRecValidFwd` is used to check if the path recorder can be used to move forward. The ability to move forward with the path recorder implies that the path recorder must have been ordered to move backwards earlier.

Basic examples

Basic examples of the function `PathRecValidFwd` are illustrated below.

See also *More examples on page 925*.

Example 1

```
VAR bool fwd_path;
VAR pathrecid fixture_id;

fwd_path:= PathRecValidFwd (\ID:=fixture_id);
```

The variable `fwd_path` is set to `TRUE` if it is possible to move forward to the position with the with identifier `fixture_id`. If not, `fwd_path` is set to `FALSE`.

Return Value

Data type: `bool`

The return value of `PathRecValidFwd` **without** specified `\ID` is:

`TRUE` if:

- The path recorder has moved the robot backwards, using `PathRecMoveBwd`.
- The robot has not moved away from the path executed by `PathRecMoveBwd`.

`FALSE` if:

- The above stated conditions are not met.

The return value of `PathRecValidFwd` **with** specified `\ID` is:

`TRUE` if:

- The path recorder has moved the robot backwards, using `PathRecMoveBwd`.
- The robot has not moved away from the path executed by `PathRecMoveBwd`.
- The specified `\ID` was passed during the backward motion.

`FALSE` if:

- The above stated conditions are not met.

Arguments

```
PathRecValidFwd ([\ID])
```

`[\ID]`

Identifier

Data type: `pathrecid`

Variable that specifies the name of the recording start position. Data type `pathrecid` is a non-value type, only used as an identifier for naming the recording position.

Continues on next page

Program execution

After the path recorder has been ordered to move backwards using `PathRecMoveBwd` it is possible to check if a valid recorded path to move the robot forward exists. If the identifier `\ID` is omitted `PathRevValidFwd` returns if it is possible to move forward to the position where the backwards movement was initiated.

More examples

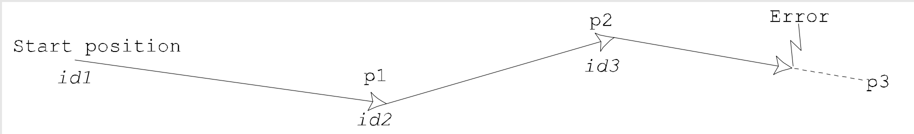
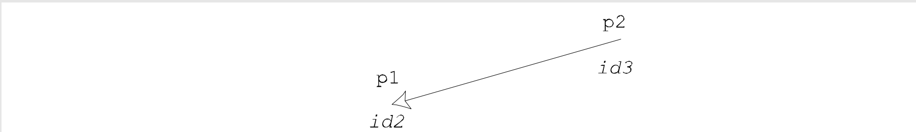
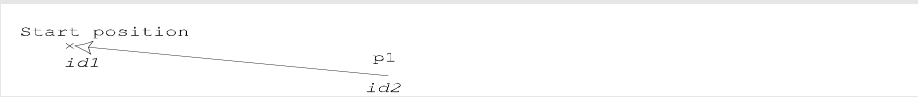
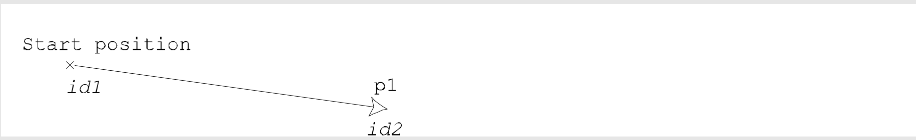
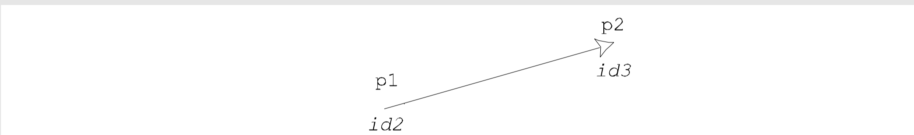
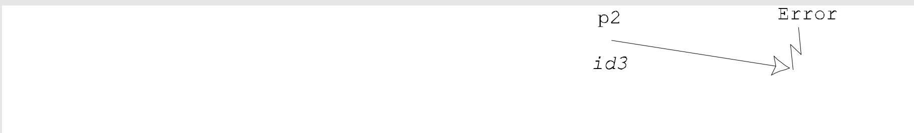
More examples of how to use the function `PathRecValidFwd` are illustrated below.

Example 1

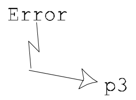
```
  VAR pathrecid id1;
  VAR pathrecid id2;
  VAR pathrecid id3;

  PathRecStart id1;
  MoveL p1, vmax, z50, tool1;
  PathRecStart id2;
  MoveL p2, vmax, z50, tool1;
  PathRecStart id3;
  !See figures 1 and 8 in tbe following table.
  MoveL p3, vmax, z50, tool1;
ERROR
  StorePath;
  IF PathRecValidBwd(\ID:=id3) THEN
    !See figure 2 in the following table.
    PathRecMoveBwd \ID:=id3;
    ! Do some other operation
  ENDIF
  IF PathRecValidBwd(\ID:=id2) THEN
    !See figure 3 in the following table.
    PathRecMoveBwd \ID:=id2;
    ! Do some other operation
  ENDIF
  !See figure 4 in the following table.
  PathRecMoveBwd;
  ! Do final service action
  IF PathRecValidFwd(\ID:=id2) THEN
    !See figure 5 in the following table.
    PathRecMoveFwd \ID:=id2;
    ! Do some other operation
  ENDIF
  IF PathRecValidFwd(\ID:=id3) THEN
    !See figure 6 in the following table.
    PathRecMoveFwd \ID:=id3;
    ! Do some other operation
  ENDIF
```


Continues on next page

```
!See figure 7 in the following table.
PathRecMoveFwd;
RestoPath;
StartMove;
RETRY;
```

1	 xx0500002121
2	 xx0500002124
3	 xx0500002126
4	 xx0500002127
5	 xx0500002128
6	 xx0500002129
7	 xx0500002138

Continues on next page

8	 xx0500002131

The example above will start the path recorder and add identifiers at three different locations along the executed path. The picture above references the example code and describes how the robot will move in the case of an error while executing towards point `p3`. The `PathRecValidBwd` and `PathRecValidFwd` are used respectively as it is not possible in advance to determine where in the program a possible error occurs.

Syntax

```
PathRecValidFwd ´(´
  [´\' ID':=' < variable (VAR) of pathrecid >] ')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Path Recorder Identifiers	*pathrecid - Path recorder identifier on page 1158*
Start - stop the path recorder	*PathRecStart - Start the path recorder on page 308* *PathRecStop - Stop the path recorder on page 311*
Check if valid backward path exists	*PathRecValidBwd - Is there a valid backward path recorded on page 921*
Play the path recorder backward	*PathRecMoveBwd - Move path recorder backwards on page 298*
Play the path recorder forward	*PathRecMoveFwd - Move path recorder forward on page 305*
Motion in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles*

2.87. PFRestart - Check interrupted path after power failure

Usage

`PFRestart` *(Power Failure Restart)* is used to check if the path has been interrupted at power failure. If so it might be necessary to make some specific actions. The function checks the path on current level, base level or on interrupt level.

Basic examples

Basic examples of the function `PFRestart` are illustrated below.

Example 1

```
IF PFRestart() = TRUE THEN
```

It is checked, if an interrupted path exists on the current level. If so the function will return `TRUE`.

Return value

Data type: `bool`

`TRUE` if an interrupted path exists on the specified path level, otherwise `FALSE`.

Arguments

```
PFRestart([\Base] | [\Irpt])
```

[\Base]

Base Level

Data type: `switch`

Returns `TRUE` if an interrupted path exists on base level.

`[ \Irpt ]`

Interrupt Level

Data type: `switch`

Returns `TRUE` if an interrupted path exists on `StorePath` level.

If no argument is given, the function will return `TRUE` if an interrupted path exists on current level.

Syntax

```
PFRestart'('
  ['\'Base] | ['\'Irpt]')'
```

A function with a return value of the data type `bool`.

2.88. PoseInv - Inverts pose data

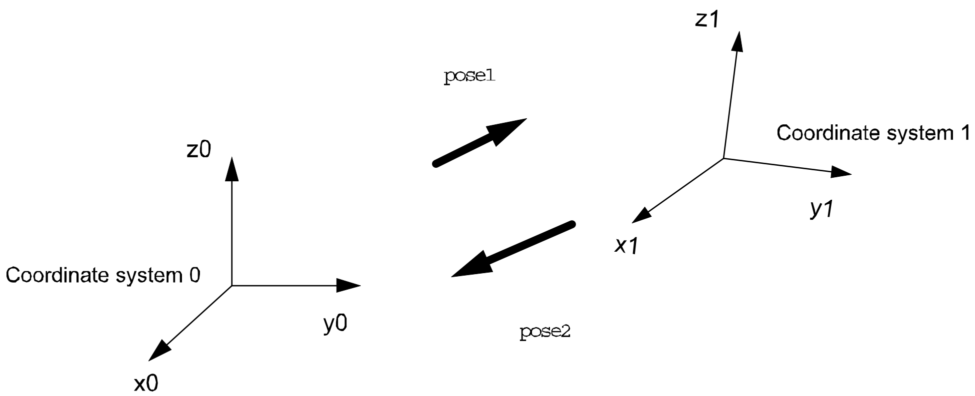
Usage

`PoseInv` (*Pose Invert*) calculates the reverse transformation of a `pose`.

Basic examples

Basic examples of the function `PoseInv` are illustrated below.

Example 1



xx0500002443

`Pose1` represents the coordinates system 1 related to the coordinate system 0. The transformation giving the coordinate system 0 related to the coordinate system 1 is obtained by the reverse transformation, stored in `pose2` .

```
VAR pose pose1;
VAR pose pose2;
...
pose2 := PoseInv(pose1);
```

Return value

Data type: `pose`

The value of the reverse pose.

Arguments

```
PoseInv (Pose)
```

`Pose`

Data type: `pose`

The `pose` to invert.

Syntax

```
PoseInv'('
  [Pose ':='] <expression (IN) of pose>
  ')'
```

A function with a return value of the data type `pose`.

Continues on next page

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*

2.89. PoseMult - Multiplies pose data

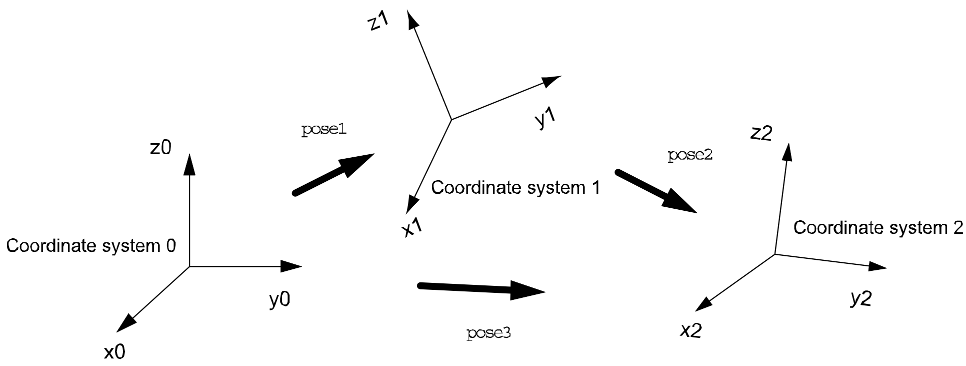
Usage

`PoseMult` (*Pose Multiply*) is used to calculate the product of two pose transformations. A typical use is to calculate a new pose as the result of a displacement acting on an original pose.

Basic examples

Basic examples of the function `PoseMult` are illustrated below.

Example 1



xx0500002444

`pose1` represents the coordinate system 1 related to the coordinate system 0. `pose2` represents the coordinate system 2 related to the coordinate system 1. The transformation giving `pose3`, the coordinate system 2 related to the coordinate system 0, is obtained by the product of the two transformations:

```
VAR pose pose1;
VAR pose pose2;
VAR pose pose3;
...
pose3 := PoseMult(pose1, pose2);
```

Return value

Data type: `pose`

The value of the product of the two poses.

Arguments

```
PoseMult (Pose1 Pose2)
```

`Pose1`

Data type: `pose`

The first pose.

`Pose2`

Data type: `pose`

The second pose.

Continues on next page

Syntax

```
PoseMult'('
  [Pose1 ':='] <expression (IN) of pose>','
  [Pose2 ':='] <expression (IN) of pose>
  ')'
```

A function with a return value of the data type `pose`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*

2.90. PoseVect - Applies a transformation to a vector

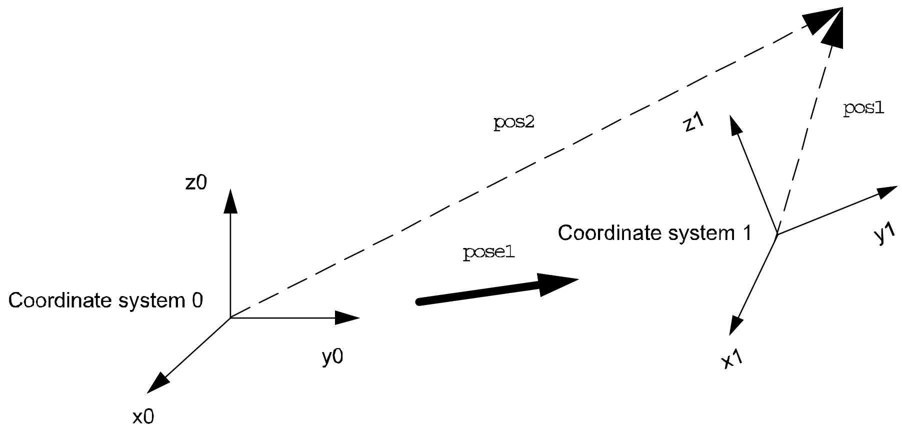
Usage

`PoseVect` (*Pose Vector*) is used to calculate the product of a pose and a vector. It is typically used to calculate a vector as the result of the effect of a displacement on an original vector.

Basic examples

Basic examples of the function `PoseVect` are illustrated below.

Example 1



xx0500002445

`pose1` represents the coordinates system 1 related to the coordinate system 0.

`pos1` is a vector related to coordinate system 1. The corresponding vector related to coordinate system 0 is obtained by the product;

```
VAR pose pose1;
VAR pos pos1;
VAR pos pos2;
...
...
pos2:= PoseVect(pose1, pos1);
```

Return value

Data type: `pos`

The value of the product of the pose and the original pos.

Arguments

```
PoseVect (Pose Pos)
```

`Pose`

Data type: `pose`

The transformation to be applied.

`Pos`

Data type: `pos`

The pos to be transformed.

Continues on next page

Syntax

```
PoseVect'('
  [Pose ':='] <expression (IN) of pose>','
  [Pos ':='] <expression (IN) of pos>
  ')'
```

A function with a return value of the data type `pos`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*

2.91. Pow - Calculates the power of a value

Usage

`Pow` (*Power*) is used to calculate the exponential value in any base.

Basic examples

Basic examples of the function `Pow` are illustrated below.

Example 1

```
VAR num x;
VAR num y
VAR num reg1;
...
reg1:= Pow(x, y);
```

`reg1` is assigned the value x^y.

Return value

Data type: `num`

The value of the `Base` raised to the power of the Exponent, i.e. $\text{Base}^{\text{Exponent}}$.

Arguments

```
Pow (Base Exponent)
```

`Base`

Data type: `num`

The base argument value.

`Exponent`

Data type: `num`

The exponent argument value.

Limitations

The execution of the function x^y will give an error if:

- $x < 0$ and y is not an integer;
- $x = 0$ and $y \leq 0$.

Syntax

```
Pow'('
  [Base ':='] <expression (IN) of num>','
  [Exponent ':='] <expression (IN) of num>
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*

2.92. PPMovedInManMode - Test whether the program pointer is moved in manual mode

Usage

`PPMovedInManMode` returns TRUE if the user has moved the program pointer while the controller is in manual mode - that is, operator key is at Man Reduced Speed or Man Full Speed. The program pointer moved state is reset when the key is switched from Auto to Man, or when using the instruction `ResetPPMoved`.

Basic examples

Basic example of the function `PPMovedInManMode` is illustrated below.

Example 1

```
IF PPMovedInManMode() THEN
  WarnUserOfPPMovement;
  DoJob;
ELSE
  DoJob;
ENDIF
```

Return value

Data type: `bool`

TRUE if the program pointer has been moved by the user while in manual mode.

Program execution

Test if the program pointer for the current program task has been moved in manual mode.

Syntax

```
PPMovedInManMode'('')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Test whether program pointer has moved	*IsStopStateEvent - Test whether moved program pointer on page 886*
Reset state of moved program pointer in manual mode	*ResetPPMoved - Reset state for the program pointer moved in manual mode on page 360*

2.93. Present - Tests if an optional parameter is used

Usage

`Present` is used to test if an optional argument has been used when calling a routine.

An optional parameter may not be used if it was not specified when calling the routine. This function can be used to test if a parameter has been specified, in order to prevent errors from occurring.

Basic examples

Basic examples of the function `Present` are illustrated below.

See also *More examples on page 938*.

Example 1

```
PROC feeder (\switch on | \switch off)

  IF Present (on) Set do1;
  IF Present (off) Reset do1;

ENDPROC
```

The output `do1`, which controls a feeder, is set or reset depending on the argument used when calling the routine.

Return value

Data type: `bool`

TRUE = The parameter value or a switch has been defined when calling the routine.

FALSE = The parameter value or a switch has not been defined.

Arguments

```
Present (OptPar)
```

`OptPar`

Optional Parameter

Data type: Any type

The name of the optional parameter to be tested.

Continues on next page

More examples

More examples of how to use the function `Present` are illustrated below.

Example 1

```
PROC glue (\switch on, num glueflow, robtarget topoint, speeddata
     speed, zonedata zone, PERS tooldata tool, \PERS wobjdata
     wobj)

  IF Present (on) PulseDO glue_on;
  SetAO gluesignal, glueflow;
  IF Present (wobj) THEN
    MoveL topoint, speed, zone, tool \WObj=wobj;
  ELSE
    MoveL topoint, speed, zone, tool;
  ENDIF
ENDPROC
```

A glue routine is made. If the argument `\on` is specified when calling the routine, a pulse is generated on the signal `glue_on`. The robot then sets an analog output `gluesignal`, which controls the glue gun, and moves to the end position. As the wobj parameter is optional, different `MoveL` instructions are used depending on whether this argument is used or not.

Syntax

```
Present '('
  [OptPar':='] <reference (REF) of any type> ')'
```

A REF parameter requires, in this case, the optional parameter name.

A function with a return value of the data type `bool`.

Related information

For information about	See
Routine parameters	*Technical reference manual - RAPID overview*, section *Basic characteristics - Routines*

2.94. ProgMemFree - Get the size of free program memory

Usage

`ProgMemFree` (*Program Memory Free*) is used to get the size of free program memory.

Basic examples

Basic examples of the function `ProgMemFree` are illustrated below.

Example 1

```
FUNC num module_size(string file_path)
  VAR num pgmfree_before;
  VAR num pgmfree_after;

  pgmfree_before:=ProgMemFree();
  Load \Dynamic, file_path;
  pgmfree_after:=ProgMemFree();
  Unload file_path;
  RETURN (pgmfree_before-pgmfree_after);
ENDFUNC
```

`ProgMemFree` is used in a function that returns the value for how much memory a module allocates in the program memory.

Return value

Data type: `num`

The size of free program memory in bytes.

Syntax

```
ProgMemFree'(' ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Load a program module	*Load - Load a program module during execution on page 208*
Unload a program module	*UnLoad - UnLoad a program module during execution on page 655*

2.95. RawBytesLen - Get the length of rawbytes data

Usage

`RawBytesLen` is used to get the current length of valid bytes in a rawbytes variable.

Basic examples

Basic examples of the instruction `RawBytesLen` are illustrated below.

Example 1

```
VAR rawbytes from_raw_data;
VAR rawbytes to_raw_data;
VAR num integer := 8
VAR num float := 13.4;
ClearRawBytes from_raw_data;
PackRawBytes integer, from_raw_data, 1 \IntX := INT;
PackRawBytes float, from_raw_data, (RawBytesLen(from_raw_data)+1)
     \Float4;
CopyRawBytes from_raw_data, 1, to_raw_data, 3;
```

In this example the variable `from_raw_data` of type rawbytes is first cleared, i.e. all bytes set to 0 (same as default at declaration). Then the value of integer is placed in the first 2 bytes and with help of the function `RawBytesLen` the value of `float` is placed in the next 4 bytes (starting at index 3).

After having filled `from_raw_data` with data, the contents (6 bytes) is copied to `to_raw_data`, starting at position 3.

Return value

Data type: `num`

The current length of valid bytes in a variable of type `rawbytes`; range 0 ... 1024.

In general, the current length of valid bytes in a rawbytes variable is updated by the system to be the last written byte in the rawbytes structure.

For details, see data type `rawbytes`, instruction `ClearRawBytes`, `CopyRawBytes`, `PackDNHeader`, `PackRawBytes` and `ReadRawBytes`.

Arguments

```
RawBytesLen (RawData)
```

`RawData`

Data type: `rawbytes`

`RawData` is the data container whose current length of valid bytes shall be returned.

Program execution

During program execution the current length of valid bytes is returned.

Continues on next page

Syntax

```
RawBytesLen ´(´
[RawData ´:=´ ] < variable (VAR) of rawbytes> ´)´
```

A function with a return value of the data type `num`.

Related information

For information about	See
`rawbytes` data	*rawbytes - Raw data on page 1165*
Clear the contents of `rawbytes` data	*ClearRawBytes - Clear the contents of rawbytes data on page 49*
Copy the contents of `rawbytes` data	*CopyRawBytes - Copy the contents of rawbytes data on page 67*
Pack DeviceNet header into `rawbytes` data	*PackDNHeader - Pack DeviceNet Header into rawbytes data on page 287*
Pack data into `rawbytes` data	*PackRawBytes - Pack data into rawbytes data on page 290*
Read `rawbytes` data	*ReadRawBytes - Read rawbytes data on page 352*
Unpack data from `rawbytes` data	*UnpackRawBytes - Unpack data from rawbytes data on page 658*
Write `rawbytes` data	*WriteRawBytes - Write rawbytes data on page 725*

2.96. ReadBin - Reads a byte from a file or serial channel

Usage

`ReadBin` (*Read Binary*) is used to read a byte (8 bits) from a file or serial channel.

This function works on both binary and character-based files or serial channels.

Basic examples

Basic examples of the function `ReadBin` are illustrated below.

See also *More examples on page 943*.

Example 1

```
VAR num character;
VAR iodev inchannel;
...
Open "com2:", inchannel\Bin;
character := ReadBin(inchannel);
```

A byte is read from the binary serial channel `inchannel`.

Return value

Data type: `num`

A byte (8 bits) is read from a specified file or serial channel. This byte is converted to the corresponding positive numeric value and returned as a `num` data type. If a file is empty (end of file), `EOF_BIN` (the number -1) is returned.

Arguments

```
ReadBin (IODevice [\Time])
```

`IODevice`

Data type: `iodev`

The name (reference) of the file or serial channel to be read.

`[\Time]`

Data type: `num`

The max. time for the reading operation (timeout) in seconds. If this argument is not specified, the max. time is set to 60 seconds. To wait forever, use the predefined constant `WAIT_MAX`.

If this time runs out before the reading operation is finished, the error handler will be called with the error code `ERR_DEV_MAXTIME`. If there is no error handler, the execution will be stopped.

The timeout function is in use also during program stop and will be noticed by the RAPID program at program start.

Program execution

Program execution waits until a byte (8 bits) can be read from the file or serial channel.

Continues on next page

More examples

More examples of the function `ReadBin` are illustrated below.

Example 1

```
VAR num bindata;
VAR iodev file;

Open "HOME:/myfile.bin", file \Read \Bin;
bindata := ReadBin(file);
WHILE bindata <> EOF_BIN DO
  TPWrite ByteToStr(bindata\Char);
  bindata := ReadBin(file);
ENDWHILE
```

Read the contents of a binary file myfile.bin from the beginning to the end and displays the received binary data converted to chars on the FlexPendant (one char on each line).

Limitations

The function can only be used for files and serial channels that have been opened with read access (`\Read` for character based files, `\Bin` or `\Append \Bin` for binary files).

Error handling

If an error occurs during reading, the system variable `ERRNO` is set to `ERR_FILEACC`.

If time out before the read operation is finished, the system variable ERRNO is set to `ERR_DEV_MAXTIME`.

These errors can then be dealt with by the error handler.

Predefined data

The constant `EOF_BIN` can be used to stop reading at the end of the file.

```
CONST num EOF_BIN := -1;
```

Syntax

```
ReadBin'('
  [IODevice ':='] <variable (VAR) of iodev>
  ['\'Time':=' <expression (IN) of num>]')'
```

A function with a return value of the type `num`.

Related information

For information about	See
Opening, etc. files or serial channels	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*
Convert a byte to a string data	*ByteToStr - Converts a byte to a string data on page 784*

2.97. ReadDir - Read next entry in a directory

Usage

`ReadDir` is used to retrieve the name of the next file or subdirectory under a directory that has been opened with the instruction `OpenDir`.

As long as the function returns `TRUE`, there can be more files or subdirectories to retrieve.

Basic examples

Basic examples of the function `ReadDir` are illustrated below.

See also *More examples on page 945*.

Example 1

```
PROC lsdir(string dirname)
  VAR dir directory;
  VAR string filename;
  OpenDir directory, dirname;
  WHILE ReadDir(directory, filename) DO
     TPWrite filename;
  ENDWHILE
  CloseDir directory;
ENDPROC
```

This example prints out the names of all files or subdirectories under the specified directory.

Return value

Data type: `bool`

The function will return `TRUE` if it has retrieved a name, otherwise `FALSE`.

Arguments

```
ReadDir (Dev FileName)
```

`Dev`

Data type: `dir`

A variable with reference to the directory, fetched by instruction `OpenDir`.

`FileName`

Data type: `string`

The retrieved file or subdirectory name.

Program execution

This function returns a bool that specifies if the retrieving of a name was successful or not.

Continues on next page

More examples

More examples of the function `ReadDir` are illustrated below

Example 1

This example implements a generic traverse of a directory structure function.

```
PROC searchdir(string dirname, string actionproc)
  VAR dir directory;
  VAR string filename;
  IF IsFile(dirname \Directory) THEN
     OpenDir directory, dirname;
     WHILE ReadDir(directory, filename) DO
           ! .. and . is the parent and resp. this directory
           IF filename <> ".." AND  filename <> "." THEN
              searchdir dirname+"/"+filename, actionproc;
           ENDIF
     ENDWHILE
     CloseDir directory;
  ELSE
     %actionproc% dirname;
  ENDIF
ERROR
  RAISE;
ENDPROC

PROC listfile(string filename)
  TPWrite filename;
ENDPROC

PROC main()
  ! Execute the listfile routine for all files found under the
  ! tree in HOME:
  searchdir "HOME:","listfile";
ENDPROC
```

This program traverses the directory structure under "`HOME:`", and for each file found it calls the `listfile` procedure. The `searchdir` is the generic part that knows nothing about the start of the search or which routine should be called for each file. It uses `IsFile` to check whether it has found a subdirectory or a file and it uses the late binding mechanism to call the procedure specified in `actionproc` for all files found. The `actionproc` routine should be a procedure with one parameter of the type `string`.

Error handling

If the directory is not opened (see `OpenDir`), the system variable `ERRNO` is set to `ERR_FILEACC`. This error can then be handled in the error handler.

Continues on next page

Syntax

```
ReadDir '('
  [ Dev':=' ] < variable (VAR) of dir>','
  [ FileName':=' ] < var or pers (INOUT) of string>´)´
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Directory	*dir - File directory structure on page 1103*
Make a directory	*MakeDir - Create a new directory on page 218*
Open a directory	*OpenDir - Open a directory on page 285*
Close a directory	*CloseDir - Close a directory on page 56*
Remove a directory	*RemoveDir - Delete a directory on page 355*
Remove a file	*RemoveFile - Delete a file on page 356*
Rename a file	*RenameFile - Rename a file on page 357*

2.98. ReadMotor - Reads the current motor angles

Usage

`ReadMotor` is used to read the current angles of the different motors of the robot and external axes. The primary use of this function is in the calibration procedure of the robot.

Basic examples

Basic example of the function `ReadMotor` is illustrated below.

See also *More examples on page 947*.

```
VAR num motor_angle2;
motor_angle2 := ReadMotor(2);
```

The current motor angle of the second axis of the robot is stored in `motor_angle2`.

Return value

Data type: `num`

The current motor angle in radians of the stated axis of the robot or external axes.

Arguments

```
ReadMotor [\MecUnit ] Axis
```

MecUnit

Mechanical Unit

Data type: `mecunit`

The name of the mechanical unit for which an axis is to be read. If this argument is omitted, the axis for the connected robot is read.

Axis

Data type: `num`

The number of the axis to be read (1 - 6).

Program execution

The motor angle returned represents the current position in radians for the motor without any calibration offset. The value is not related to a fix position of the robot, only to the resolver internal zero position, i.e. normally the resolver zero position closest to the calibration position (the difference between the resolver zero position and the calibration position is the calibration offset value). The value represents the full movement of each axis, although this may be several turns.

More examples

More examples of the function `ReadMotor` are illustrated below.

Example 1

```
VAR num motor_angle3;
motor_angle3 := ReadMotor(\MecUnit:=ROB_1, 3);
```

The current motor angle of the third axis of the robot `ROB_1` is stored in `motor_angle3`.

Continues on next page

Syntax

```
ReadMotor'('
  ['\'MecUnit ':=' < variable (VAR) of mecunit>',']
  [Axis' :=' ] < expression (IN) of num> ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Reading the current joint angle	*CJointT - Reads the current joint angles on page 800*

2.99. ReadNum - Reads a number from a file or serial channel

Usage

`ReadNum` (*Read Numeric*) is used to read a number from a character-based file or serial channel.

Basic examples

Basic examples of the function `ReadNum` are illustrated below.

See also *More examples on page 950*.

Example 1

```
VAR iodev infile;
...
Open "HOME:/file.doc", infile\Read;
reg1 := ReadNum(infile);
```

`reg1` is assigned a number read from the file `file.doc`.

Return value

Data type: `num`

The numeric value read from a specified file or serial channel. If the file is empty (end of file), the number `EOF_NUM (9.998E36)` is returned.

Arguments

```
ReadNum (IODevice [\Delim] [\Time])
```

`IODevice`

Data type: `iodev`

The name (reference) of the file or serial channel to be read.

`[\Delim]`

Delimiters

Data type: `string`

A string containing the delimiters to use when parsing a line in the file or serial channel. By default (without `\Delim`), the file is read line by line and the line-feed character (\0A) is the only delimiter considered by the parsing. When the `\Delim` argument is used, any character in the specified string argument will be considered to determine the significant part of the line.

When using the argument `\Delim`, the control system always adds the characters carriage return (`\0D`) and line-feed (`\0A`) to the delimiters specified by the user.

To specify non-alphanumeric characters, use `\xx`, where `xx` is the hexadecimal representation of the ASCII code of the character (example: TAB is specified by `\09`).

Continues on next page

`[\Time]`

Data type: `num`

The max. time for the reading operation (timeout) in seconds. If this argument is not specified, the max. time is set to 60 seconds. To wait forever, use the predefined constant `WAIT_MAX`.

If this time runs out before the read operation is finished, the error handler will be called with the error code `ERR_DEV_MAXTIME`. If there is no error handler, the execution will be stopped.

The timeout function is also in use during program stop and will be noticed by the RAPID program at program start.

Program execution

Starting at the current file position, the function reads and discards any heading delimiters. A heading delimiter without the argument `\Delim` is a line-feed character. Heading delimiters with the argument `\Delim` are any characters specified in the `\Delim` argument plus carriage return and line-feed characters. It then reads everything up to and including the next delimiter character (will be discarded), but not more than 80 characters. If the significant part exceeds 80 characters, the remainder of the characters will be read on the next reading.

The string that is read is then converted to a numeric value; e.g. "234.4" is converted to the numeric value 234.4.

More examples

More examples of the function `ReadNum` are illustrated below.

```
reg1 := ReadNum(infile\Delim:="\09");
IF reg1 > EOF_NUM THEN
  TPWrite "The file is empty";
  ...
```

Reads a number in a line where numbers are separated by TAB (`"\09"`) or SPACE (`" "`) characters. Before using the number read from the file, a check is performed to make sure that the file is not empty.

Limitations

The function can only be used for character based files that have been opened for reading.

Error handling

If an access error occurs during reading, the system variable `ERRNO` is set to `ERR_FILEACC`.

If there is an attempt to read non-numeric data, the system variable `ERRNO` is set to `ERR_RCVDATA`.

If time out before the read operation is finished, the system variable `ERRNO` is set to `ERR_DEV_MAXTIME`.

These errors can then be dealt with by the error handler.

Predefined data

The constant `EOF_NUM` can be used to stop reading, at the end of the file.

```
CONST num EOF_NUM := 9.998E36;
```

Continues on next page

Syntax

```
ReadNum '('
  [IODevice ':=']<variable (VAR) of iodev>
  ['\'Delim':='<expression (IN) of string>]
  ['\'Time':='<expression (IN) of num>]')'
```

A function with a return value of the type `num`.

Related information

For information about	See
Opening, etc. files or serial channels	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*

2.100. ReadStr - Reads a string from a file or serial channel

Usage

`ReadStr` (*Read String*) is used to read a string from a character-based file or serial channel.

Basic examples

Basic examples of the function `ReadStr` are illustrated below.

See also *More examples on page 953*.

Example 1

```
VAR string text;
VAR iodev infile;
...
Open "HOME:/file.doc", infile\Read;
text := ReadStr(infile);
```

`text` is assigned a string read from the file `file.doc`.

Return value

Data type: `string`

The string read from the specified file or serial channel. If the file is empty (end of file), the string `"EOF"` is returned.

Arguments

```
ReadStr (IODevice [\Delim] [\RemoveCR] [\DiscardHeaders]
     [\Time])
```

`IODevice`

Data type: `iodev`

The name (reference) of the file or serial channel to be read.

`[\Delim]`

Delimiters

Data type: `string`

A string containing the delimiters to use when parsing a line in the file or serial channel. By default the file is read line by line and the line-feed character (\0A) is the only delimiter considered by the parsing. When the `\Delim` argument is used, any character in the specified string argument plus by default line-feed character will be considered to determine the significant part of the line.

To specify non-alphanumeric characters, use `\xx`, where `xx` is the hexadecimal representation of the ASCII code of the character (example: TAB is specified by `\09`).

`[\RemoveCR]`

Data type: `switch`

A switch used to remove the trailing carriage return character when reading PC files. In PC files, a new line is specified by carriage return and line feed (CRLF). When reading a line in such files, the carriage return character is by default read into the return string. When using this argument, the carriage return character will be read from the file but not included in the return string.

Continues on next page

`[\DiscardHeaders]`

Data type: `switch`

This argument specifies whether the heading delimiters (specified in `\Delim` plus default line-feed) are skipped or not before transferring data to the return string. By default, if the first character at the current file position is a delimiter, it is read but not transferred to the return string, the line parsing is stopped and the return will be an empty string. If this argument is used, all delimiters included in the line will be read from the file but discarded, and no return will be done until the return string will contain the data starting at the first non-delimiter character in the line.

`[\Time]`

Data type: `num`

The max. time for the reading operation (timeout) in seconds. If this argument is not specified, the max. time is set to 60 seconds. To wait forever, use the predefined constant `WAIT_MAX`.

If this time runs out before the read operation is finished, the error handler will be called with the error code `ERR_DEV_MAXTIME`. If there is no error handler, the execution will be stopped.

The timeout function is in use also during program stop and will be noticed in the RAPID program at program start.

Program execution

Starting at the current file position, if the `\DiscardHeaders` argument is used, the function reads and discards any heading delimiters (line-feed characters and any character specified in the `\Delim` argument). In all cases, it then reads everything up to the next delimiter character, but not more than 80 characters. If the significant part exceeds 80 characters, the remainder of the characters will be read on the next reading. The delimiter that caused the parsing to stop is read from the file but not transferred to the return string. If the last character in the string is a carriage return character and the `\RemoveCR` argument is used, this character will be removed from the string.

More examples

More examples of the function `ReadStr` are illustrated below.

Example 1

```
text := ReadStr(infile);
IF text = EOF THEN
  TPWrite "The file is empty";
  ...
```

Before using the string read from the file, a check is performed to make sure that the file is not empty.

Continues on next page

Example 2

Consider a file containing:

```
<LF><SPACE><TAB>Hello<SPACE><SPACE>World<CR><LF>
```

```
text := ReadStr(infile);
```

text will be an empty string: the first character in the file is the default <LF> delimiter.

```
text := ReadStr(infile\DiscardHeaders);
```

text will contain <SPACE><TAB>Hello<SPACE><SPACE>World<CR>: the first character in the file, the default <LF> delimiter, is discarded.

```
text := ReadStr(infile\RemoveCR\DiscardHeaders);
```

text will contain <SPACE><TAB>Hello<SPACE><SPACE>World: the first character in the file, the default <LF> delimiter, is discarded; the final carriage return character is removed

```
text := ReadStr(infile\Delim:="  \09"\RemoveCR\DiscardHeaders);
```

text will contain "Hello": the first characters in the file that match either the default <LF> delimiter or the character set defined by \Delim (space and tab) are discarded. Data is then transferred up to the first delimiter that is read from the file but not transferred into the string. A new invocation of the same statement will return "World".

Example 3

Consider a file containing:

```
<CR><LF>Hello<CR><LF>
text := ReadStr(infile);
```

text will contain the <CR> (\0d) character: <CR> and <LF> characters are read from the file, but only <CR> is transferred to the string. A new invocation of the same statement will return "Hello\0d".

```
text := ReadStr(infile\RemoveCR);
```

text will contain an empty string: <CR> and <LF> characters are read from the file; <CR> is transferred but removed from the string. A new invocation of the same statement will return "Hello".

```
text := ReadStr(infile\Delim:="\0d");
```

text will contain an empty string: <CR> is read from the file but not transferred to the return string. A new invocation of the same instruction will return an empty string again: <LF> is read from the file but not transferred to the return string.

```
text := ReadStr(infile\Delim:="\0d"\DiscardHeaders);
```

text will contain "Hello". A new invocation of the same instruction will return "EOF" (end of file).

Continues on next page

Limitations

The function can only be used for files or serial channels that have been opened for reading in a character-based mode.

Error handling

If an error occurs during reading, the system variable `ERRNO` is set to `ERR_FILEACC`.

If timeout before the read operation is finished, the system variable `ERRNO` is set to `ERR_DEV_MAXTIME`.

These errors can then be dealt with by the error handler.

Predefined data

The constant `EOF` can be used to check if the file was empty when trying to read from the file or to stop reading at the end of the file.

```
CONST string EOF := "EOF";
```

Syntax

```
ReadStr '('
[IODevice' :='] <variable (VAR) of iodev>
['\'Delim' :='<expression (IN) of string>]
['\'RemoveCR]
['\'DiscardHeaders]
['\'Time':=' <expression (IN) of num>]')'
```

A function with a return value of the type `string`.

Related information

For information about	See
Opening, etc. files or serial channels	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*

2.101. ReadStrBin - Reads a string from a binary serial channel or file

Usage

`ReadStrBin` (*Read String Binary*) is used to read a string from a binary serial channel or file.

Basic examples

Basic examples of the function `ReadStrBin` are illustrated below.

Example 1

```
VAR iodev channel2;
VAR string text;
...
Open "com2:", channel2 \Bin;
text := ReadStrBin (channel2, 10);
text := ReadStrBin(infile,20);
IF text = EOF THEN
```

`text` is assigned a `10` characters text string read from the serial channel referred to by `channel2`

Before using the string read from the file, a check is performed to make sure that the file is not empty.

Return value

Data type: `string`

The text string read from the specified serial channel or file. If the file is empty (end of file), the string `"EOF"` is returned.

Arguments

```
ReadStrBin (IODevice NoOfChars [\Time])
```

`IODevice`

Data type: `iodev`

The name (reference) of the binary serial channel or file to be read.

`NoOfChars`

Number of Characters

Data type: `num`

The number of characters to be read from the binary serial channel or file.

`[\Time]`

Data type: `num`

The max. time for the reading operation (timeout) in seconds. If this argument is not specified, the max. time is set to 60 seconds. To wait forever, use the predefined constant `WAIT_MAX`.

If this time runs out before the read operation is finished, the error handler will be called with the error code `ERR_DEV_MAXTIME`. If there is no error handler, the execution will be stopped.

The timeout function is in use also during program stop and will be noticed by the RAPID program at program start.

Continues on next page

Program execution

The function reads the specified number of characters from the binary serial channel or file.

Limitations

The function can only be used for serial channels or files that have been opened for reading in a binary mode.

Error handling

If an error occurs during reading, the system variable `ERRNO` is set to `ERR_FILEACC`.

If timeout before the read operation is finished, the system variable `ERRNO` is set to `ERR_DEV_MAXTIME`.

These errors can then be dealt with by the error handler.

Predefined data

The constant `EOF` can be used to check if the file was empty, when trying to read from the file or to stop reading at the end of the file.

```
CONST string EOF := "EOF";
```

Syntax

```
ReadStrBin '('
  [IODevice ':='] <variable (VAR) of iodev>','
  [NoOfChars' :='] <expression (IN) of num>
  ['\'Time ':=' <expression (IN) of num>]')'
```

A function with a return value of the type `string`.

Related information

For information about	See
Opening, etc. serial channels or files	*Technical reference manual - RAPID overview*, section *RAPID summary - Communication*
Write binary string	*WriteStrBin - Writes a string to a binary serial channel on page 727*

2.102. ReadVar - Read variable from a device

Usage

`ReadVar` is used to read a variable from a device connected to the serial sensor interface.

The sensor interface communicates with sensors over serial channels using the RTP1 transport protocol.

This is an example of a sensor channel configuration.

COM_PHY_CHANNEL:

- Name “COM1:”
- Connector “COM1”
- Baudrate 19200

COM_TRP:

- Name “sen1:”
- Type “RTP1”
- PhyChannel “COM1”

Basic examples

Basic examples of the function `ReadVar` are illustrated below.

Example 1

```
CONST num XCoord := 8;
CONST num YCoord := 9;
CONST num ZCoord := 10;

VAR pos SensorPos;

! Connect to the sensor device "sen1:" (defined in sio.cfg).
SenDevice "sen1:";

! Read a cartesian position from the sensor.

SensorPos.x := ReadVar ("sen1:", XCoord);
SensorPos.y := ReadVar ("sen1:", YCoord);
SensorPos.z := ReadVar ("sen1:", ZCoord);
```


Continues on next page

Arguments

```
ReadVar (device, VarNo, [ \TaskName ])
```

`device`

Data type: `string`

The I/O device name configured in sio.cfg for the sensor used.

`VarNo`

Data type: `num`

The argument `VarNo` is used to select variable to be read.

`[ \TaskName ]`

Data type: `string`

The argument `TaskName` makes it possible to access devices in other RAPID tasks.

Fault management

Error constant (`ERRNO` value)	Description
`SEN_NO_MEAS`	Measurement failure
`SEN_NOREADY`	Sensor unable to handle command
`SEN_GENERRO`	General sensor error
`SEN_BUSY`	Sensor busy
`SEN_UNKNOWN`	Unknown sensor
`SEN_EXALARM`	External sensor error
`SEN_CAALARM`	Internal sensor error
`SEN_TEMP`	Sensor temperature error
`SEN_VALUE`	Illegal communication value
`SEN_CAMCHECK`	Sensor check failure
`SEN_TIMEOUT`	Communication error

Syntax

```
ReadVar
  [ device ':=' ] < expression(IN) of string>','
  [ VarNo ':=' ] < expression (IN) of num > ','
  [ '\' TaskName' :=' < expression (IN) of string > ] ';'
```

A function with a return value of the data type `num`.

Continues on next page

Related information

For information about	See
Connect to a sensor device	*SenDevice - connect to a sensor device on page 425*
Write a sensor variable	*WriteVar - write variable on page 729*
Write a sensor data block	*WriteBlock - write block of data to device on page 719*
Read a sensor data block	*ReadBlock - read a block of data from device on page 343*
Configuration of sensor communication	*Technical reference manual - RAPID overview*, section *Communication*

2.103. RelTool - Make a displacement relative to the tool

Usage

`RelTool` (*Relative Tool*) is used to add a displacement and/or a rotation, expressed in the active tool coordinate system, to a robot position.

Basic examples

Basic examples of the function `RelTool` are illustrated below.

Example 1

```
MoveL RelTool (p1, 0, 0, 100), v100, fine, tool1;
```

The robot is moved to a position that is `100` mm from `p1` in the z direction of the tool.

Example 2

```
MoveL RelTool (p1, 0, 0, 0 \Rz:= 25), v100, fine, tool1;
```

The tool is rotated 25° around its z-axis.

Return value

Data type: `robtarget`

The new position with the addition of a displacement and/or a rotation, if any, relative to the active tool.

Arguments

```
RelTool (Point Dx Dy Dz [\Rx] [\Ry] [\Rz])
```

`Point`

Data type: `robtarget`

The input robot position. The orientation part of this position defines the current orientation of the tool coordinate system.

`Dx`

Data type: `num`

The displacement in mm in the x direction of the tool coordinate system.

`Dy`

Data type: `num`

The displacement in mm in the y direction of the tool coordinate system.

`Dz`

Data type: `num`

The displacement in mm in the z direction of the tool coordinate system.

`[\Rx]`

Data type: `num`

The rotation in degrees around the x axis of the tool coordinate system.

`[\Ry]`

Data type: `num`

The rotation in degrees around the y axis of the tool coordinate system.

Continues on next page

`[\Rz]`

Data type: `num`

The rotation in degrees around the z axis of the tool coordinate system.

If two or three rotations are specified at the same time, these will be performed first around the x-axis, then around the new y-axis, and then around the new z-axis.

Syntax

```
RelTool'('
  [ Point ':=' ] < expression (IN) of robtarget>','
  [Dx ':='] <expression (IN) of num>','
  [Dy ':='] <expression (IN) of num>','
  [Dz ':='] <expression (IN) of num>
  ['\'Rx ':=' <expression (IN) of num> ]
  ['\'Ry ':=' <expression (IN) of num> ]
  ['\'Rz ':=' <expression (IN) of num> ]')'
```

A function with a return value of the data type `robtarget`.

Related information

For information about	See
Position data	*robtarget - Position data on page 1176*
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Mathematics*
Positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Motion*

2.104. RemainingRetries - Remaining retries left to do

Usage

`RemainingRetries` is used to find out how many `RETRY` that is left to do from the error handler in the program. The maximum number of retries is defined in the configuration.

Basic examples

Basic examples of the function `RemainingRetries` are illustrated below.

Example 1

```
...
ERROR
  IF RemainingRetries() > 0 THEN
    RETRY;
  ELSE
    TRYNEXT;
  ENDIF
...
```

This program will retry the instruction, in spite of the error, until the maximum number of retries is done and then try the next instruction.

Return value

Data type: `num`

The return value shows how many of the maximum number of retries that is left to do.

Syntax

```
RemainingRetries'(''')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Error handlers	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Error Recovery*
Resume execution after an error	*RETRY - Resume execution after an error on page 364*
Configure maximum number of retries	*Technical reference manual - System parameters*, section *System misc*
Reset the number of retries counted	*ResetRetryCount - Reset the number of retries on page 361*

2.105. RMQGetSlotName - Get the name of an RMQ client

Usage

`RMQGetSlotName` (*RAPID Mesasage Queue Get Slot Name*) is used to get the slot name of an RMQ or a Robot Application Builder client from a given slot identity - that is, from a given `rmqslot`.

Basic examples

Basic example of the function `RMQGetSlotName` is illustrated below.

Example 1

```
VAR rmqslot slot;
VAR string client_name;
RMQFindSlot slot, "RMQ_T_ROB1";
...
client_name := RMQGetSlotName(slot);
TPWrite "Name of the client: " + client_name;
```

The example illustrates how to get the name of a client using the identity of the client.

Return value

Data type: `string`

The name of the client is returned. This can be an RMQ name, or the name of a Robot Application Builder client using the RMQ functionality.

Arguments

```
RMQGetSlotName (Slot)
```

`Slot`

Data type: `rmqslot`

The identity slot number of the client to find the name.

Program execution

The instruction `RMQGetSlotName` is used to find the name of the client with the specified identity number specified in argument `Slot`. The client can be another RMQ, or a Robot Application Builder client.

Error handling

Following recoverable errors can be generated. The errors can be handled in an `ERROR` handler. The system variable `ERRNO` will be set to:

`ERR_RMQ_INVALID`	The destination slot has not been connected or the destination slot is no longer available. If not connected, a call to `RMQFindSlot` must be done. If not available, the reason is that a remote client has been disconnected from the controller.

Continues on next page

Syntax

```
RMQGetSlotName'('
  [ Slot ':=' ] < variable (VAR) of rmqslot >')'
```

A function with a return value of the data type `string`.

Related information

For information about	See
Description of the RAPID Message Queue functionality	*Application manual - Robot communication and I/O control*, section *RAPID Message Queue*.
Find the identity number of a RAPID Message Queue task or Robot Application Builder client	*RMQFindSlot - Find a slot identity from the slot name on page 371*
Send data to the queue of a RAPID task or Robot Application Builder client	*RMQSendMessage - Send an RMQ data message on page 386*
Get the first message from a RAPID Message Queue.	*RMQGetMessage - Get an RMQ message on page 373*
Send data to the queue of a RAPID task or Robot Application Builder client, and wait for an answer from the client	*RMQSendWait - Send an RMQ data message and wait for a response on page 390*
Extract the header data from an `rmqmessage`	*RMQGetMsgHeader - Get header information from an RMQ message on page 380*
Extract the data from an `rmqmessage`	*RMQGetMsgData - Get the data part from an RMQ message on page 377*
Order and enable interrupts for a specific data type	*IRMQMessage - Orders RMQ interrupts for a data type on page 167*
`RMQ Slot`	*rmqslot - Identity number of an RMQ client on page 1174*

2.106. RobName - Get the TCP robot name

Usage

`RobName` (*Robot Name*) is used to get the name of the TCP robot in some program task. If the task doesn't control any TCP robot, this function returns an empty string.

Basic examples

Basic examples of the function `RobName` are illustrated below.

See also *More examples on page 966*.

Example 1

```
VAR string my_robot;
...
my_robot := RobName();
IF my_robot="" THEN
  TPWrite "This task does not control any TCP robot";
ELSE
  TPWrite "This task controls TCP robot with name "+ my_robot;
ENDIF
```

Write to FlexPendant the name of the TCP robot which is controlled from this program task. If no TCP robot is controlled, write that the task controls no robot.

Return value

Data type: `string`

The mechanical unit name for the TCP robot that is controlled from this program task. Return empty string if no TCP robot is controlled.

More examples

More examples of how to use the instruction `RobName` are illustrated below.

Example 1

```
VAR string my_robot;
...
IF TaskRunRob() THEN
  my_robot := RobName();
  TPWrite "This task controls robot with name "+ my_robot;
ENDIF
```

If this program task controls any TCP robot, write to FlexPendant the name of that TCP robot.

Syntax

```
RobName '('')'
```

A function with a return value of the data type `string`.

Continues on next page

Related information

For information about	See
Check if task run some TCP robot	*TaskRunRob - Check if task controls some robot on page 1014*
Check if task run some mechanical unit	*TaskRunMec - Check if task controls any mechanical unit on page 1013*
Get the name of mechanical units in the system	*GetNextMechUnit - Get name and data for mechanical units on page 852*
String functions	*Technical reference manual - RAPID Instructions, Functions and Data types*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*

2.107. RobOS - Check if execution is on RC or VC

Usage

`RobOS` (*Robot Operating System*) can be used to check if the execution is performed on Robot Controller RC or Virtual Controller VC.

Basic examples

Basic examples of the function `RobOS` are illustrated below.

Example 1

```
IF RobOS() THEN
  ! Execution statements in RC
ELSE
  ! Execution statements in VC
ENDIF
```

Return value

Data type: `bool`

`TRUE` if execution runs on Robot Controller RC, `FALSE` otherwise.

Syntax

```
RobOS '('')'
```

A function with a return value of the data type `bool`.

2.108. Round - Round is a numeric value

Usage

`Round` is used to round a numeric value to a specified number of decimals or to an integer value.

Basic examples

Basic examples of the function `Round` are illustrated below.

Example 1

```
VAR num val;
val := Round(0.38521\Dec:=3);
```

The variable val is given the value 0.385.

Example 2

```
val := Round(0.38521\Dec:=1);
```

The variable `val` is given the value 0.4.

Example 3

```
val := Round(0.38521);
```

The variable `val` is given the value 0.

Return value

Data type: `num`

The numeric value rounded to the specified number of decimals.

Arguments

```
Round ( Val [\Dec])
```

`Val`

Value

Data type: `num`

The numeric value to be rounded.

`[\Dec]`

Decimals

Data type: `num`

Number of decimals.

If the specified number of decimals is 0 or if the argument is omitted, the value is rounded to an integer.

The number of decimals must not be negative or greater than the available precision for numeric values.

Continues on next page

Syntax

```
Round'('
  [ Val ':=' ] <expression (IN) of num>
  [ \Dec ':=' <expression (IN) of num> ]
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*
Truncating a value	*Trunc - Truncates a numeric value on page 1028*

2.109. RunMode - Read the running mode

Usage

`RunMode` (*Running Mode*) is used to read the current running mode of the program task.

Basic examples

Basic examples of the function `RunMode` are illustrated below.

Example 1

```
IF RunMode() = RUN_CONT_CYCLE THEN
...
ENDIF
```

The program section is executed only for continuous or cycle running.

Return value

Data type: `symnum`

The current running mode is defined as described in the table below.

Return value	Symbolic constant	Comment
0	RUN_UNDEF	Undefined running mode
1	RUN_CONT_CYCLE	Continuous or cycle running mode
2	RUN_INSTR_FWD	Instruction forward running mode
3	RUN_INSTR_BWD	Instruction backward running mode
4	RUN_SIM	Simulated running mode. Not yet released.
5	RUN_STEP_MOVE	Move instructions in forward running mode and logical instructions in continuous running mode

Arguments

```
RunMode ( [ \Main] )
```

`[ \Main ]`

Data type: `switch`

Return current mode for the task if it is a motion task. If used in a non-motion task, it will return the current mode of the motion task that the non-motion task is connected to.

If this argument is omitted, the return value always mirrors the current running mode for the program task which executes the function `RunMode`.

Syntax

```
RunMode '(' ['\'Main] ')'
```

A function with a return value of the data type `symnum`.

Related information

For information about	See
Reading operating mode	*OpMode - Read the operating mode on page 908*

2.110. Sin - Calculates the sine value

Usage

`Sin` (*Sine*) is used to calculate the sine value from an angle value.

Basic examples

Basic examples of the function `Sin` are illustrated below.

Example 1

```
VAR num angle;
VAR num value;
...
...
value := Sin(angle);
```

`value` will get the sine value of `angle`.

Return value

Data type: `num`

The sine value, range [-1, 1] .

Arguments

```
Sin (Angle)
```

`Angle`

Data type: `num`

The angle value, expressed in degrees.

Syntax

```
Sin'('
  [Angle':='] <expression (IN) of num>
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Mathematics*

2.111. SocketGetStatus - Get current socket state

Usage

`SocketGetStatus` returns the current state of a socket.

Basic examples

Basic examples of the function `SocketGetStatus` are illustrated below.

See also *More examples on page 974*.

Example 1

```
VAR socketdev socket1;
VAR socketstatus state;
...
SocketCreate socket1;
state := SocketGetStatus( socket1 );
```

The socket status `SOCKET_CREATED` will be stored in the variable `state`.

Return value

Data type: `socketstatus`

The current state of the socket.

Only the predefined symbolic constants of type `socketstatus` can be used to check the state.

Arguments

```
SocketGetStatus( Socket )
```

`Socket`

Data type: `socketdev`

The socket variable which state is of interest.

Program execution

The function returns one of the following predefined states of socketstatus: `SOCKET_CREATED`, `SOCKET_CONNECTED`, `SOCKET_BOUND`, `SOCKET_LISTENING` or `SOCKET_CLOSED`.

Continues on next page

More examples

More examples of the function `SocketGetStatus` are illustrated below.

```
VAR socketstatus status;
VAR socketdev my_socket;
...
SocketCreate my_socket;
SocketConnect my_socket, "192.168.0.1", 1025;
! A lot of RAPID code
status := SocketGetStatus( my_socket );
!Check which instruction that was executed last, not the state of
!the socket
IF status = SOCKET_CREATED THEN
  TPWrite "Instruction SocketCreate has been executed";
ELSEIF status = SOCKET_CLOSED THEN
  TPWrite "Instruction SocketClose has been executed";
ELSEIF status = SOCKET_BOUND THEN
  TPWrite "Instruction SocketBind has been executed";
ELSEIF status = SOCKET_LISTENING THEN
  TPWrite "Instruction SocketListen or SocketAccept has been
       executed";
ELSEIF status = SOCKET_CONNECTED THEN
  TPWrite "Instruction SocketConnect, SocketReceive or SocketSend
       has been executed";
ELSE
  TPWrite "Unknown socket status";
ENDIF
```

A client socket is created and connected to a remote computer. Before the socket is used in a `SocketSend` instruction the state of the socket is checked so that it is still connected.

Limitations

The state of a socket can only be changed by executing RAPID socket instruction. E.g. if the socket is connected and later the connection is broken, this will not be reported by the `SocketGetStatus` function. Instead there will be an error returned when the socket is used in a `SocketSend` or `SocketReceive` instruction.

Syntax

```
SocketGetStatus  '('
[ Socket ´:=´ ] < variable (VAR) of socketdev > ')'
```

A function with a return value of the data type `socketstatus`.

Continues on next page

Related information

For information about	See
Socket communication in general	*Application manual - Robot communication and I/O control*
Create a new socket	*SocketCreate - Create a new socket on page 460*
Connect to remote computer (only client)	*SocketConnect - Connect to a remote computer on page 457*
Send data to remote computer	*SocketSend - Send data to remote computer on page 469*
Receive data from remote computer	*SocketReceive - Receive data from remote computer on page 464*
Close the socket	*SocketClose - Close a socket on page 455*
Bind a socket (only server)	*SocketBind - Bind a socket to my IP-address and port on page 453*
Listening connections (only server)	*SocketListen - Listen for incoming connections on page 462*
Accept connections (only server)	*SocketAccept - Accept an incoming connection on page 450*

2.112. Sqrt - Calculates the square root value

Usage

`Sqrt` (*Square root*) is used to calculate the square root value.

Basic examples

Basic examples of the function `Sqrt` are illustrated below.

Example 1

```
VAR num x_value;
VAR num y_value;
...
...
y_value := Sqrt( x_value);
```

`y-value` will get the square root value of `x_value`, i.e. √(`x_value`).

Return value

Data type: `num`

The square root value (√).

Arguments

```
Sqrt (Value)
```

`Value`

Data type: `num`

The argument value for square root, i.e. √`value`.

`Value` needs to be ≥ 0.

Limitations

The execution of the function `Sqrt(x)` will give an error if `x` < 0.

Syntax

```
Sqrt'('
  [Value':='] <expression (IN) of num>
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*

2.113. STCalcForce - Calculate the tip force for a Servo Tool

Usage

`STCalcForce` is used to calculate the tip force for a Servo Tool. This function is used, for example, to find the max allowed tip force for a servo tool.

Basic examples

Basic examples of the function `STCalcForce` are illustrated below.

Example 1

```
VAR num tip_force;

tip_force := STCalcForce(gun1, 7);
```

Calculate the tip force when the desired motor torque is `7` Nm.

Return Value

Data type: `num`

The calculated tip force [N].

Arguments

```
STCalcForce (ToolName MotorTorque)
```

`ToolName`

Data type: `string`

The name of the mechanical unit.

`MotorTorque`

Data type: `num`

The desired motor torque [Nm].

Error handling

If the specified servo tool name is not a configured servo tool, the system variable `ERRNO` is set to `ERR_NO_SGUN`.

The error can be handled in a Rapid error handler.

Syntax

```
STCalcForce
  [ 'ToolName ':=' ] < expression (IN) of string > ´,´
  [ 'MotorTorque' :=' ] < expression (IN) of num > ´;´
```

A function with a return value of the data type num.

Continues on next page

Related information

For information about	See
Open a servo tool	*STOpen - Open a Servo Tool on page 513*
Close a servo tool	*STClose - Close a Servo Tool on page 496*
Calculate the motor torque	*STCalcTorque - Calc. the motor torque for a servo tool on page 979*

2.114. STCalcTorque - Calc. the motor torque for a servo tool

Usage

`STCalcTorque` is used to calculate the motor torque for a Servo Tool. This function is used, for example, when a force calibration is performed.

Basic examples

Basic examples of the function `STCalcTorque` are illustrated below.

Example 1

```
VAR num curr_motortorque;

curr_motortorque := STCalcTorque( gun1, 1000);
```

Calculate the motor torque when the desired tip force is `1000` N.

Return value

Data type: `num`

The calculated motor torque [Nm].

Arguments

```
STCalcTorque (ToolName TipForce)
```

`ToolName`

Data type: `string`

The name of the mechanical unit.

`TipForce`

Data type: `num`

The desired tip force [N].

Error handling

If the specified servo tool name is not a configured servo tool, the system variable `ERRNO` is set to `ERR_NO_SGUN`.

The error can be handled in a Rapid error handler.

Syntax

```
STCalcTorque
  [ 'ToolName ':=' ] < expression (IN) of string > ´,´
  [' TipForce' :=' ] < expression (IN) of num > ';'
```

A function with a return value of the data type `num`.

Continues on next page

Related information

For information about	See
Open a servo tool	*STOpen - Open a Servo Tool on page 513*
Close a servo tool	*STClose - Close a Servo Tool on page 496*
Calculate the tip force	*STCalcForce - Calculate the tip force for a Servo Tool on page 977*

2.115. STIsCalib - Tests if a servo tool is calibrated

Usage

`STIsCalib` is used to test if a servo tool is calibrated - that is, check if the gun tips are calibrated or synchronized.

Basic examples

Basic examples of the function `STIsCalib` are illustrated below.

Example 1

```
IF STIsCalib(gun1\sguninit) THEN
  ...
ELSE
  !Start the gun calibration
  STCalib gun1\TipChg;
ENDIF
```

Example 2

```
IF STIsCalib(gun1\sgunsynch) THEN
  ...
ELSE
  !Start the gun calibration to synchronize the gun position with
       the revolution counter
  STCalib gun1\ToolChg;
ENDIF
```

Return value

Data type: `bool`

`TRUE` if the tested tool is calibrated - that is, the distance between the tool tips is calibrated, or if the tested tool is synchronized - that is, the position of the tool tips is synchronized with the revolution counter of the tool.

`FALSE` if the tested tool is not calibrated or synchronized.

Arguments

```
STIsCalib(ToolName [ \sguninit ] | [ \sgunsynch ])
```

`ToolName`

Data type: `string`

The name of the mechanical unit.

`[ \sguninit ]`

Data type: `switch`

This argument is used to check if the gun position is initialized and calibrated.

`[ \sgunsynch ]`

Data type: `switch`

This argument is used to check if the gun position is synchronized with the revolution counter.

Continues on next page

Syntax

```
STIsCalib´(´
  [ ´ToolName ´:=´ ] < expression (IN) of string >
  [ ´\´sguninit ] | [ ´\´sgunsynch ] ´)´
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Calibrating a servo tool	*STCalib - Calibrate a Servo Tool on page 492*

2.116. STIsClosed - Tests if a servo tool is closed

Usage

`STIsClosed` is used to test if a servo tool is closed.

Basic examples

Basic examples of the instruction `STIsClosed` are illustrated below.

Example 1

```
IF STIsClosed(gun1) THEN
  !Start the weld process
  Set weld_start;
ELSE
  ...
ENDIF
```

Check if the gun is closed or not.

Example 2

```
STClose "sgun", 1000, 3 \Conc;
WHILE NOT(STIsClosed("sgun"\RetThickness:=thickness)) DO
  WaitTime 0.1;

ENDWHILE
IF thickness > max_thickness THEN...
```

Start to close the gun named `sgun`. Continue immediately with the next instruction in which the program waits for the gun to be closed. Read the achieved thickness value when the instruction `STIsClosed` has returned `TRUE`.

Example 3

Examples of non valid combinations:

```
STClose "sgun", 1000, 3 \RetThickness:=thickness \Conc;
WHILE NOT(STIsClosed("sgun"\RetThickness:=thickness_2)) DO;
...
```

Close the gun. The parameter thickness will **not** hold any valid value since the `\Conc` switch is used. Wait until the gun is closed. When the gun is closed and `STIsClosed` returns `TRUE`, the parameter thickness_2 will hold a valid value since the `\Conc` switch was used for the `STClose`.

```
STClose "sgun", 1000, 3 \RetThickness:=thickness;
WHILE NOT(STIsClosed("sgun"\RetThickness:=thickness_2)) DO;
...
```

Close the gun. The parameter thickness will hold a valid value when the gun has been closed since the `\Conc` switch is not used. The parameter thickness_2 will not hold any valid value since the `\Conc` switch was not used in the `STClose` instruction.

Continues on next page

Return value

Data type: `bool`

TRUE if the tested tool is closed, i.e. the desired tip force is achieved.

FALSE if the tested tool is not closed.

Arguments

```
STIsClosed (ToolName)
```

`ToolName`

Data type: `string`

The name of the mechanical unit.

`[\RetThickness]`

Data type: `num`

The achieved thickness [mm].

NOTE! Only valid if `\Conc` has been used in a preceding `STClose` instruction.

Syntax

```
STIsClosed'('
  [ 'ToolName ':=' ] < expression (IN) of string > ')'
  ['\'' RetThickness' :=' < variable or persistent (INOUT) of num
       > ]
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Open a servo tool	*STOpen - Open a Servo Tool on page 513*
Close a servo tool	*STClose - Close a Servo Tool on page 496*
Test if a servo tool is open	*STIsOpen - Tests if a servo tool is open on page 986*

2.117. STIsIndGun - Tests if a servo tool is in independent mode

Usage

`STIsIndGun` is used to test if a servo tool is in independent mode.

Basic examples

Basic example of the function `STIsIndGun` is illustrated below.

Example 1

```
IF STIsIndGun(gun1) THEN
  Start the gun calibration
  STCalib gun1\???????;
ELSE
  ...
ENDIF
```

Return value

Data type: `bool`

`TRUE` if the tested tool is in independent mode - that is, the gun can be moved independently of the robot movements.

`FALSE` if the tested tool is *not* in independent mode.

Arguments

```
STIsIndGun(ToolName)
```

`ToolName`

Data type: `string`

The name of the mechanical unit.

Syntax

```
STIsIndGun´(´
  [ ´ToolName ´:=´ ] < expression (IN) of string > ´)´
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Calibrating a servo tool	*STCalib - Calibrate a Servo Tool on page 492*
Setting the gun in independent mode	*STIndGun - Sets the gun in independent mode on page 501*
Resetting the gun from independent mode	*STIndGunReset - Resets the gun from independent mode on page 503*

2.118. STIsOpen - Tests if a servo tool is open

Usage

`STIsOpen` is used to test if a servo tool is open.

Basic examples

Basic examples of the instruction `STIsOpen` are illustrated below.

Example 1

```
IF STIsOpen(gun1) THEN
  !Start the motion
  MoveL ...
ELSE
  ...
ENDIF
```

Check if the gun is open or not.

Example 2

```
STCalib "sgun" \TipWear \Conc;§
WHILE NOT(STIsOpen("sgun") \RetTipWear:=tipwear
      \RetPosAdj:=posadj) DO;
WaitTime 0.1;

ENDWHILE
```

IF tipwear > 20...

IF posadj > 25...

Perform a tip wear calibration. Wait until the gun `sgun` is open. Read the tip wear and positional adjustment values.

Example 3

Examples of non valid combinations:

```
STCalib "sgun" \TipWear \RetTipWear:=tipwear_1 \Conc;
WHILE NOT(STIsOpen("sgun") \RetTipWear:=tipwear_2) DO;
  WaitTime 0.1;

ENDWHILE
```

Start a tip wear calibration. The parameter `tipwear_1` will **not** hold any valid value since the `\Conc` switch is used. When the calibration is ready and the `STIsOpen` returns `TRUE`, the parameter `tipwear_2` will hold a valid value.

```
STCalib "sgun" \TipWear \RetTipWear:=tipwear_1;

WHILE NOT(STIsOpen("sgun") \RetTipWear:=tipwear_2) DO;
  WaitTime 0.1;

ENDWHILE
```


Continues on next page

Perform a tip wear calibration. The parameter `tipwear_1` will hold a valid value since the `\Conc` switch is not used. When `STIsOpen` returns `TRUE`, the parameter `tipwear_2` will not hold any valid value since the `\Conc` switch was not used in `STCalib`.

Return value

Data type: `bool`

`TRUE` if the tested tool is open, i.e. the tool arm is in the programmed open position.

`FALSE` if the tested tool is not open.

Arguments

```
STIsOpen (ToolName)
```

`ToolName`

Data type: `string`

The name of the mechanical unit.

`[\RetTipWear]`

Data type: `num`

The achieved tip wear [mm].

NOTE! Only valid if `\Conc` has been used in a preceding `STCalib` instruction and if `STIsOpen` returns `TRUE`.

`[\RetPosAdj]`

Data type: `num`

The positional adjustment since the last calibration [mm].

NOTE! Only valid if `\Conc` has been used in a preceding `STCalib` instruction and if `STIsOpen` returns `TRUE`.

Syntax

```
STIsOpen'('
  [ 'ToolName ':=' ] < expression (IN) of string > ')'
  [' \'RetTipWear' :=' < variable or persistent(INOUT) of num >
      ]';'
  [ '\'RetPosAdj' :=' < variable or persistent(INOUT) of num > ]
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Open a servo tool	*STOpen - Open a Servo Tool on page 513*
Close a servo tool	*STClose - Close a Servo Tool on page 496*
Test if a servo tool is closed	*STIsClosed - Tests if a servo tool is closed on page 983*

2.119. StrDigCalc - Arithmetic operations with datatype stringdig

Usage

`StrDigCalc` is used to perform arithmetic operations (+, -, *, /, %) on two positive digit strings in the same way as numeric arithmetic operations on positive integer values.

This function can handle positive integers above 8 388 608 with exact representation.

Basic examples

Basic examples of the function `StrDigCalc` are illustrated below.

See also *More examples on page 989*.

Example 1

```
res := StrDigCalc(str1, OpAdd, str2);
```

`res` is assigned the result of the addition operation on the values represented by the digital strings `str1` and `str2`.

Return value

Data type: `stringdig`

`stringdig` is used to represent big positive integers in a string with only digits.

This data type is introduced because the data type `num` cannot handle positive integers above 8 388 608 with exact representation.

Arguments

```
StrDigCalc (StrDig1 Operation StrDig2)
```

`StrDig1`

String Digit 1

Data type: `stringdig`

String representing a positive integer value.

`Operation`

Arithmetic operator

Data type: `opcalc`

Defines the arithmetic operation to perform on the two digit strings. Following arithmetic operatons of data type `opcalc` can be used; `OpAdd, OpSub, OpMult, OpDiv` and `OpMod`.

`StrDig2`

String Digit 2

Data type: `stringdig`

String representing a positive integer value.

Continues on next page

Program execution

This function will:

- Check only digits 0...9 in `StrDig1` and `StrDig2`
- Convert the two digital strings to `long integers`
- Perform an arithmetic operation on the two `long integers`
- Convert the result from `long integer` to `stringdig`

More examples

More examples of how to use the function `StrDigCalc` are illustrated below.

Example 1

```
res := StrDigCalc(str1, OpSub, str2);
```

`res` is assigned the result of the substration operation on the values represented by the digital strings `str1` and `str2`.

Example 2

```
res := StrDigCalc(str1, OpMult, str2);
```

`res` is assigned the result of the multiplication operartion on the values represented by the digital strings `str1` and `str2`.

Example 3

```
res := StrDigCalc(str1, OpDiv, str2);
```

`res` is assigned the result of the division operation on the values represented by the digital strings `str1` and `str2`.

Example 4

```
res := StrDigCalc(str1, OpMod, str2);
```

`res` is assigned the result of the modulus operation on the values represented by the digital strings `str1` and `str2`.

Error handling

The following errors can be handled in a Rapid error handler.

Error code	Description
`ERR_INT_NOTVAL`	Input values not only digits or modulus by zero
`ERR_INT_MAXVAL`	Input value above 4294967295
`ERR_CALC_OVERFLOW`	Result out of range 0...4294967295
`ERR_CALC_NEG`	Negative substraction i.e. StrDig2 > StrDig1
`ERR_CALC_DIVZERO`	Division by zero

Limitations

`StrDigCalc` only accepts strings that contain digits (characters 0...9). All other characters in `stringdig` will result in error.

This function can only handle positive integers up to 4 294 967 295.

Continues on next page

Syntax

```
StrDigCalc'('
  [ StrDig1 ':=' ] < expression (IN) of stringdig > ','
  [ Operation' :=' ] < expression (IN) of opcalc > ','
  [ StrDig2' :=' ] < expression (IN) of stringdig > ')'
```

A function with a return value of the data type `stringdig`.

Related information

For information about	See
Strings with only digits.	*stringdig - String with only digits on page 1197*
Arithmetic operators.	*opcalc - Arithmetic Operator on page 1148*

2.120. StrDigCmp - Compare two strings with only digits

Usage

`StrDigCmp` is used to compare two positive digit strings in the same way as numeric compare of positive integers.

This function can handle positive integers above 8 388 608 with exact representation.

Basic examples

Basic examples of the function `StrDigCmp` are illustrated below.

Example 1

```
VAR stringdig digits1 := "1234";
VAR stringdig digits2 := "1256";
VAR bool is_equal;
is_equal := StrDigCmp(digits1, EQ, digits2);
```

The variable `is_equal` will be set to `FALSE`, because the numeric value `1234` is not equal to `1256`.

Example 2

```
CONST string file_path := "...";
CONST string mod_name := "...";
VAR num num_file_time:
VAR stringdig dig_file_time;
VAR num num_mod_time;
VAR stringdig dig_mod_time;
...
num_file_time := FileTime(file_path, \ModifyTime,
     \StrDig:=dig_file_time);
num_mod_time := ModTime(mod_name,\StrDig:=dig_mod_time);
IF StrDigCmp(dig_file_time, GT, dig_mod_time) THEN
  ! Load the new program module
ENDIF
```

Both `FileTime` and `ModTime` returns number of seconds since `00:00:00 GMT jan 1 1970` which cannot be represented with exact representation in a `num` variable. Because of this limitation, function `StrDigCmp` and data type `stringdig` are used.

In variable `dig_file_time`, the last modified time of the module file on disk is stored. In variable `dig_mod_time`, the last modify time of the file for the same module before it was loaded into the program memory in the controller is stored. Compare of the two digit strings, show that the module on the disk is newer, so it should be loaded into the program memory.

Return value

Data type: `bool`

TRUE if the given condition is met, FALSE if not.

Continues on next page

Arguments

```
StrDigCmp (StrDig1 Relation StrDig2)
```

`StrDig1`

String Digit 1

Data type: `stringdig`

The first string with only digits to be numerical compared.

`Relation`

Data type: `opnum`

Defines how to compare the two digit strings. Following predefined constants of data type `opnum` can be used `LT, LTEQ, EQ, NOTEQ, GTEQ` or `GT`.

`StrDig2`

String Digit 2

Data type: `stringdig`

The second string with only digits to be numerical compared.

Program execution

This function will:

- Check that only digits 0...9 are used in `StrDig1` and `StrDig2`
- Convert the two digital strings to `long integers`
- Numerically compare the two `long integers`

Error handling

The following errors can be handled in a Rapid error handler.

Error code	Description
`ERR_INT_NOTVAL`	Input values not only digits
`ERR_INT_MAXVAL`	Value above 4294967295

Limitations

`StrDigCmp` only accepts strings that contain digits (characters 0...9). All other characters in `stringdig` will result in error.

This function can only handle positive integers up to 4 294 967 295.

Syntax

```
StrDigCmp'('
  [ StrDig1 ':=' ] < expression (IN) of stringdig > ','
  [ Relation' :=' ] < expression (IN) of opnum > ','
  [ StrDig2' :=' ] < expression (IN) of stringdig > ')'
```

A function with a return value of the data type `bool`.

Continues on next page

Related information

For information about	See
String with only digits	*stringdig - String with only digits on page 1197*
Comparison operators	*opnum - Comparison operator on page 1149*
File time information	*FileTime - Retrieve time information about a file on page 845*
File modify time of the loaded module	*ModTime - Get file modify time for the loaded module on page 896*

2.121. StrFind - Searches for a character in a string

Usage

`StrFind` (*String Find*) is used to search in a string, starting at a specified position, for a character that belongs to a specified set of characters.

Basic examples

Basic examples of the function `StrFind` are illustrated below.

Example 1

```
VAR num found;
found := StrFind("Robotics",1,"aeiou");
```

The variable `found` is given the value 2.

```
found := StrFind("Robotics",1,"aeiou"\NotInSet);
```

The variable `found` is given the value 1

```
found := StrFind("IRB 6400",1,STR_DIGIT);
```

The variable `found` is given the value 5.

```
found := StrFind("IRB 6400",1,STR_WHITE);
```

The variable `found` is given the value `4`.

Return value

Data type: `num`

The character position of the first character at or past the specified position that belongs to the specified set. If no such character is found, string length +1 is returned.

Arguments

```
StrFind (Str ChPos Set [\NotInSet])
```

`Str`

String

Data type: `string`

The string to search in.

`ChPos`

Character Position

Data type: `num`

Start character position. A runtime error is generated if the position is outside the string.

`Set`

Data type: `string`

Set of characters to test against. See also *Predefined data on page 995*.

`[\NotInSet]`

Data type: `switch`

Search for a character not in the set of characters presented in `Set`.

Continues on next page

Syntax

```
StrFind'('
  [ Str ':=' ] <expression (IN) of string> ','
  [ ChPos ':=' ] <expression (IN) of num> ','
  [ Set ':=' ] <expression (IN) of string>
  ['\'NotInSet ]
  ')'
```

A function with a return value of the data type `num`.

Predefined data

A number of predefined string constants are available in the system and can be used together with string functions.

Name	Character set
`STR_DIGIT`	<digit> ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
`STR_UPPER`	<upper case letter> ::= A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | À | Á | Â | Ã | Ä | Å | Æ | Ç | È | É | Ê | Ë | Ì | Í | Î | Ï | 1)| Ñ | Ò | Ó | Ô | Õ | Ö | Ø | Ù | Ú | Û | Ü | 2) | 3)
`STR_LOWER`	<lower case letter> ::= a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z | à | á | â | ã | ä | å | æ | ç | è | é | ê | ë | ì | í | î | ï | 1) | ñ | ò | ó | ô | õ | ö | ø | ù | ú | û | ü | 2) | 3) | ß | ÿ-
`STR_WHITE`	<blank character> ::=

Related information

For information about	See
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*

2.122. StrLen - Gets the string length

Usage

`StrLen` (*String Length*) is used to find the current length of a string.

Basic examples

Basic examples of the function `StrLen` are illustrated below.

Example 1

```
VAR num len;
len := StrLen("Robotics");
```

The variable `len` is given the value `8`.

Return value

Data type: `num`

The number of characters in the string (>=0).

Arguments

```
StrLen (Str)
```

`Str`

String

Data type: `string`

The string in which the number of characters is to be counted.

Syntax

```
StrLen'('
  [ Str ':=' ] <expression (IN) of string>' )'
```

A function with a return value of the data type `num`.

Related information

For information about	See
String functions	*Technical reference manual - RAPID Instructions, Functions and Data types*, section *RAPID summary - String Functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID Instructions, Functions and Data types*, section *Basic characteristics - Basic elements*

2.123. StrMap - Maps a string

Usage

`StrMap` (*String Mapping*) is used to create a copy of a string in which all characters are translated according to a specified mapping.

Basic examples

Basic examples of the function `StrMap` are illustrated below.

Example 1

```
VAR string str;
str := StrMap("Robotics","aeiou","AEIOU");
```

The variable `str` is given the value "`RObOtIcs`".

Example 2

```
str := StrMap("Robotics",STR_LOWER, STR_UPPER);
```

The variable `str` is given the value "`ROBOTICS`".

Return value

Data type: `string`

The string created by translating the characters in the specified string, as specified by the "from" and "to" strings. Each character from the specified string that is found in the "from" string is replaced by the character at the corresponding position in the "to" string. Characters for which no mapping is defined are copied unchanged to the resulting string.

Arguments

```
StrMap ( Str FromMap ToMap)
```

`Str`

String

Data type: `string`

The string to translate.

`FromMap`

Data type: `string`

Index part of mapping. See also *Predefined data on page 998*.

`ToMap`

Data type: `string`

Value part of mapping. See also *Predefined data on page 998*.

Syntax

```
StrMap'('
  [ Str ':=' ] <expression (IN) of string> ´,´
  [ FromMap':=' ] <expression (IN) of string> ´,´
  [ ToMap':=' ] <expression (IN) of string>
  ')'
```

A function with a return value of the data type `string`.

Continues on next page

Predefined data

A number of predefined string constants are available in the system and can be used together with string functions.

Name	Character set
`STR_DIGIT`	<digit> ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
`STR_UPPER`	<upper case letter> ::= A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | À | Á | Â | Ã | Ä | Å | Æ | Ç | È | É | Ê | Ë | Ì | Í | Î | Ï | 1)| Ñ | Ò | Ó | Ô | Õ | Ö | Ø | Ù | Ú | Û | Ü | 2) | 3)
`STR_LOWER`	<lower case letter> ::= a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z | à | á | â | ã | ä | å | æ | ç | è | é | ê | ë | ì | í | î | ï | 1) | ñ | ò | ó | ô | õ | ö | ø | ù | ú | û | ü | 2) | 3) | ß | ÿ-
`STR_WHITE`	<blank character> ::=

Related information

For information about	See
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*

2.124. StrMatch - Search for pattern in string

Usage

`StrMatch` (*String Match*) is used to search in a string, starting at a specified position, for a specified pattern.

Basic examples

Basic examples of the function `StrMatch` are illustrated below.

Example 1

```
VAR num found;

found := StrMatch("Robotics",1,"bo");
```

The variable `found` is given the value `3`.

Return value

Data type: `num`

The character position of the first substring, at or past the specified position, that is equal to the specified pattern string. If no such substring is found, string length +1 is returned.

Arguments

```
StrMatch (Str ChPos Pattern)
```

`Str`

String

Data type: `string`

The string to search in.

`ChPos`

Character Position

Data type: `num`

Start character position. A runtime error is generated if the position is outside the string.

`Pattern`

Data type: `string`

Pattern string to search for.

Syntax

```
StrMatch'('
  [ Str ':=' ] <expression (IN) of string>´,´
  [ ChPos ':=' ] <expression (IN) of num> ´,´
  [ Pattern':=' ] <expression (IN) of string>
  ´)´
```

A function with a return value of the data type `num`.

Continues on next page

Related information

For information about	See
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*

2.125. StrMemb - Checks if a character belongs to a set

Usage

`StrMemb` (*String Member*) is used to check whether a specified character in a string belongs to a specified set of characters.

Basic examples

Basic examples of the function `StrMemb` are illustrated below.

Example 1

```
VAR bool memb;
memb := StrMemb("Robotics",2,"aeiou");
```

The variable `memb` is given the value `TRUE`, as `o` is a member of the set `"aeiou"`.

```
memb := StrMemb("Robotics",3,"aeiou");
```

The variable `memb` is given the value `FALSE`, as `b` is not a member of the set `"aeiou"`.

```
memb := StrMemb("S-721 68 VÄSTERÅS",3,STR_DIGIT);
```

The variable `memb` is given the value `TRUE`, as `7` is a member of the set `STR_DIGIT`.

Return value

Data type: `bool`

`TRUE` if the character at the specified position in the specified string belongs to the specified set of characters.

Arguments

```
StrMemb (Str ChPos Set)
```

`Str`

String

Data type: `string`

The string to check in.

`ChPos`

Character Position

Data type: `num`

The character position to check. A runtime error is generated if the position is outside the string.

`Set`

Data type: `string`

Set of characters to test against.

Continues on next page

Syntax

```
StrMemb'('
  [ Str ':=' ] <expression (IN) of string> ','
  [ ChPos ':=' ] <expression (IN) of num> ','
  [ Set ':=' ] <expression (IN) of string>
  ')'
```

A function with a return value of the data type `bool`.

Predefined data

A number of predefined string constants are available in the system and can be used together with string functions.

Name	Character set
`STR_DIGIT`	<digit> ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
`STR_UPPER`	<upper case letter> ::= A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | À | Á | Â | Ã | Î | Ï | 1)| Ñ | Ò | Ó | Ô | Õ | Ö | Ø | Ù | Ú | Û | Ü | 2) | 3)
`STR_LOWER`	<lower case letter> ::= a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z | à | á | â | ã | ä | å | æ | ç | è | é | ê | ë | ì | í | î | ï | 1) | ñ | ò | ó | ô | õ | ö | ø | ù | ú | û | ü | 2) | 3) | ß | ÿ-
`STR_WHITE`	<blank character> ::=

Related information

For information about	See
String functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - String Functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*

2.126. StrOrder - Checks if strings are ordered

Usage

`StrOrder` (*String Order*) compares two strings (character by character) and returns a boolean indicating whether the two strings are in order according to a specified character ordering sequence.

Basic examples

Basic examples of the function `StrOrder` are illustrated below.

Example 1

```
VAR bool le;

le := StrOrder("FIRST","SECOND",STR_UPPER);
```

The variable `le` is given the value `TRUE`, because "`F`" comes before "`S`" in the character ordering sequence `STR_UPPER`.

Example 2

```
VAR bool le;

le := StrOrder("FIRST","FIRSTB",STR_UPPER);
```

The variable `le` is given the value `TRUE`, because `Str2 "FIRSTB"` has an additional character in the character ordering sequence (no character compared to `"B"`).

Example 3

```
VAR bool le;

le := StrOrder("FIRSTB","FIRST",STR_UPPER);
```

The variable `le` is given the value `FALSE`, because `Str1 "FIRSTB"` has an additional character in the character ordering sequence (`"B"` compared to no character).

Return value

Data type: `bool`

`TRUE` if the first string comes before the second string (`Str1` <= `Str2`) when characters are ordered as specified.

Characters that are not included in the defined ordering are all assumed to follow the present ones.

Arguments

```
StrOrder ( Str1 Str2 Order)
```

`Str1`

String 1

Data type: `string`

First string value.

Continues on next page

`Str2`

String 2

Data type: `string`

Second string value.

`Order`

Data type: `string`

Sequence of characters that define the ordering. See also *Predefined data on page 1004*.

Syntax

```
StrOrder'('
  [ Str1 ':=' ] <expression (IN) of string> ´,´
  [ Str2 ':=' ] <expression (IN) of string> ´,´
  [ Order ':=' ] <expression (IN) of string>
  ')'
```

A function with a return value of the data type `bool`.

Predefined data

A number of predefined string constants are available in the system and can be used together with string functions.

Name	Character set
STR_DIGIT	<digit> ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
STR_UPPER	<upper case letter> ::= A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | À | Á | Â | Ã | Ä | Å | Æ | Ç | È | É | Ê | Ë | Ì | Í | Î | Ï | 1)| Ñ | Ò | Ó | Ô | Õ | Ö | Ø | Ù | Ú | Û | Ü | 2) | 3)
STR_LOWER	<lower case letter> ::= a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z | à | á | â | ã | ä | å | æ | ç | è | é | ê | ë | ì | í | î | ï | 1) | ñ | ò | ó | ô | õ | ö | ø | ù | ú | û | ü | 2) | 3) | ß | ÿ-
STR_WHITE	<blank character> ::=

Related information

For information about	See
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*

2.127. StrPart - Finds a part of a string

Usage

`StrPart` (*String Part)* is used to find a part of a string, as a new string.

Basic examples

Basic examples of the function `StrPart` are illustrated below.

Example 1

```
VAR string part;
part := StrPart("Robotics",1,5);
```

The variable `part` is given the value `"Robot"`.

Return value

Data type: `string`

The substring of the specified string which has the specified length and starts at the specified character position.

Arguments

```
StrPart (Str ChPos Len)
```

`Str`

String

Data type: `string`

The string in which a part is to be found.

`ChPos`

Character Position

Start character position. A runtime error is generated if the position is outside the string.

`Len`

Length

Data type: `num`

Length of string part. A runtime error is generated if the length is negative or greater than the length of the string, or if the substring is (partially) outside the string.

Syntax

```
StrPart'('
[ Str ':=' ] <expression (IN) of string> ','
[ ChPos ':=' ] <expression (IN) of num> ','
[ Len ':=' ] <expression (IN) of num>
')'
```

A function with a return value of the data type `string`.

Continues on next page

Related information

For information about	See
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String Functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*

2.128. StrToByte - Converts a string to a byte data

Usage

`StrToByte` (*String To Byte*) is used to convert a string with a defined byte data format into a byte data.

Basic examples

Basic examples of the function `StrToByte` are illustrated below.

Example 1

```
VAR string con_data_buffer{5} := ["10", "AE", "176", "00001010",
     "A"];
VAR byte data_buffer{5};

data_buffer{1} := StrToByte(con_data_buffer{1});
```

The content of the array component `data_buffer{1}` will be 10 decimal after the `StrToByte ...` function.

```
data_buffer{2} := StrToByte(con_data_buffer{2}\Hex);
```

The content of the array component `data_buffer{2}` will be 174 decimal after the `StrToByte ...` function.

```
data_buffer{3} := StrToByte(con_data_buffer{3}\Okt);
```

The content of the array component `data_buffer{3}` will be 126 decimal after the `StrToByte ...` function.

```
data_buffer{4} := StrToByte(con_data_buffer{4}\Bin);
```

The content of the array component `data_buffer{4}` will be 10 decimal after the `StrToByte ...` function.

```
data_buffer{5} := StrToByte(con_data_buffer{5}\Char);
```

The content of the array component `data_buffer{5}` will be 65 decimal after the `StrToByte ...` function.

Return value

Data type: `byte`

The result of the conversion operation in decimal representation.

Arguments

```
StrToByte (ConStr [\Hex] | [\Okt] | [\Bin] | [\Char])
```

`ConStr`

Convert String

Data type: `string`

The string data to be converted.

If the optional switch argument is omitted, the string to be converted has `decimal` (Dec) format.

Continues on next page

`[\Hex]`

Hexadecimal

Data type: `switch`

The string to be converted has `hexadecimal` format.

`[\Okt]`

Octal

Data type: `switch`

The string to be converted has `octal` format.

`[\Bin]`

Binary

Data type: `switch`

The string to be converted has `binary` format.

`[\Char]`

Character

Data type: `switch`

The string to be converted has `ASCII` character format.

Limitations

Depending on the format of the string to be converted, the following string data is valid:

Format	String length	Range
Dec .....: ’0’ - ’9’	3	"0" - "255"
Hex .....: ’0’ - ’9’, ’a’ -’f’, ’A’ - ’F’	2	"0" - "FF"
Okt ......: ’0’ - ’7’	3	"0" - "377"
Bin ......: ’0’ - ’1’	8	"0" - "11111111"
Char ....: Any ASCII character	1	One ASCII char

RAPID character codes (e.g. “\07” for BEL control character) can be used as arguments in `ConStr`.

Syntax

```
StrToByte’(’
  [ConStr’ :=’] <expression (IN) of string>
  [’\’ Hex ] | [’\’ Okt] | [’\’ Bin] | [’\’ Char]
  ’)’
```

A function with a return value of the data type `byte`.

Continues on next page

Related information

For information about	See
Convert a byte to a string data	*ByteToStr - Converts a byte to a string data on page 784*
Other bit (byte) functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics - Bit functions*
Other string functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*

2.129. StrToVal - Converts a string to a value

Usage

`StrToVal` (*String To Value*) is used to convert a string to a value of any data type.

Basic examples

Basic examples of the function `StrToVal` are illustrated below.

See also *More examples on page 1011*.

Example 1

```
VAR bool ok;
VAR num nval;
ok := StrToVal("3.85",nval);
```

The variable `ok` is given the value `TRUE` and `nval` is given the value `3.85`.

Return value

Data type: `bool`

`TRUE` if the requested conversion succeeded, `FALSE` otherwise.

Arguments

```
StrToVal ( Str Val )
```

`Str`

String

Data type: `string`

A string value containing literal data with format corresponding to the data type used in argument `Val`. Valid format as for RAPID literal aggregates.

`Val`

Value

Data type: `ANYTYPE`

Name of the variable or persistent of any data type for storage of the result from the conversion.

All type of value data with structure atomic, record, record component, array or array element can be used. The data is unchanged if the requested conversion failed because the format don't correspond to the data used in argument `Str`.

Continues on next page

More examples

More examples of the function `StrToVal` are illustrated below.

Example 1

```
VAR string str15 := "[600, 500, 225.3]";
VAR bool ok;
VAR pos pos15;

ok := StrToVal(str15,pos15);
```

The variable `ok` is given the value `TRUE` and the variable `pos15` is given the value that are specified in the string `str15`.

Syntax

```
StrToVal'('
  [ Str ':=' ] <expression (IN) of string> ´,´
  [ Val ':=' ] <var or pers (INOUT) of ANYTYPE>
  ')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*

2.130. Tan - Calculates the tangent value

Usage

`Tan` (*Tangent*) is used to calculate the tangent value from an angle value.

Basic examples

Basic examples of the function are illustrated below.

Example 1

```
VAR num angle;
VAR num value;
...
...
value := Tan(angle);
```

`value` will get the tangent value of `angle`.

Return value

Data type: `num`

The tangent value.

Arguments

```
Tan (Angle)
```

`Angle`

Data type: `num`

The angle value, expressed in degrees.

Syntax

```
Tan'('
  [Angle ':='] <expression (IN) of num>
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Mathematics*
Arc tangent with return value in the range [-180, 180]	*ATan2 - Calculates the arc tangent2 value on page 769*

2.131. TaskRunMec - Check if task controls any mechanical unit

Usage

`TaskRunMec` is used to check if the program task controls any mechanical units (robot with TCP or manipulator without TCP).

Basic examples

Basic examples of the function `TaskRunMec` are illustrated below.

Example 1

```
VAR bool flag;
...
flag := TaskRunMec( );
```

If current task controls any mechanical unit `flag` will be `TRUE`, otherwise `FALSE`.

Return value

Data type: `bool`

If current task controls any mechanical unit the return value will be `TRUE`, otherwise `FALSE`.

Program execution

Check if current program task controls any mechanical unit.

Syntax

```
TaskRunMec'(' ')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Check if task control some robot	*TaskRunRob - Check if task controls some robot on page 1014*
Activating/Deactivating mech. units	*ActUnit - Activates a mechanical unit on page 17* *DeactUnit - Deactivates a mechanical unit on page 79*
Configuration of mechanical units	*Technical reference manual - System parameters*

2.132. TaskRunRob - Check if task controls some robot

Usage

`TaskRunRob` is used to check if the program task controls some robot (mechanical unit with TCP).

Basic examples

Basic examples of the function `TaskRunRob` are illustrated below.

Example 1

```
VAR bool flag;
...
flag := TaskRunRob( );
```

If current task controls some robot, `flag` will be set to `TRUE`, otherwise `FALSE`.

Return value

Data type: `bool`

If current task controls some robot, the return value will be `TRUE`, otherwise `FALSE`.

Program execution

Check if current program task controls some robot.

Syntax

```
TaskRunRob '(' ')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Check if task controls any mechanical unit	*TaskRunMec - Check if task controls any mechanical unit on page 1013*
Activating/Deactivating mechanical units	*ActUnit - Activates a mechanical unit on page 17* *DeactUnit - Deactivates a mechanical unit on page 79*
Configuration of mechanical units	*Technical reference manual - System parameters*

2.133. TasksInSync - Returns the number of synchronized tasks

Usage

`TasksInSync` is used to retrieve the number of synchronized tasks.

Basic examples

A basic example of the function `TasksInSync` is illustrated below.

Example 1

```
VAR tasks tasksInSyncList{6};
...

PROC main ()
  VAR num noOfSynchTasks;
  ...
  noOfSynchTasks:= TasksInSync (tasksInSyncList);
  TPWrite "No of synchronized tasks = "\Num:=noOfSynchTasks;
ENDPROC
```

The variable `noOfSynchTasks` is assigned the number of synchronized tasks and the `tasksInSyncList` will contain the names of the synchronized tasks. In this example the task list is a variable but it can also be a persistent.

Return value

Data type: `num`

The number of synchronized tasks.

Arguments

```
TaskInSync (TaskList)
```

`TaskList`

Data type: `tasks`

Inout argument that in a task list (array) will present the name (`string`) of the program tasks that are synchronized. The task list can be either of type `VAR` or `PERS`.

Program execution

The function returns the number of synchronized tasks in the system. The names of the synchronized tasks are presented in the inout argument TaskList. In cases where there are no synchronized tasks, the list will only contain empty strings.

Limitations

Currently only one synch group is supported, so `TasksInSync` returns the number of tasks that are synchronized in that group.

Syntax

```
TasksInSync
  [ TaskList‘ :=’ ] < var or pers array {*} (INOUT) of tasks> ´,’
```

A function with a return value of the data type `num`.

Continues on next page

Related information

For information about	See
Specify cooperated program tasks	*tasks - RAPID program tasks on page 1204* *SyncMoveOn - Start coordinated synchronized movements on page 534*
Start coordinated synchronized movements	*SyncMoveOn - Start coordinated synchronized movements on page 534*

2.134. TestAndSet - Test variable and set if unset

Usage

`TestAndSet` can be used together with a normal data object of the type `bool`, as a binary semaphore, to retrieve exclusive right to specific RAPID code areas or system resources. The function could be used both between different program tasks and different execution levels (TRAP or Event Routines) within the same program task.

Example of resources that can need protection from access at the same time:

- Use of some RAPID routines with function problems when executed in parallel.
- Use of the FlexPendant - Operator Log

Basic examples

Basic examples of the function `TestAndSet` are illustrated below.

See also *More examples on page 1018*.

Example 1

`MAIN` program task:

```
PERS bool tproutine_inuse := FALSE;
...
WaitUntil TestAndSet(tproutine_inuse);
TPWrite "First line from MAIN";
TPWrite "Second line from MAIN";
TPWrite "Third line from MAIN";
tproutine_inuse := FALSE;
```

`BACK1` program task:

```
PERS bool tproutine_inuse := FALSE;
...
WaitUntil TestAndSet(tproutine_inuse);
TPWrite "First line from BACK1";
TPWrite" Second line from BACK1";
TPWrite "Third line from BACK1";
tproutine_inuse := FALSE;
```

To avoid mixing up the lines, in the Operator Log, one from `MAIN` and one from `BACK1`, the use of the `TestAndSet` function guarantees that all three lines from each task are not separated.

If program task `MAIN` takes the semaphore `TestAndSet(tproutine_inuse)` first, then program task `BACK1` must wait until the program task `MAIN` has left the semaphore.

Return value

Data type: `bool`

`TRUE` if the semaphore has been taken by me (executor of `TestAndSet` function), otherwise `FALSE`.

Continues on next page

Arguments

```
TestAndSet Object
```

`Object`

Data type: `bool`

User defined data object to be used as semaphore. The data object could be a variable `VAR` or a persistent variable `PERS`. If `TestAndSet` are used between different program tasks, the object must be a persistent variable `PERS` or an installed variable `VAR` (intertask objects).

Program execution

This function will in one indivisible step check the user defined variable and, if it is unset, will set it and return `TRUE`, otherwise it will return `FALSE`.

```
IF Object = FALSE THEN
  Object := TRUE;
  RETURN TRUE;
ELSE
  RETURN FALSE;
ENDIF
```

More examples

More examples of the function `TestAndSet` are illustrated below.

Example 1

```
LOCAL VAR bool doit_inuse := FALSE;
...
PROC doit(...)
  WaitUntil TestAndSet (doit_inuse);
  ...
  doit_inuse := FALSE;
ENDPROC
```

If a module is installed built-in and shared, it is possible to use a local module variable for protection of access from different program tasks at the same time.

NOTE!

In this case with installed built-in modules and when using persistent variable as semaphore object: If program execution is stopped in the routine `doit` and the program pointer is moved to `main`, the variable `doit_inuse` will not be reset. To avoid this, reset the variable `doit_inuse` to `FALSE` in the `START` event routine.

Syntax

```
TestAndSet ´(´
  [ Object ':=' ] < variable or persistent (INOUT) of bool> ´)´
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Wait until variable unset - then set (type wait with interrupt control)	*WaitTestAndSet - Wait until variable unset - then set on page 692*

2.135. TestDI - Tests if a digital input is set

Usage

`TestDI` is used to test whether a digital input is set.

Basic examples

Basic examples of the function `TestDI` are illustrated below.

Example 1

```
IF TestDI (di2) THEN . . .
```

If the current value of the signal `di2` is equal to `1`, then . . .

```
IF NOT TestDI (di2) THEN . . .
```

If the current value of the signal `di2` is equal to `0`, then . . .

```
WaitUntil TestDI(di1) AND TestDI(di2);
```

Program execution continues only after both the `di1` input and the `di2` input have been set.

Return value

Data type: `bool`

`TRUE` = The current value of the signal is equal to 1.

`FALSE` = The current value of the signal is equal to 0.

Arguments

```
TestDI (Signal)
```

`Signal`

Data type: `signaldi`

The name of the signal to be tested.

Syntax

```
TestDI '('
  [ Signal' :=' ] < variable (VAR) of signaldi > ')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
Reading the value of a digital input signal	*signalxx - Digital and analog signals on page 1181*
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and Output Signals*

2.136. TestSignRead - Read test signal value

Usage

`TestSignRead` is used to read the actual test signal value.

This function returns the momentary value or the mean value of the latest samples, depending on channel specification in instruction `TestSignDefine`.

Basic examples

Basic examples of the function `TestSignRead` are illustrated below.

See also *More examples on page 1021*.

Example 1

```
CONST num speed_channel:=1;
VAR num speed_value;
...
TestSignDefine speed_channel, speed, orbit, 1, 0;
...
! During some movements with orbit's axis 1
speed_value := TestSignRead(speed_channel);
...
TestSignReset;
```

`speed_value` is assigned the mean value of the latest 8 samples generated each 0.5 ms of the test signal `speed` on channel `speed_channel` defined as channel `1`. The channel `speed_channel` measures the speed of `axis 1` on the mechanical unit `orbit`.

Return value

Data type: `num`

The numeric value in SI units on the motor side for the specified channel according to the definition in instruction `TestSignDefine`.

Arguments

```
TestSignRead (Channel)
```

`Channel`

Data type: `num`

The channel number 1-12 for the test signal to be read. The same number must be used in the definition instruction `TestSignDefine`.

Program execution

Returns the momentary value or the mean value of the latest samples, depending on the channel specification in the instruction `TestSignDefine`.

For predefined test signals with valid SI units for external manipulator axes, see data type `testsignal`.

Continues on next page

More examples

More examples of the function `TestSignRead` are illustrated below.

Example 1

```
CONST num torque_channel:=2;
VAR num torque_value;
VAR intnum timer_int;
CONST jointtarget psync := [...];
...
CONNECT timer_int WITH TorqueTrap;
ITimer \Single, 0.05, timer_int;
TestSignDefine torque_channel, torque_ref, IRBP_K, 2, 0.001;
...
MoveAbsJ psync \NoEOffs, v5, fine, tool0;
...
IDelete timer_int;
TestSignReset;

TRAP TorqueTrap
  IF (TestSignRead(torque_channel) > 6) THEN
     TPWrite "Torque pos = " + ValToStr(CJointT());
     Stop;
  ELSE
     IDelete timer_int;
     CONNECT timer_int WITH TorqueTrap;
     ITimer \Single, 0.05, timer_int;
  ENDIF
ENDTRAP
```

When the torque reference for manipulator `IRBP_K` axis `2` is for the first time greater than `6` Nm on the motor side during the slow movement to position `psync`, the joint position is displayed on the FlexPendant.

Syntax

```
TestSignRead'('
  [ Channel ':='] <expression (IN) of num>')'
```

A function with a return value of the type `num`.

Related information

For information about	See
Define test signal	*TestSignDefine - Define test signal on page 551*
Reset test signals	*TestSignReset - Reset all test signal definitions on page 553*

2.137. TextGet - Get text from system text tables

Usage

`TextGet` is used to get a text string from the system text tables.

Basic examples

Basic examples of the function `TextGet` are illustrated below.

Example 1

```
VAR string text1;
...
text1 := TextGet(14, 5);
```

The variable `text1` is assigned the text stored in text resource `14` and index `5`.

Return value

Data type: `string`

Specified text from the system text tables.

Arguments

```
TextGet ( Table Index )
```

`Table`

Data type: `num`

The text table number (positive integer).

`Index`

Data type: `num`

The index number (positive integer) within the text table.

Error handling

If table or index is not valid, and no text string can be fetched from the system text tables, the system variable `ERRNO` is set to `ERR_TXTNOEXIST`. The execution continues in the error handler.

Syntax

```
TextGet '('
  [ Table ':=' ] < expression (IN) of num > ','
  [ Index ':=' ] < expression (IN) of num> ')'
```

A function with a return value of the data type `string`.

Continues on next page

Related information

For information about	See
Get text table number	*TextTabGet - Get text table number on page 1026*
Install text table	*TextTabInstall - Installing a text table on page 554*
Format text files	*Technical reference manual - RAPID kernel*, section *RAPID Kernel reference manual - Text files*
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*

2.138. TextTabFreeToUse - Test whether text table is free

Usage

`TextTabFreeToUse` should be used to test whether the text table name (text resource string) is free to use (not already installed in the system), i.e. whether it is possible to install the text table in the system or not.

Basic examples

Basic examples of the function `TextTabFreeToUse` are illustrated below.

Example 1

```
! System Module with Event Routine to be executed at event
! POWER ON, RESET or START

PROC install_text()
  IF TextTabFreeToUse("text_table_name") THEN
     TextTabInstall "HOME:/text_file.eng";
  ENDIF
ENDPROC
```

The first time the event routine `install_text` is executed, the function `TextTabFreeToUse` returns `TRUE` and the text file `text_file.eng` is installed in the system. After that the installed text strings can be fetched from the system to RAPID by the functions `TextTabGet` and `TextGet`.

Next time the event routine `install_text` is executed, the function `TextTabFreeToUse` returns `FALSE` and the installation is **not** repeated.

Return value

Data type: `bool`

This function returns:

- `TRUE`, if the text table is **not** already installed in the system
- `FALSE`, if the text table is already installed in the system

Arguments

```
TextTabFreeToUse ( TableName )
```

`TableName`

Data type: `string`

The text table name (a string with max. 80 characters). Refer to `<text_resource>`:: in *RAPID Reference Manual - RAPID Kernel*, section *Text files*. The string `text_resource` is the text table name.

Continues on next page

Limitations

Limitations for installation of text tables (text resources) in the system:

- It is not possible to install the same text table more than once in the system
- It is not possible to uninstall (free) a single text table from the system. The only way to uninstall text tables from the system is to cold start the system. All text tables (both system and user defined) will then be uninstalled.

Syntax

```
TextTabFreeToUse'('
  [ TableName':=' ] < expression (IN) of string > ')'
```

A function with a return value of the data type `bool`

Related information

For information about	See
Install text table	*TextTabInstall - Installing a text table on page 554*
Format of text files	*Technical reference manual - RAPID kernel*, section *RAPID Kernel reference manual - Text files*
Get text table number	*TextTabGet - Get text table number on page 1026*
Get text from system text tables	*TextGet - Get text from system text tables on page 1022*
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*

2.139. TextTabGet - Get text table number

Usage

`TextTabGet` is used to get the text table number of a user defined text table during run time.

Basic examples

Basic examples of the function `TextTabGet` are illustrated below.

A new text table named `deburr_part1` for user defined texts. The new text table has the file name `deburr.eng`.

deburr.eng - USERS deburr_part1 english text description file

#

DESCRIPTION:

Users text file for RAPID development

#

deburr_part1::

0:

RAPID S4: Users text table deburring part1

1:

Part 1 is not in pos

2:

Identity of worked part: XYZ

3:

Part error in line 1

#

End of file

Example 1

```
VAR num text_res_no;
...
text_res_no := TextTabGet("deburr_part1");
```

The variable `text_res_no` is assigned the text table number for the defined text table `deburr_part1`.

Example 2

```
ErrWrite TextGet(text_res_no, 1), TextGet(text_res_no, 2);
```

A message is stored in the robot log. The message is also shown on the FlexPendant display. The messages will be taken from the text table `deburr_part1` :

Part 1 is not in pos

Identity of worked part: XYZ

Return value

Data type: `num`

The text table number of the defined text table.

Continues on next page

Arguments

```
TextTabGet ( TableName )
```

`TableName`

Data type: `string`

The text table name.

Syntax

```
TextTabGet '('
  [ TableName' =' ] < expression (IN) of string > ';)'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Get text from system text tables	*TextGet - Get text from system text tables on page 1022*
Install text table	*TextTabInstall - Installing a text table on page 554*
Format text files	*Technical reference manual - RAPID kernel*, section *RAPID Kernel reference manual -Text files*
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*

2.140. Trunc - Truncates a numeric value

Usage

`Trunc` (*Truncate*) is used to truncate a numeric value to a specified number of decimals or to an integer value.

Basic examples

Basic examples of the function `Trunc` are illustrated below.

Example 1

```
VAR num val;
val := Trunc(0.38521\Dec:=3);
```

The variable `val` is given the value `0.385`.

Example 2

```
reg1 := 0.38521
val := Trunc(reg1\Dec:=1);
```

The variable `val` is given the value `0.3`.

Example 3

```
val := Trunc(0.38521);
```

The variable `val` is given the value `0`.

Return value

Data type: `num`

The numeric value truncated to the specified number of decimals.

Arguments

```
Trunc ( Val [\Dec] )
```

`Val`

Value

Data type: `num`

The numeric value to be truncated.

`[\Dec]`

Decimals

Data type: `num`

Number of decimals.

If the specified number of decimals is 0 or if the argument is omitted, the value is truncated to an integer.

The number of decimals must not be negative or greater than the available precision for numeric values.

Continues on next page

Syntax

```
Trunc'('
  [ Val ':=' ] <expression (IN) of num>
  [ \Dec ':=' <expression (IN) of num> ]
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*
Rounding a value	*Round - Round is a numeric value on page 969*

2.141. Type - Get the data type name for a variable

Usage

`Type` is used to get the data type name for the specified variable in argument `Data`.

Basic examples

Basic examples of the function `Type` are illustrated below.

Example 1

```
VAR string rettype;
VAR intnum intnumtype;
rettype := Type(intnumtype);
TPWrite "Data type name: " + rettype;
```

The print out will be: "Data type name: intnum"

Example 2

```
VAR string rettype;
VAR intnum intnumtype;
rettype := Type(intnumtype \BaseName);
TPWrite "Data type name: " + rettype;
```

The print out will be: "Data type name: num"

Example 3

```
VAR string rettype;
VAR num numtype;
rettype := Type(numtype);
TPWrite "Data type name: " + rettype;
```

The print out will be: "Data type name: num"

Return value

Data type: `string`

A string with the data type name for the specified variable in argument `Data`.

Arguments

```
Type (Data [\BaseName])
```

`Data`

Data object name

Data type: `anytype`

The name of the variable to get the data type name for.

`[\BaseName]`

Base data type Name

Data type: `switch`

If used, then the function returns the underlying data type name, when the specified `Data` is an `ALIAS` declared data type.

Continues on next page

Syntax

```
Type'('
  [ Data' :=' ] < reference (REF) of anytype >
  [ '\' BaseName ]
  ')'
```

A function with a return value of the data type `string`.

Related information

For information about	See
Definition of Alias types.	*Technical reference manual - RAPID kernel*, section *Lexical elements - Alias types*

2.142. UIAlphaEntry - User Alpha Entry

Usage

`UIAlphaEntry` (*User Interaction Alpha Entry*) is used to let the operator enter a string from the available user device, such as the FlexPendant. A message is written to the operator, who answers with a text string. The string is then transferred back to the program.

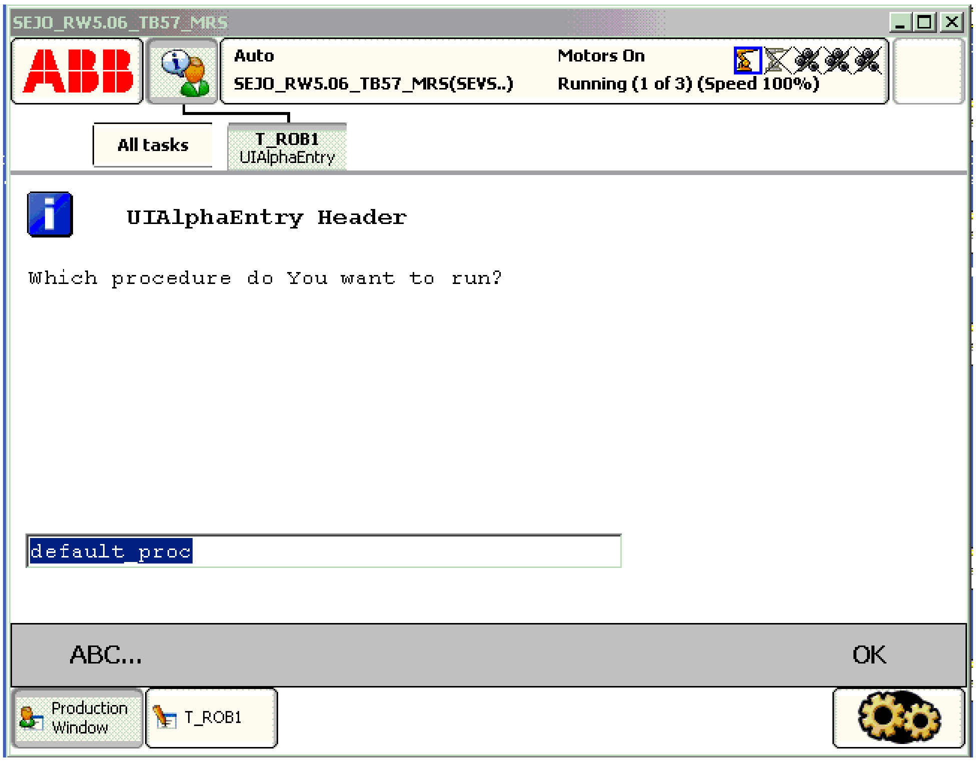
Basic examples

Basic examples of the instruction `UIAlpaEntry` are illustrated below.

See *More examples on page 1035*.

Example 1

```
VAR string answer;
 ...
answer := UIAlphaEntry(
  \Header:= "UIAlphaEntry Header",
  \Message:= "Which procedure do You want to run?"
  \Icon:=iconInfo
  \InitString:= "default_proc");
%answer%;
```



xx0500002437

Above alpha message box with icon, header, message, and init string are written on the FlexPendant display. The user edit init string or write a new string with the supported Alpha Pad. Program execution waits until OK is pressed and then the written string is returned in the variable `answer`. The program then calls the specified procedure with late binding.

Continues on next page

Return value

Data type: `string`

This functions returns the input string.

If function breaks via `\BreakFlag:`

- If parameter `\InitString` is specified, this string is returned

- If parameter `\InitString` is not specified, empty string `""` is returned.

If function breaks via `ERROR` handler, no return value will be returned at all.

Arguments

```
UIAlphaEntry ([\Header] [\Message] | [\MsgArray]
      [\Wrap] [\Icon] [\InitString]
      [\MaxTime] [\DIBreak] [\DOBreak] [\BreakFlag])
```

`[\Header]`

Data type: `string`

Header text to be written at the top of the message box. Max. 40 characters.

`[\Message]`

Data type: `string`

One text line to be written on the display. Max 55 characters.

`[\MsgArray]`

Message Array

Data type: `string`

Several text lines from an array to be written on the display.

Only one of parameter `\Message` or `\MsgArray` can be used at the same time.

Max. layout space is 9 lines with 55 characters.

`[\Wrap]`

Data type: switch

If selected, all the specified strings in the argument `\MsgArray` will be concatenated to one string with single space between each individual strings and spread out on as few lines as possible.

Default, each string in the argument `\MsgArray` will be on separate line on the display.

`[\Icon]`

Data type: `icondata`

Defines the icon to be displayed. Only one of the predefined icons of type icondata can be used. See *Predefined data on page 1034*.

Default no icon.

`[\InitString]`

Data type: `string`

An initial string to be display in the text entry box as default.

Continues on next page

`[\MaxTime]`

Data type: `num`

The maximum amount of time in seconds that program execution waits. If the OK button is not pressed within this time, the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_MAXTIME` can be used to test whether or not the maximum time has elapsed.

`[\DIBreak]`

Digital Input Break

Data type: `signaldi`

The digital input signal that may interrupt the operator dialog. If the OK button is not pressed before the signal is set to 1 (or is already 1), the program continues to execute in the error handler, unless the `BreakFlag` is used (see below). The constant `ERR_TP_DIBREAK` can be used to test whether or not this has occurred.

`[\DOBreak]`

Digital Output Break

Data type: `signaldo`

The digital output signal that may interrupt the operator dialog. If the OK button is not pressed before the signal is set to 1 (or is already 1), the program continues to execute in the error handler, unless the `BreakFlag` is used (see below). The constant `ERR_TP_DOBREAK` can be used to test whether or not this has occurred.

`[\BreakFlag]`

Data type: `errnum`

A variable (before used set to 0 by the system) that will hold the error code if \MaxTime, `\DIBreak` or `\DOBreak` is used. The constants `ERR_TP_MAXTIME, ERR_TP_DIBREAK` and `ERR_TP_DOBREAK` can be used to select the reason. If this optional variable is omitted, the error handler will be executed.

Program execution

The alpha message box with alpha pad, icon, header, message lines, and init string are displayed according to the programmed arguments. Program execution waits until the user edits or creates a new string and presses OK, or the message box is interrupted by time-out or signal action. The input string and interrupt reason are transferred back to the program.

New message box on TRAP level takes focus from message box on basic level.

Predefined data

```
!Icons:
  CONST icondata iconNone := 0;
  CONST icondata iconInfo := 1;
  CONST icondata iconWarning := 2;
  CONST icondata iconError := 3;
```


Continues on next page

More examples

More examples of the function `UIAlphaEntry` are illustrated below.

Example 1

```
VAR errnum err_var;
VAR string answer;
VAR string logfile;
...
answer := UIAlphaEntry (\Header:= "Log file name:"
  \Message:= "Enter the name of the log file to create?"
       \Icon:=iconInfo
  \InitString:= "signal.log" \MaxTime:=60
       \DIBreak:=di5\BreakFlag:=err_var);
TEST err_var
  CASE ERR_TP_MAXTIME:
  CASE ERR_TP_DIBREAK:
     ! No operator answer
     logfile:="signal.log";
  CASE 0:
     ! Operator answer
     logfile := answer;
  DEFAULT:
     ! Not such case defined
ENDTEST
```

The message box is displayed and the operator can enter a string and press OK. The message box can also be interrupted with time out or break by digital input signal. In the program it's possible to find out the reason and take the appropriate action.

Error handling

If parameter `\BreakFlag` is not used, these situations can then be dealt with by the error handler:

If there is a time-out (parameter `\MaxTime`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_MAXTIME` and the execution continues in the error handler.

If digital input is set (parameter `\DIBreak`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_DIBREAK` and the execution continues in the error handler.

If a digital output is set (parameter `\DOBreak`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_DOBREAK` and the execution continues in the error handler.

This situation can only be dealt with by the error handler:

If there is no client, e.g. a FlexPendant, to take care of the instruction, the system variable `ERRNO` is set to `ERR_TP_NO_CLIENT` and the execution continues in the error handler.

Limitations

Avoid using too small a value for the time-out parameter `\MaxTime` when `UIAlphaEntry` is frequently executed, for example in a loop. It can result in an unpredictable behavior of the system performance, like slow response of the FlexPendant.

Continues on next page

Syntax

```
UIAlphaEntry´(´
[´\´Header’:=’ <expression (IN) of string>]
[´\´ Message’:=’ <expression (IN) of string>]
| [´\´MsgArray’:=’<array {*} (IN) of string>]
[´\´Wrap]
[´\´Icon’:=’ <expression (IN) of icondata>]
[´\´InitString’:=’<expression (IN) of string>]
[´\´MaxTime’:=’ <expression (IN) of num>]
[´\´DIBreak’:=’ <variable (VAR) of signaldi>]
[´\´DOBreak´:=´<variable (VAR) of signaldo>]
[’\’BreakFlag ´:=´ <var or pers (INOUT) of errnum>]‘)’
```

A function with return value of the data type string.

Related information

For information about	See
Icon display data	*icondata - Icon display data on page 1121*
User Interaction Message Box type basic	*UIMsgBox - User Message Dialog Box type basic on page 644*
User Interaction Message Box type advanced	*UIMessageBox - User Message Box type advanced on page 1057*
User Interaction Number Entry	*UINumEntry - User Number Entry on page 1064*
User Interaction Number Tune	*UINumTune - User Number Tune on page 1070*
User Interaction List View	*UIListView - User List View on page 1050*
System connected to FlexPendant etc.	*UIClientExist - Exist User Client on page 1037*
Procedure call with Late binding	*Technical reference manual - RAPID overview*, section *Basic characteristics - Routines - Procedure call*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

2.143. UIClientExist - Exist User Client

Usage

`UIClientExist` (*User Interaction Client Exist*) is used to check if some User Device such as the FlexPendant is connected to the controller.

Basic examples

Basic examples of the function `UIClientExist` are illustrated below.

Example 1

```
IF UIClientExist() THEN
  ! Possible to get answer from the operator
  ! The TPReadFK and UIMsgBox ... can be used
ELSE
  ! Not possible to communicate with any operator
ENDIF
```

The test is done if it is possible to get some answer from the operator of the system.

Return value

Data type: `bool`

Returns `TRUE` if a FlexPendant is connected to the system, otherwise `FALSE`.

Limitations

`UIClientExist` returns `TRUE` up to 16 seconds. After that, the FlexPendant is removed. After that time, `UIClientExist` returns `FALSE` (i.e when network connection lost from FlexPendent is detected). Same limitation when the FlexPendant is connected again.

Syntax

```
UIClientExist'(' ')
```

A function with return value of the type `bool`.

Related information

For information about	See
User Interaction Message Box type basic	*UIMsgBox - User Message Dialog Box type basic on page 644*
User Interaction Message Box type advanced	*UIMessageBox - User Message Box type advanced on page 1057*
User Interaction Number Entry	*UINumEntry - User Number Entry on page 1064*
User Interaction Number Tune	*UINumTune - User Number Tune on page 1070*
User Interaction Alpha Entry	*UIAlphaEntry - User Alpha Entry on page 1032*
User Interaction List View	*UIListView - User List View on page 1050*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

2.144. UIDnumEntry - User Number Entry

Usage

`UIDnumEntry` (*User Interaction Number Entry*) is used to let the operator enter a numeric value from the available user device, such as the FlexPendant. A message is written to the operator, who answers with a numeric value. The numeric value is then checked, approved and transferred back to the program.

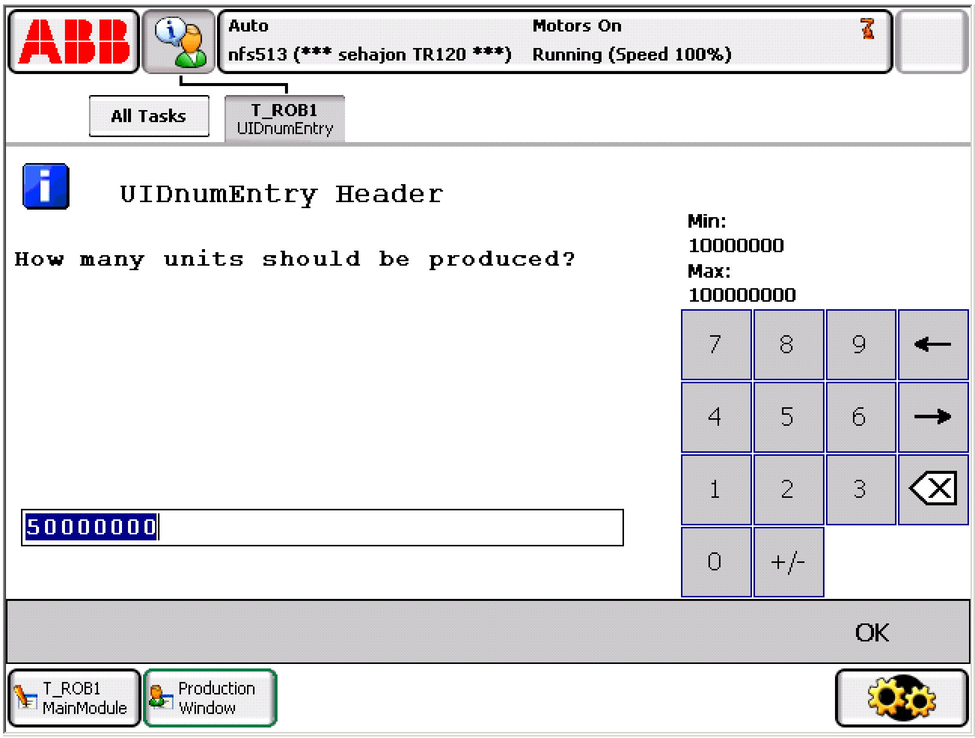
Basic examples

Basic examples of the function `UIDnumEntry` are illustrated below.

See also *More examples on page 1041*.

Example 1

```
VAR dnum answer;
...
answer := UIDnumEntry(
  \Header:="UIDnumEntry Header"
  \Message:="How many units should be produced?"
  \Icon:=iconInfo
  \InitValue:=50000000
  \MinValue:=10000000
  \MaxValue:=100000000
  \AsInteger);
```



xx0900001064

Continues on next page

Above, the numeric message box with icon, header, message, init-, max-, and minvalue written on the FlexPendant display. The message box checks that the operator selects an integer within the value range. Program execution waits until OK is pressed and then the selected numerical value is returned.

Return value

Data type: `dnum`

This function returns the input numeric value.

If function breaks via `\BreakFlag`:

- If parameter `\InitValue` is specified, this value is returned
- If parameter `\InitValue` is not specified, value 0 is returned.

If function breaks via `ERROR` handler there is no return value at all.

Arguments

```
UIDnumEntry ( [\Header] [\Message] | [\MsgArray]
      [\Wrap] [\Icon] [\InitValue] [\MinValue] [\MaxValue]
      [\AsInteger] [\MaxTime] [\DIBreak] [\DOBreak]
      \BreakFlag] )
```

`[\Header]`

Data type: `string`

Header text to be written at the top of the message box. Max. 40 characters.

`[\Message]`

Data type: `string`

One text line to be written on the display. Max. 40 characters.

`[\MsgArray]`

Message Array

Data type: `string`

Several text lines from an array to be written on the display.

Only one of parameter `\Message` or `\MsgArray` can be used at the same time.

Max. layout space is 9 lines with 40 characters each.

`[\Wrap]`

Data type: `switch`

If selected, all the specified strings in the argument `\MsgArray` will be concatenated to one string with a single space between each individual string, and spread out on as few lines as possible.

Default, each string in the argument `\MsgArray` will be on a separate line on the display.

`[\Icon]`

Data type: `icondata`

Defines the icon to be displayed. Only one of the predefined icons of type `icondata` can be used. See *Predefined data on page 1041*.

Default no icon.

Continues on next page

`[\InitValue]`

Data type: `dnum`

Initial value that is displayed in the entry box.

`[\MinValue]`

Data type: `dnum`

The minimum value for the return value.

`[\MaxValue]`

Data type: `dnum`

The maximum value for the return value.

`[\AsInteger]`

Data type: `switch`

Eliminates the decimal point from the number pad to ensure that the return value is an integer.

`[\MaxTime]`

Data type: `num`

The maximum amount of time in seconds that program execution waits. If the OK button is not pressed within this time, the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_MAXTIME` can be used to test whether or not the maximum time has elapsed.

`[\DIBreak]`

Digital Input Break

Data type: `signaldi`

The digital input signal that may interrupt the operator dialog. If the OK button is not pressed before the signal is set to 1 (or is already 1) then the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_DIBREAK` can be used to test whether or not this has occurred.

`[\DOBreak]`

Digital Output Break

Data type: `signaldo`

The digital output signal that may interrupt the operator dialog. If the OK button is not pressed before the signal is set to 1 (or is already 1) then the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_DOBREAK` can be used to test whether or not this has occurred.

`[\BreakFlag]`

Data type: `errnum`

A variable (before used, set to 0 by the system) that will hold the error code if `\MaxTime`, `\DIBreak`, or `\DOBreak` is used. The constants `ERR_TP_MAXTIME`, `ERR_TP_DIBREAK`, and `ERR_TP_DOBREAK` can be used to select the reason. If this optional variable is omitted, the error handler will be executed.

Continues on next page

Program execution

The numeric message box with numeric pad, icon, header, message lines, init-, max-, and minvalue is displayed according to the programmed arguments. Program execution waits until the user has entered an approved numeric value and pressed OK or the message box is interrupted by timeout or signal action. The input numeric value and interrupt reason are transferred back to the program.

New message box on TRAP level takes focus from message box on basic level.

Predefined data

```
!Icons:
  CONST icondata iconNone := 0;
  CONST icondata iconInfo := 1;
  CONST icondata iconWarning := 2;
  CONST icondata iconError := 3;
```

More examples

More examples of the function `UIDnumEntry` are illustrated below.

Example 1

```
VAR errnum err_var;
VAR dnum answer;
VAR dnum distance;
...
answer := UIDnumEntry (\Header:= "BWD move on path"
  \Message:="Enter the path overlap?" \Icon:=iconInfo
  \InitValue:=5 \MinValue:=0 \MaxValue:=10
  \MaxTime:=60 \DIBreak:=di5 \BreakFlag:=err_var);
TEST err_var
  CASE ERR_TP_MAXTIME:
  CASE ERR_TP_DIBREAK:
     ! No operator answer distance := 5;
  CASE 0
     ! Operator answer
     distance := answer;
  DEFAULT:
     ! No such case defined
ENDTEST
```

The message box is displayed and the operator can enter a numeric value and press OK. The message box can also be interrupted with a time out or break by digital input signal. In the program, it is possible to find out the reason and take the appropriate action.

Continues on next page

Error handling

If parameter `\BreakFlag` is not used, these situations can then be dealt with by the error handler:

- If there is a timeout (parameter `\MaxTime`) before an input from the operator then the system variable `ERRNO` is set to `ERR_TP_MAXTIME` and the execution continues in the error handler.
- If a digital input is set (parameter `\DIBreak`) before an input from the operator then the system variable `ERRNO` is set to `ERR_TP_DIBREAK` and the execution continues in the error handler.
- If a digital output is set (parameter `\DOBreak`) before an input from the operator then the system variable `ERRNO` is set to `ERR_TP_DOBREAK` and the execution continues in the error handler.

Limitations

Avoid using too small a value for the timeout parameter `\MaxTime` when `UIDnumEntry` is frequently executed, for example, in a loop. It can result in unpredictable behavior from the system performance, like the slow response of the FlexPendant.

Syntax

```
UIDnumEntry´(´
  [´\´Header´:=´ <expression (IN) of string>]
  [Message’:=’ <expression (IN) of string> ]
  | [´\´MsgArray’:=’<array {*} (IN) of string>]
  [´\´Wrap]
  [´\´Icon’:=’ <expression (IN) of icondata>]
  [´\´InitValue’:=’<expression (IN) of dnum>]
  [´\´MinValue’:=’<expression (IN) of dnum>]
  [´\´MaxValue’:=’<expression (IN) of dnum>]
  [´\´AsInteger]
  [´\´MaxTime’:=’ <expression (IN) of num>]
  [\´DIBreak’:=’ <variable (VAR) of signaldi>]
  [´\´DOBreak’:=’ <variable (VAR) of signaldo>]
  [´\´BreakFlag’:=’ <var or pers (INOUT) of errnum>] ´)´
```

A function with return value of the data type `dnum`.

Continues on next page

Related information

For information about	See
Icon display data	*icondata - Icon display data on page 1121*
User Interaction Message Box type basic	*UIMsgBox - User Message Dialog Box type basic on page 644*
User Interaction Message Box type advanced	*UIMessageBox - User Message Box type advanced on page 1057*
User Interaction Number Entry	*UINumEntry - User Number Entry on page 1064*
User Interaction Number Tune	*UIDnumTune - User Number Tune on page 1044*
User Interaction Number Tune	*UINumTune - User Number Tune on page 1070*
User Interaction Alpha Entry	*UIAlphaEntry - User Alpha Entry on page 1032*
User Interaction List View	*UIListView - User List View on page 1050*
System connected to FlexPendant etc.	*UIClientExist - Exist User Client on page 1037*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

2.145. UIDnumTune - User Number Tune

Usage

`UIDnumTune` (*User Interaction Number Tune*) is used to let the operator tune a numeric value from the available user device, such as the FlexPendant. A message is written to the operator, who tunes a numeric value. The tuned numeric value is then checked, approved and transferred back to the program.

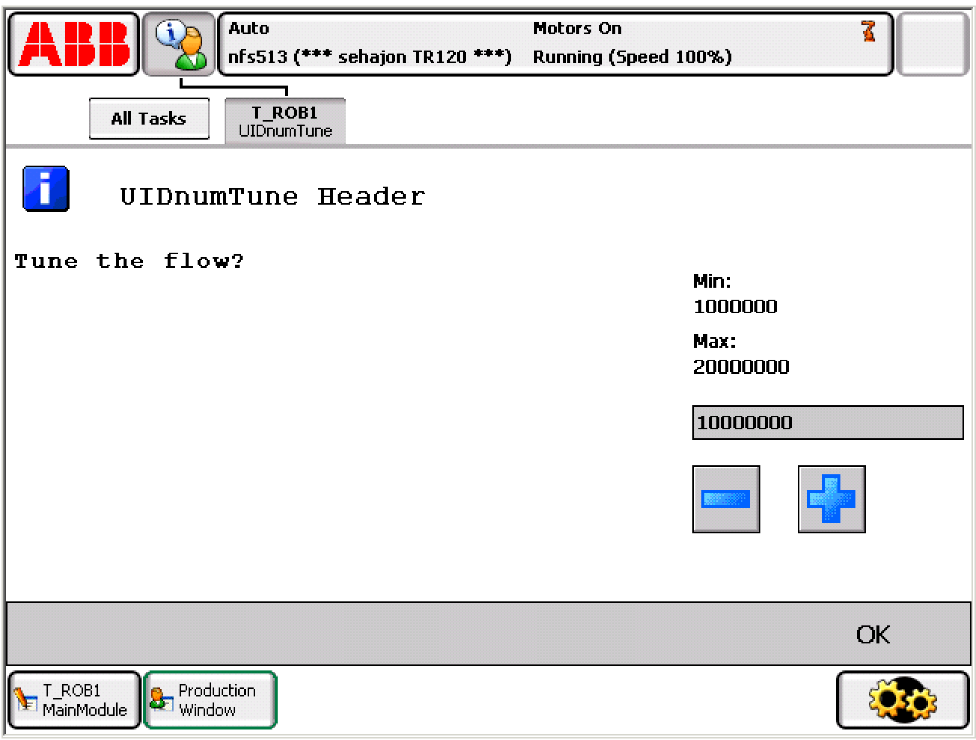
Basic examples

Basic examples of the function `UIDnumTune` are illustrated below.

See also *More examples on page 1047*.

Example 1

```
VAR dnum flow;
...
flow := UIDnumTune(
  \Header:="UIDnumTune Header"
  \Message:="Tune the flow?"
  \Icon:=iconInfo,
  10000000,
  1000000
  \MinValue:=1000000
  \MaxValue:=20000000);
```



xx0900001063

Continues on next page

Above, the numeric tune message box with icon, header, message, init-, increment, max-, and minvalue written on the FlexPendant display. The message box checks that the operator tunes the `flow` value with step 1000000 from init value 10000000 and is within the value range 1000000-20000000. Program execution waits until OK is pressed and then the selected numerical value is returned and stored in the variable `flow`.

Return value

Data type: `dnum`

This function returns the tuned numeric value.

If function breaks via `\BreakFlag`, the specified `InitValue` is returned.

If function breaks via `ERROR` handler, no return value is returned at all.

Arguments

```
UIDnumTune ( [\Header] [\Message] | [\MsgArray] [\Wrap]
      [\Icon] InitValue Increment [\MinValue] [\MaxValue]
      [\MaxTime] [\DIBreak] [\DOBreak] [\BreakFlag] )
```

`[\Header]`

Data type: `string`

Header text to be written at the top of the message box. Max. 40 characters.

`[\Message]`

Data type: `string`

One text line to be written on the display. Max. 40 characters.

`[\MsgArray]`

Message Array

Data type: `string`

Several text lines from an array to be written on the display.

Only one of parameter `\Message` or `\MsgArray` can be used at the same time.

Max. layout space is 11 lines with 40 characters each.

`[\Wrap]`

Data type: `switch`

If selected, all the specified strings in the argument `\MsgArray` will be concatenated to one string with a single space between each individual string and spread out on as few lines as possible.

Default, each string in the argument `\MsgArray` will be on a separate line on the display.

`[\Icon]`

Data type: `icondata`

Defines the icon to be displayed. Only one of the predefined icons of type icondata can be used. See *Predefined data on page 1047*.

Default no icon.

Continues on next page

`InitValue`

Initial Value

Data type: `dnum`

Initial value that is displayed in the entry box.

`Increment`

Data type: `dnum`

This parameter specifies how much the value should change when the plus or minus button is pressed.

`[\MinValue]`

Data type: `dnum`

The minimum value for the return value.

`[\MaxValue]`

Data type: `dnum`

The maximum value for the return value.

`[\MaxTime]`

Data type: `num`

The maximum amount of time in seconds that program execution waits. If the OK button is not pressed within this time, the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_MAXTIME` can be used to test whether or not the maximum time has elapsed.

`[\DIBreak]`

Digital Input Break

Data type: `signaldi`

The digital input signal that may interrupt the operator dialog. If the OK button is not pressed before the signal is set to 1 (or is already 1) then the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant ERR_TP_DIBREAK can be used to test whether or not this has occurred.

`[\DOBreak]`

Digital Output Break

Data type: `signaldo`

The digital output signal that may interrupt the operator dialog. If the OK button is not pressed before the signal is set to 1 (or is already 1) then the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_DOBREAK` can be used to test whether or not this has occurred.

`[\BreakFlag]`

Data type: `errnum`

A variable (before used, set to 0 by the system) that will hold the error code if `\MaxTime`, `\DIBreak`, or `\DOBreak` is used. The constants `ERR_TP_MAXTIME`, `ERR_TP_DIBREAK`, and `ERR_TP_DOBREAK` can be used to select the reason. If this optional variable is omitted, the error handler will be executed.

Continues on next page

Program execution

The numeric tune message box with tune +/- buttons, icon, header, message lines, init-, increment, max, and minvalue is displayed according to the programmed arguments. Program execution waits until the user has tuned the numeric value and pressed OK or the message box is interrupted by timeout or signal action. The input numeric value and interrupt reason are transferred back to the program.

New message box on `TRAP` level takes focus from message box on basic level.

Predefined data

```
!Icons:
CONST icondata iconNone := 0;
CONST icondata iconInfo := 1;
CONST icondata iconWarning := 2;
CONST icondata iconError := 3;
```

More examples

More examples of the function `UIDnumTune` are illustrated below.

Example 1

```
VAR errnum err_var;
VAR dnum tune_answer;
VAR dnum distance;
...
tune_answer := UIDnumTune (\Header:=" BWD move on path"
  \Message:="Enter the path overlap?" \Icon:=iconInfo,
  5, 1 \MinValue:=0 \MaxValue:=10
  \MaxTime:=60 \DIBreak:=di5 \BreakFlag:=err_var);
TEST err_var
  CASE ERR_TP_MAXTIME:
  CASE ERR_TP_DIBREAK:
     ! No operator answer
     distance := 5;
  CASE 0:
     ! Operator answer
     distance := tune_answer;
  DEFAULT:
     ! No such case defined
ENDTEST
```

The tune message box is displayed and the operator can tune the numeric value and press OK. The message box can also be interrupted with timeout or break by digital input signal. In the program, it is possible to find out the reason and take the appropriate action.

Continues on next page

Error handling

If parameter `\BreakFlag` is not used then these situations can be dealt with by the error handler:

- If there is a timeout (parameter `\MaxTime`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_MAXTIME` and the execution continues in the error handler.
- If a digital input is set (parameter `\DIBreak`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_DIBREAK` and the execution continues in the error handler.
- If a digital output is set (parameter `\DOBreak`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_DOBREAK` and the execution continues in the error handler.

This situation can only be dealt with by the error handler:

- If there is no client, e.g. a FlexPendant, to take care of the instruction then the system variable `ERRNO` is set to `ERR_TP_NO_CLIENT` and the execution continues in the error handler.
- If the initial value (parameter `\InitValue`) is not specified within the range of the minimum and maximum value (parameters `\MinValue` and `\MaxValue`) then the system variable `ERRNO` is set to `ERR_UI_INITVALUE` and the execution continues in the error handler.
- If the minimum value (parameter `\MinValue`) is greater than the maximum value (parameter `\MaxValue`) then the system variable `ERRNO` is set to `ERR_UI_MAXMIN` and the execution continues in the error handler.

Limitations

Avoid using too small a value for the timeout parameter `\MaxTime` when `UIDnumTune` is frequently executed, for example, in a loop. It can result in unpredictable behavior from the system performance, like a slow response of the FlexPendant.

Syntax

```
UIDnumTune'('
  ['\'Header':=' <expression (IN) of string>]
  ['\'Message':=' <expression (IN) of string> ]
  | ['\'MsgArray':='<array {*} (IN) of string>]
  ['\'Wrap]
  ['\'Icon':=' <expression (IN) of icondata>] ',']
  [InitValue':=' ] <expression (IN) of dnum> ','
  [Increment':=' ] <expression (IN) of dnum>
  ['\'MinValue':=' <expression (IN) of dnum>]
  ['\'MaxValue':=' <expression(IN) of dnum>]
  ['\'MaxTime':=' <expression (IN) of num>]
  ['\'DIBreak':=' <variable (VAR) of signaldi>]
  ['\'DOBreak':=' <variable (VAR) of signaldo>]
  ['\'BreakFlag':=' <var or pers (INOUT) of errnum>] ')'
```

A function with return value of the data type `dnum`.

Continues on next page

Related information

For information about	See
Icon display data	*icondata - Icon display data on page 1121*
User Interaction Message Box type basic	*UIMsgBox - User Message Dialog Box type basic on page 644*
User Interaction Message Box type advanced	*UIMessageBox - User Message Box type advanced on page 1057*
User Interaction Number Entry	*UIDnumEntry - User Number Entry on page 1038*
User Interaction Number Entry	*UINumEntry - User Number Entry on page 1064*
User Interaction Number Tune	*UINumTune - User Number Tune on page 1070*
User Interaction Alpha Entry	*UIAlphaEntry - User Alpha Entry on page 1032*
User Interaction List View	*UIListView - User List View on page 1050*
System connected to FlexPendant etc.	*UIClientExist - Exist User Client on page 1037*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

2.146. UIListView - User List View

Usage

`UIListView` (*User Interaction List View*) is used to define menu lists with text and optional icons on the available User Device such as the FlexPendant. The menu has two different styles, one with validations buttons and one that reacts instantly to the user selection.

Basic examples

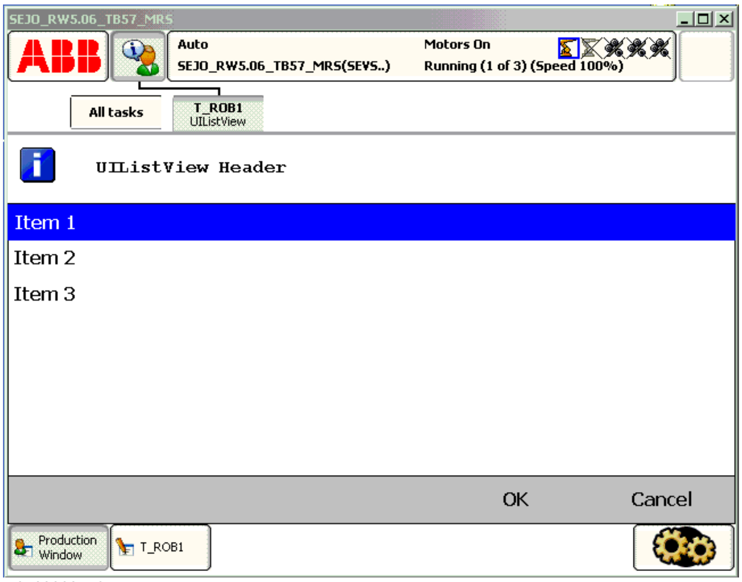
Basic examples of the function `UIListView` are illustrated below.

See also *More examples on page 1054*.

Example 1

```
CONST listitem list{3} := [ ["","Item 1"], ["","Item 2"],
      ["","Item 3"] ];
VAR num list_item;
VAR btnres button_answer;
...
list_item := UIListView (
  \Result:=button_answer
  \Header:="UIListView Header",
  list
  \Buttons:=btnOKCancel
  \Icon:=iconInfo
  \DefaultIndex:=1);
IF button_answer = resOK THEN
  IF list_item = 1 THEN
     ! Do item1
  ELSEIF list_item = 2 THEN
     ! Do item 2
  ELSE
     ! Do item3
  ENDIF
ELSE
  ! User has select Cancel
ENDIF
```


Continues on next page



xx0500002416

Above menu list with icon, header, menu `Item 1 ... Item 3`, and buttons are written on the FlexPendant display. Program execution waits until OK or Cancel is pressed. Both the selection in the list and the pressed button are transfered to the program.

Return value

Data type: `num`

This function returns the user selection in the list menu corresponding to the index in the array specified in the parameter `ListItems`.

If the function breaks via `\BreakFlag`:

- If parameter `\DefaultIndex` is specified, this index is returned
- If parameter `\DefaultIndex` is not specified, 0 is returned

If function breaks via `ERROR` handler, no return value is returned at all.

Arguments

```
UIListView ( [\Result] [\Header] ListItems [\Buttons] |
    [\BtnArray] [\Icon] [\DefaultIndex ] [\MaxTime]
    [\DIBreak] [\DOBreak] [\BreakFlag])
```

`[\Result]`

Data type: `btnres`

The numeric value of the button that is selected from the list menu box.

If argument `\Buttons` is used, the predefined symbolic constants of type `btnres` is returned. If argument `\BtnArray` is used, the corresponding array index is returned.

Argument `\Result` set to resUnkwn equal to 0 if one of following condition:

- none of parameters `\Buttons` or `\BtnArray` are used
- argument `\Buttons:=btnNone` is used
- if the function breaks via `\BreakFlag` or `ERROR` handler

See *Predefined data on page 1054*.

Continues on next page

`[\Header]`

Data type: `string`

Header text to be written at the top of the list menu box. Max. 40 characters.

`ListItem`

Data type: `listitem`

An array with one or several list menu items to be displayed consisting of:

Component `image` of type `string`:

The name of the icon image that should be used. To launch own images, the images has to be placed in the `HOME:` directory in the active system or directly in the active system.

The recommendation is to place the files in the `HOME:` directory so that they are saved if a Backup and Restore is done.

A warmstart is required and then the FlexPendant loads the images.

A demand on the system is that the RobotWare option *FlexPendant Interface* is used.

The image that will be shown can have the width and height of 28 pixels. If the image is bigger, then it will be resized to show only 28 * 28 pixels.

No exact value can be specified on the size that an image can have or the amount of images that can be loaded to the FlexPendant. It depends on the size of other files loaded to the FlexPendant. The program execution will just continue if an image is used that has not been loaded to the FlexPendant.

Use empty string ”” or stEmpty if no icon to display.

Component `text` of type `string`:

- The text for the menu line to display.
- Max. 75 characters for each list menu item.

`[\Buttons]`

Data type: `buttondata`

Defines the push buttons to be displayed. Only one of the predefined buttons combination of type buttondata can be used. See *Predefined data on page 1054*.

`[\BtnArray]`

Button Array

Data type: `string`

Own definition of push buttons stored in an array of strings. This function returns the array index when corresponding string is selected.

Only one of parameter `\Buttons` or `\BtnArray` can be used at the same time. If none of the parameters `\Buttons` or `\BtnArray` or argument `\Buttons:=btnNone` are used then the menu list reacts instantly to the user selection.

Max. 5 buttons with 42 characters each.

Continues on next page

`[\Icon]`

Data type: `icondata`

Defines the icon to be displayed. Only one of the predefined icons of type `icondata` can be used.

Default no icon. See *Predefined data on page 1054*.

`[\DefaultIndex]`

Data type: `num`

The default user selection in the list menu corresponding to the index in the array specified in the parameter `ListItems`.

`[\MaxTime]`

Data type: `num`

The maximum amount of time in seconds that program execution waits. If no button is pressed or no selection is done within this time then the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_MAXTIME` can be used to test whether or not the maximum time has elapsed.

`[\DIBreak]`

Digital Input Break

Data type: `signaldi`

The digital input signal that may interrupt the operator dialog. If no button is pressed or no selection is done before the signal is set to 1 (or is already 1) then the program continues to execute in the error handler, unless the `BreakFlag` is used (see below). The constant `ERR_TP_DIBREAK` can be used to test whether or not this has occurred.

`[\DOBreak]()`

Digital Output Break

Data type: `signaldo`

The digital output signal that may interrupt the operator dialog. If no button is pressed or no selection is done before the signal is set to 1 (or is already 1) then the program continues to execute in the error handler, unless the `BreakFlag` is used (see below). The constant `ERR_TP_DOBREAK` can be used to test whether or not this has occurred.

`[\BreakFlag]`

Data type: `errnum`

A variable that will hold the error code if `\MaxTime`, `\DIBreak`, or `\DOBreak` is used. The constants `ERR_TP_MAXTIME`, `ERR_TP_DIBREAK`, and `ERR_TP_DOBREAK` can be used to select the reason. If this optional variable is omitted, the error handler will be executed.

Program execution

The menu list with icon, header, list items, and default item are displayed according to the programmed arguments. Program execution waits until the operator has done the selection or the menu list is interrupted by time-out or signal action. The selected list item and interrupt reason are transferred back to the program.

New menu list on TRAP level takes focus from menu list on basic level.

Continues on next page

Predefined data

```
!Icons:
CONST icondata iconNone := 0;
CONST icondata iconInfo := 1;
CONST icondata iconWarning := 2;
CONST icondata iconError := 3;

!Buttons:
CONST buttondata btnNone := -1;
CONST buttondata btnOK := 0;
CONST buttondata btnAbrtRtryIgn := 1;
CONST buttondata btnOKCancel := 2;
CONST buttondata btnRetryCancel := 3;
CONST buttondata btnYesNo := 4;
CONST buttondata btnYesNoCancel := 5;

!Results:
CONST btnres resUnkwn := 0;
CONST btnres resOK := 1;
CONST btnres resAbort := 2;
CONST btnres resRetry := 3;
CONST btnres resIgnore := 4;
CONST btnres resCancel := 5;
CONST btnres resYes := 6;
CONST btnres resNo := 7;
```

More examples

More examples of the function `UIListView` are illustrated below.

Example 1

```
CONST listitem list{2} := [ ["","Calibrate tool1"], ["","Calibrate
     tool2"] ];
VAR num list_item;
VAR errnum err_var;
...
list_item := UIListView
  ( \Header:="Select tool ?",
  list \Icon:=iconInfo
  \MaxTime:=60
  \DIBreak:=di5
  \BreakFlag:=err_var);
TEST err_var
  CASE ERR_TP_MAXTIME:
  CASE ERR_TP_DIBREAK:
    ! No operator answer
  CASE 0:
```


Continues on next page

```
        ! Operator answer
        IF list_item =1 THEN
          ! Calibrate tool1
        ELSEIF list_item=2 THEN
          ! Calibrate tool2
        ENDIF
      DEFAULT:
        ! Not such case defined
    ENDTEST
```

The message box is displayed and the operator can select an item in the list. The message box can also be interrupted with time out or break by digital input signal. In the program it's possible to find out the reason and take the appropriate action.

Error handling

If parameter `\BreakFlag` is not used, these situations can then be dealt with by the error handler:

- If there is a time-out (parameter `\MaxTime`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_MAXTIME` and the execution continues in the error handler.
- If digital input is set (parameter `\DIBreak`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_DIBREAK` and the execution continues in the error handler.
- If a digital output is set (parameter `\DOBreak`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_DOBREAK` and the execution continues in the error handler.

This situation can only be dealt with by the error handler:

- If there is no client, e.g. a FlexPendant, to take care of the instruction then the system variable `ERRNO` is set to `ERR_TP_NO_CLIENT` and the execution continues in the error handler.

Limitations

Avoid using too small a value for the time-out parameter `\MaxTime` when `UIListView` is frequently executed, for example in a loop. It can result in unpredictable behavior from the system performance, like slow response of the FlexPendant.

Continues on next page

Syntax

```
UIListView '('
  [['\'Result ´:=´ <var or pers (INOUT) of btnres>]
  ['\'Header ´:=´ <expression (IN) of string>] ',']
  [ListItems ´=´] <array {*} (IN) of listitem>
  ['\'Buttons ´:=´ <expression (IN) of buttondata>]
  | ['\'BtnArray ´:=´<array {*} (IN) of string>]
  ['\'Icon ':=' <expression (IN) of icondata>]
  ['\'DefaultIndex ´:=´<expression (IN) of num>]
  ['\'MaxTime ´:=´ <expression (IN) of num>]
  ['\'DIBreak ´:=´ <variable (VAR) of signaldi>]
  ['\'DOBreak ´:=´ <variable (VAR) of signaldo>]
  ['\'BreakFlag ´:=´ <var or pers (INOUT) of errnum>]')'
```

A function with return value of the data type `num`.

Related information

For information about	See
Icon display data	*icondata - Icon display data on page 1121*
Push button data	*buttondata - Push button data on page 1089*
Push button result data	*btnres - Push button result data on page 1086*
List item data structure	*listitem - List item data structure on page 1131*
User Interaction Message Box type basic	*UIMsgBox - User Message Dialog Box type basic on page 644*
User Interaction Message Box type advanced	*UIMessageBox - User Message Box type advanced on page 1057*
User Interaction Number Entry	*UINumEntry - User Number Entry on page 1064*
User Interaction Number Tune	*UINumTune - User Number Tune on page 1070*
User Interaction Alpha Entry	*UIAlphaEntry - User Alpha Entry on page 1032*
System connected to FlexPendant etc.	*UIClientExist - Exist User Client on page 1037*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

2.147. UIMessageBox - User Message Box type advanced

Usage

`UIMessageBox` (*User Interaction Message Box*) is used to communicate with the user of the robot system on available user device, such as the FlexPendant. A message is written to the operator, who answers by selecting a button. The user selection is then transferred back to the program.

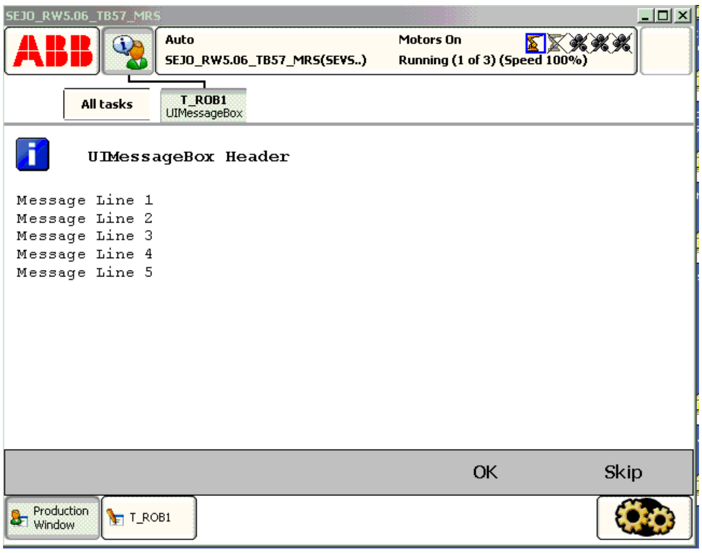
Basic examples

Basic examples of the function UIMessageBox are illustrated below.

See also *More examples on page 1061*.

Example 1

```
VAR btnres answer;
CONST string my_message{5}:= ["Message Line 1","Message Line 2",
  "Message Line 3","Message Line 4","Message Line 5"];
CONST string my_buttons{2}:=["OK","Skip"];
...
answer:= UIMessageBox (
  \Header:="UIMessageBox Header"
  \MsgArray:=my_message
  \BtnArray:=my_buttons
  \Icon:=iconInfo);
IF answer = 1 THEN
  ! Operator selection OK
ELSEIF answer = 2 THEN
  ! Operator selection Skip
ELSE
  ! No such case defined
ENDIF
```



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Continues on next page

Above message box is with icon, header, message, and user defined push buttons that are written on the FlexPendant display. Program execution waits until OK or Skip is pressed. In other words, `answer` will be assigned 1 (OK) or 2 (Skip) depending on which of the buttons is pressed (corresponding array index).

NOTE!

`Message Line 1` ... `Message Line 5` are displayed on separate lines 1 to 5 (the switch `\Wrap` is not used).

Return value

Data type: `btnres`

The numeric value of the button that is selected from the message box.

If argument `\Buttons` is used, the predefined symbolic constants of type `btnres` is returned.

If argument `\BtnArray` is used, the corresponding array index is returned.

If function breaks via `\BreakFlag` or if `\Buttons:=btnNone`:

- If parameter `\DefaultBtn` is specified, this index is returned.
- If parameter `\DefaultBtn` is not specified, `resUnkwn` equal to 0 is returned.

If function breaks via `ERROR` handler, there is no return value at all.

Arguments

```
UIMessageBox ( [\Header] [\Message] | [\MsgArray]
      [\Wrap] [\Buttons] | [\BtnArray] [\DefaultBtn]
      [\Icon] [\Image] [\MaxTime] [\DIBreak] [\DOBreak]
      [\BreakFlag] )
```

`[\Header]`

Data type: `string`

Header text to be written at the top of the message box. Max. 40 characters.

`[\Message]`

Data type: `string`

One text line to be written on the display. Max 55 characters.

`[\MsgArray]`

Message Array

Data type: `string`

Several text lines from an array to be written on the display.

Only one of parameter `\Message` or `\MsgArray` can be used at the same time.

Max. layout space is 11 lines with 55 characters each.

`[\Wrap]`

Data type: `switch`

If selected, all the specified strings in the argument `\MsgArray` will be concatenated to one string with single spaces between each individual string and spread out on as few lines as possible.

Default, each string in the argument `\MsgArray` will be on separate line on the display.

Continues on next page

`[\Buttons]`

Data type: `buttondata`

Defines the push buttons to be displayed. Only one of the predefined buttons combination of type buttondata can be used. See *Predefined data on page 1060*.

Default, the system displays the OK button.

`[\BtnArray]`

Button Array

Data type: `string`

Own definition of push buttons stored in an array of strings. This function returns the array index when corresponding string is selected.

Only one of parameter `\Buttons` or `\BtnArray` can be used at the same time.

Max. 5 buttons with 42 characters each.

`[\DefaultBtn]`

Default Button

Data type: `btnres`

Allows to specify a value that should be returned if the message box is interrupted by `\MaxTime`, `\DIBreak`, or `\DOBreak`. It's possible to specify the predefined symbolic constant of type `btnres` or any user defined value. See *Predefined data on page 1060*.

`[\Icon]`

Data type: `icondata`

Defines the icon to be displayed. Only one of the predefined icons of type `icondata` can be used. See *Predefined data on page 1060*.

Default, no icon.

`[\Image]`

Data type: `string`

The name of the image that should be used. To launch own images, the images has to be placed in the `HOME:` directory in the active system or directly in the active system.

The recommendation is to place the files in the `HOME:` directory so that they are saved if a Backup and Restore is done.

A warmstart is required and then the FlexPendant loads the images.

A demand on the system is that the RobotWare option *FlexPendant Interface* is used.

The image that will be shown can have the width of 185 pixels and the height of 300 pixels. If the image is bigger, only 185 * 300 pixels of the image will be shown starting at the top left of the image.

No exact value can be specified on the size that an image can have or the amount of images that can be loaded to the FlexPendant. It depends on the size of other files loaded to the FlexPendant. The program execution will just continue if an image is used that has not been loaded to the FlexPendant.

Continues on next page

`[\MaxTime]`

Data type: `num`

The maximum amount of time in seconds that program execution waits. If no button is selected within this time, the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_MAXTIME` can be used to test whether or not the maximum time has elapsed.

`[\DIBreak]`

Digital Input Break

Data type: `signaldi`

The digital input signal that may interrupt the operator dialog. If no button is selected when the signal is set to 1 (or is already 1) then the program continues to execute in the error handler, unless the `BreakFlag` is used (see below). The constant `ERR_TP_DIBREAK` can be used to test whether or not this has occurred.

`[\DOBreak]`

Digital Output Break

Data type: `signaldo`

The digital output signal that may interrupt the operator dialog. If no button is selected when the signal is set to 1 (or is already 1) then the program continues to execute in the error handler, unless the `BreakFlag` is used (see below). The constant `ERR_TP_DOBREAK` can be used to test whether or not this has occurred.

`[\BreakFlag]`

Data type: `errnum`

A variable (before used set to 0 by the system) that will hold the error code if `\MaxTime`, `\DIBreak`, or `\DOBreak` is used. The constants `ERR_TP_MAXTIME`, `ERR_TP_DIBREAK`, and `ERR_TP_DOBREAK` can be used to select the reason. If this optional variable is omitted, the error handler will be executed.

Program execution

The message box with icon, header, message lines, image, and buttons are displayed according to the programmed arguments. Program execution waits until the user selects one button or the message box is interrupted by time-out or signal action. The user selection and interrupt reason are transferred back to the program.

A new message box on TRAP level takes focus from message box on basic level.

Predefined data

```
!Icons:
  CONST icondata iconNone := 0;
  CONST icondata iconInfo := 1;
  CONST icondata iconWarning := 2;
  CONST icondata iconError := 3;
```


Continues on next page

```
!Buttons:
  CONST buttondata btnNone := -1;
  CONST buttondata btnOK := 0;
  CONST buttondata btnAbrtRtryIgn := 1;
  CONST buttondata btnOKCancel := 2;
  CONST buttondata btnRetryCancel := 3;
  CONST buttondata btnYesNo := 4;
  CONST buttondata btnYesNoCancel := 5;

!Results:
  CONST btnres resUnkwn := 0;
  CONST btnres resOK := 1;
  CONST btnres resAbort := 2;
  CONST btnres resRetry := 3;
  CONST btnres resIgnore := 4;
  CONST btnres resCancel := 5;
  CONST btnres resYes := 6;
  CONST btnres resNo := 7;
```

More examples

More examples of the function `UIMessageBox` are illustrated below.

Example 1

```
VAR errnum err_var;
VAR btnres answer;
...
answer := UIMessageBox (\Header:= "Cycle step 3"
  \Message:="Continue with the calibration ?"
        \Buttons:=btnOKCancel
  \DefaultBtn:=resCancel \Icon:=iconInfo \MaxTime:=60
        \DIBreak:=di5
  \BreakFlag:=err_var);
IF answer = resOK THEN
  ! OK from the operator
ELSE
  ! Cancel from the operator or operation break
  TEST err_var
    CASE ERR_TP_MAXTIME:
      ! Time out
    CASE ERR_TP_DIBREAK:
      ! Input signal break
    DEFAULT:
      ! Not such case defined
  ENDTEST
ENDIF
```

The message box is displayed, and the operator can answer OK or Cancel. The message box can also be interrupted with time out or break by digital input signal. In the program it's possible to find out the reason.

Continues on next page

Error handling

If parameter `\BreakFlag` is not used, these situations can then be dealt with by the error handler:

- If there is a time-out (parameter `\MaxTime`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_MAXTIME` and the execution continues in the error handler.
- If digital input is set (parameter `\DIBreak`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_DIBREAK` and the execution continues in the error handler.
- If a digital output is set (parameter `\DOBreak`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_DOBREAK` and the execution continues in the error handler.

This situation can only be dealt with by the error handler:

- If there is no client, e.g. a FlexPendant, to take care of the instruction, the system variable `ERRNO` is set to `ERR_TP_NO_CLIENT` and the execution continues in the error handler.

Limitations

Avoid using too small a value for the time-out parameter `\MaxTime` when `UIMessageBox` is frequently executed, for example in a loop. It can result in an unpredictable behavior of the system performance, like slow response of the FlexPendant.

Syntax

```
UIMessageBox´(´
  [´\´Header´:=´ <expression (IN) of string>]
  [´\´Message´:=´ <expression (IN) of string>]
  | [´\´MsgArray´:=´<array {*} (IN) of string>]
  [´\´Wrap]
  [´\´Buttons´=´ <expression (IN) of buttondata>]
  | [´\´BtnArray´:=´<array {*}(IN) of string>]
  ['\'DefaultBtn´:=´<expression (IN) of btnres>]
  ['\'Icon´:=´<expression (IN) of icondata>]
  ['\'Image´:=´<expression (IN) of string>]
  [´\´MaxTime´:=´ <expression (IN) of num>]
  [´\´DIBreak´:=´ <variable (VAR) of signaldi>]
  [´\´DOBreak´:=´ <variable (VAR) of signaldo>]
  [´\´BreakFlag´:=´ <var or pers (INOUT) of errnum>] ´)´
```

A function with return value of the data type `btnres`.

Continues on next page

Related information

For information about	See
Icon display data	*icondata - Icon display data on page 1121*
Push button data	*buttondata - Push button data on page 1089*
Push button result data	*btnres - Push button result data on page 1086*
User Interaction Message Box type basic	*UIMsgBox - User Message Dialog Box type basic on page 644*
User Interaction Number Entry	*UINumEntry - User Number Entry on page 1064*
User Interaction Number Tune	*UINumTune - User Number Tune on page 1070*
User Interaction Alpha Entry	*UIAlphaEntry - User Alpha Entry on page 1032*
User Interaction List View	*UIListView - User List View on page 1050*
System connected to FlexPendant etc.	*UIClientExist - Exist User Client on page 1037*
FlexPendant interface	*Product Specification - Controller Software IRC5, RobotWare 5.0*, section *Communication - FlexPendant Interface*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

2.148. UINumEntry - User Number Entry

Usage

`UINumEntry` (*User Interaction Number Entry*) is used to let the operator enter a numeric value from the available user device, such as the FlexPendant. A message is written to the operator, who answers with a numeric value. The numeric value is then checked, approved and transferred back to the program.

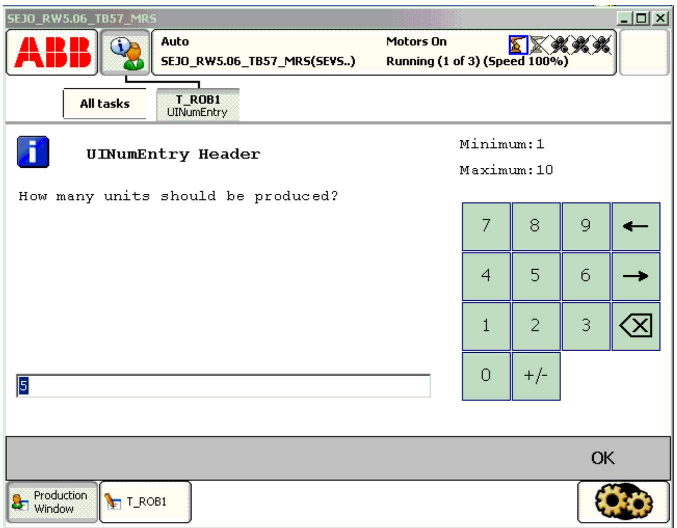
Basic examples

Basic examples of the function `UINumEntry` are illustrated below.

See also *More examples on page 1067*.

Example 1

```
VAR num answer;
...
answer := UINumEntry(
  \Header:="UINumEntry Header"
  \Message:="How many units should be produced?"
  \Icon:=iconInfo
  \InitValue:=5
  \MinValue:=1
  \MaxValue:=10
  \AsInteger);
FOR i FROM 1 TO answer DO
  produce_part;
ENDFOR
```



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Above numeric message box with icon, header, message, init-, max-, and minvalue are written on the FlexPendant display. The message box checks that the operator selects an integer within the value range. Program execution waits until OK is pressed and then the selected numerical value is returned. The routine `produce_part` is then repeated the number of input times via the FlexPendant.

Continues on next page

Return value

Data type: `num`

This function returns the input numeric value.

If function breaks via `\BreakFlag`:

- If parameter `\InitValue` is specified, this value is returned
- If parameter `\InitValue` is not specified, value 0 is returned.

If function breaks via `ERROR` handler, no return value at all.

Arguments

```
UINumEntry ( [\Header] [\Message] | [\MsgArray]
      [\Wrap] [\Icon] [\InitValue] [\MinValue] [\MaxValue]
      [\AsInteger] [\MaxTime] [\DIBreak] [\DOBreak]
      \BreakFlag] )
```

`[\Header]`

Data type: `string`

Header text to be written at the top of the message box. Max. 40 characters.

`[\Message]`

Data type: `string`

One text line to be written on the display. Max 40 characters.

`[\MsgArray]`

Message Array

Data type: `string`

Several text lines from an array to be written on the display.

Only one of parameter `\Message` or `\MsgArray` can be used at the same time.

Max. layout space is 9 lines with 40 characters each.

`[\Wrap]`

Data type: `switch`

If selected, all the specified strings in the argument `\MsgArray` will be concatenated to one string with a single space between each individual string, and spread out on as few lines as possible.

Default, each string in the argument `\MsgArray` will be on a separate line on the display.

`[\Icon]`

Data type: `icondata`

Defines the icon to be displayed. Only one of the predefined icons of type `icondata` can be used. See *Predefined data on page 1067*.

Default no icon.

`[\InitValue]`

Data type: `num`

Initial value that is displayed in the entry box.

Continues on next page

`[\MinValue]`

Data type: `num`

The minimum value for the return value.

`[\MaxValue]`

Data type: `num`

The maximum value for the return value.

`[\AsInteger]`

Data type: `switch`

Eliminates the decimal point from the number pad to ensure that the return value is an integer.

`[\MaxTime]`

Data type: `num`

The maximum amount of time in seconds that program execution waits. If the OK button is not pressed within this time, the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_MAXTIME` can be used to test whether or not the maximum time has elapsed.

`[\DIBreak]`

Digital Input Break

Data type: `signaldi`

The digital input signal that may interrupt the operator dialog. If the OK button is not pressed before the signal is set to 1 (or is already 1) then the program continues to execute in the error handler, unless the `BreakFlag` is used (see below). The constant `ERR_TP_DIBREAK` can be used to test whether or not this has occurred.

`[\DOBreak]`

Digital Output Break

Data type: `signaldo`

The digital output signal that may interrupt the operator dialog. If the OK button is not pressed before the signal is set to 1 (or is already 1) then the program continues to execute in the error handler, unless the `BreakFlag` is used (see below). The constant `ERR_TP_DOBREAK` can be used to test whether or not this has occurred.

`[\BreakFlag]`

Data type: `errnum`

A variable (before used set to 0 by the system) that will hold the error code if `\MaxTime`, `\DIBreak`, or `\DOBreak` is used. The constants `ERR_TP_MAXTIME`, `ERR_TP_DIBREAK`, and `ERR_TP_DOBREAK` can be used to select the reason. If this optional variable is omitted, the error handler will be executed.

Continues on next page

Program execution

The numeric message box with numeric pad, icon, header, message lines, init-, max-, and minvalue are displayed according to the programmed arguments. Program execution waits until the user has entered an approved numeric value and presses OK or the message box is interrupted by time-out or signal action. The input numeric value and interrupt reason are transferred back to the program.

New message box on TRAP level take focus from message box on basic level.

Predefined data

```
!Icons:
  CONST icondata iconNone := 0;
  CONST icondata iconInfo := 1;
  CONST icondata iconWarning := 2;
  CONST icondata iconError := 3;
```

More examples

More examples of the function `UINumEntry` are illustrated below.

Example 1

```
VAR errnum err_var;
VAR num answer;
VAR num distance;
...
answer := UINumEntry (\Header:= "BWD move on path"
  \Message:="Enter the path overlap ?" \Icon:=iconInfo
  \InitValue:=5 \MinValue:=0 \MaxValue:=10
  \MaxTime:=60 \DIBreak:=di5 \BreakFlag:=err_var);
TEST err_var
  CASE ERR_TP_MAXTIME:
  CASE ERR_TP_DIBREAK:
     ! No operator answer distance := 5;
  CASE 0
     ! Operator answer
     distance := answer;
  DEFAULT:
     ! Not such case defined
ENDTEST
```

The message box is displayed and the operator can enter a numeric value and press OK. The message box can also be interrupted with a time out or break by digital input signal. In the program it’s possible to find out the reason and take the appropriate action.

Continues on next page

Error handling

If parameter `\BreakFlag` is not used, these situations can then be dealt with by the error handler:

- If there is a time-out (parameter `\MaxTime`) before an input from the operator then the system variable `ERRNO` is set to `ERR_TP_MAXTIME` and the execution continues in the error handler.
- If digital input is set (parameter `\DIBreak`) before an input from the operator then the system variable `ERRNO` is set to `ERR_TP_DIBREAK` and the execution continues in the error handler.
- If a digital output is set (parameter `\DOBreak`) before an input from the operator then the system variable `ERRNO` is set to `ERR_TP_DOBREAK` and the execution continues in the error handler.

This situation can only be dealt with by the error handler:

- If there is no client, e.g. a FlexPendant, to take care of the instruction then the system variable `ERRNO` is set to `ERR_TP_NO_CLIENT` and the execution continues in the error handler.
- If the initial value (parameter `\InitValue`) is not specified within the range of the minimum and maximum value (parameters `\MinValue` and `\MaxValue`) then the system variable `ERRNO` is set to `ERR_UI_INITVALUE` and the execution continues in the error handler.
- If the minimum value (parameter `\MinValue`) is greater then the maximum value (parameter `\MaxValue`) then the system variable `ERRNO` is set to `ERR_UI_MAXMIN` and the execution continues in the error handler.
- If the initial value (parameter `\InitValue`) is not an integer as specified in the parameter `\AsInteger` then the system variable `ERRNO` is set to `ERR_UI_NOTINT` and the execution continues in the error handler.

Limitations

Avoid using too small a value for the time-out parameter `\MaxTime` when `UINumEntry` is frequently executed, for example in a loop. It can result in unpredictable behavior from the system performance, like slow response of the FlexPendant.

Continues on next page

Syntax

```
UINumEntry´(´
  [´\´Header´:=´ <expression (IN) of string>]
  [Message’:=’ <expression (IN) of string> ]
  | [´\´MsgArray’:=’<array {*} (IN) of string>]
  [´\´Wrap]
  [´\´Icon’:=’ <expression (IN) of icondata>]
  [´\´InitValue’:=’<expression (IN) of num>]
  [´\´MinValue’:=’<expression (IN) of num>]
  [´\´MaxValue’:=’<expression (IN) of num>]
  [´\´AsInteger]
  [´\´MaxTime’:=’ <expression (IN) of num>]
  [\´DIBreak’:=’ <variable (VAR) of signaldi>]
  [´\´DOBreak’:=’ <variable (VAR) of signaldo>]
  [´\´BreakFlag’:=’ <var or pers (INOUT) of errnum>] ´)´
```

A function with return value of the data type `num`.

Related information

For information about	See
Icon display data	*icondata - Icon display data on page 1121*
User Interaction Message Box type basic	*UIMsgBox - User Message Dialog Box type basic on page 644*
User Interaction Message Box type advanced	*UIMessageBox - User Message Box type advanced on page 1057*
User Interaction Number Tune	*UINumTune - User Number Tune on page 1070*
User Interaction Alpha Entry	*UIAlphaEntry - User Alpha Entry on page 1032*
User Interaction List View	*UIListView - User List View on page 1050*
System connected to FlexPendant etc.	*UIClientExist - Exist User Client on page 1037*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

2.149. UINumTune - User Number Tune

Usage

`UINumTune` (*User Interaction Number Tune*) is used to let the operator tune a numeric value from the available user device, such as the FlexPendant. A message is written to the operator, who tunes a numeric value. The tuned numeric value is then checked, approved and transferred back to the program.

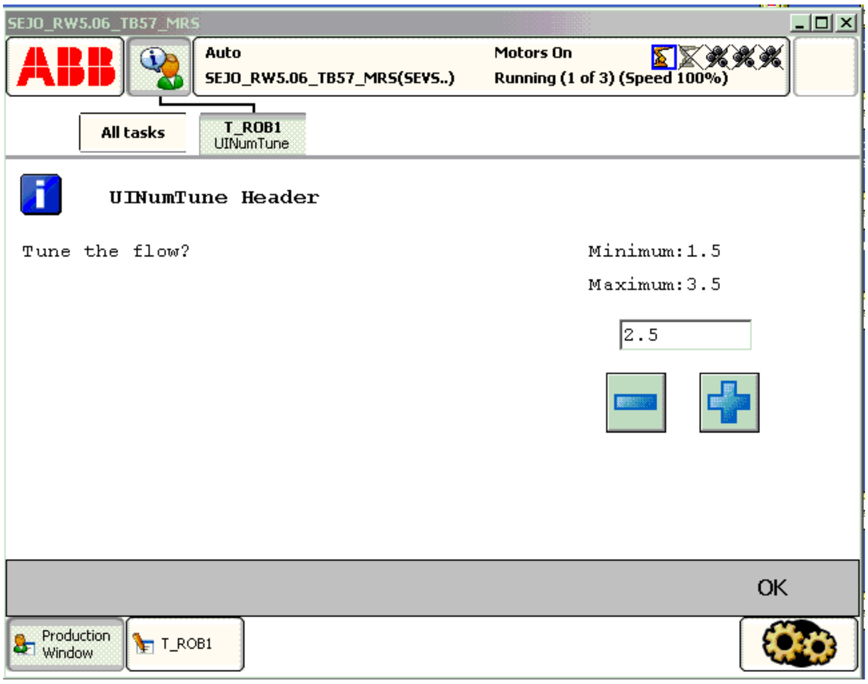
Basic examples

Basic examples of the function `UINumTune` are illustrated below.

See also *More examples on page 1073*.

Example 1

```
VAR num flow;
...
flow := UINumTune(
  \Header:="UINumTune Header"
  \Message:="Tune the flow?"
  \Icon:=iconInfo,
  2.5,
  0.1
  \MinValue:=1.5
  \MaxValue:=3.5);
```



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Continues on next page

Above numeric tune message box with icon, header, message, init-, increment, max-, and minvalue are written on the FlexPendant display. The message box checks that the operator tune the `flow` value with step 0.1 from init value 2.5 is within the value range 1.5 .. 3.5. Program execution waits until OK is pressed and then the selected numerical value is returned and stored in the variable `flow`.

Return value

Data type: `num`

This function returns the tuned numeric value.

If function breaks via `\BreakFlag`, the specified `InitValue` is returned.

If function breaks via `ERROR` handler, no return value is returned at all.

Arguments

```
UINumTune ( [\Header] [\Message] | [\MsgArray] [\Wrap]
     [\Icon] InitValue Increment [\MinValue] [\MaxValue]
     [\MaxTime] [\DIBreak] [\DOBreak] [\BreakFlag] )
```

`[\Header]`

Data type: `string`

Header text to be written at the top of the message box. Max. 40 characters.

`[\Message]`

Data type: `string`

One text line to be written on the display. Max 40 characters.

`[\MsgArray]`

Message Array

Data type: `string`

Several text lines from an array to be written on the display.

Only one of parameter `\Message` or `\MsgArray` can be used at the same time.

Max. layout space is 11 lines with 40 characters each.

`[\Wrap]`

Data type: `switch`

If selected, all the specified strings in the argument `\MsgArray` will be concatenated to one string with a single space between each individual string and spread out on as few lines as possible.

Default, each string in the argument `\MsgArray` will be on separate line on the display.

`[\Icon]`

Data type: `icondata`

Defines the icon to be displayed. Only one of the predefined icons of type icondata can be used. See *Predefined data on page 1073*.

Default no icon.

Continues on next page

`InitValue`

Initial Value

Data type: `num`

Initial value that is displayed in the entry box.

`Increment`

Data type: `num`

This parameter specifies how much the value should change when the plus or minus button is pressed.

`[\MinValue]`

Data type: `num`

The minimum value for the return value.

`[\MaxValue]`

Data type: `num`

The maximum value for the return value.

`[\MaxTime]`

Data type: `num`

The maximum amount of time in seconds that program execution waits. If the OK button is not pressed within this time, the program continues to execute in the error handler unless the `BreakFlag` is used (see below). The constant `ERR_TP_MAXTIME` can be used to test whether or not the maximum time has elapsed.

`[\DIBreak]`

Digital Input Break

Data type: `signaldi`

The digital input signal that may interrupt the operator dialog. If the OK button is not pressed before the signal is set to 1 (or is already 1) then the program continues to execute in the error handler, unless the `BreakFlag` is used (see below). The constant ERR_TP_DIBREAK can be used to test whether or not this has occurred.

`[\DOBreak]`

Digital Output Break

Data type: `signaldo`

The digital output signal that may interrupt the operator dialog. If the OK button is not pressed before the signal is set to 1 (or is already 1) then the program continues to execute in the error handler, unless the `BreakFlag` is used (see below). The constant `ERR_TP_DOBREAK` can be used to test whether or not this has occurred.

`[\BreakFlag]`

Data type: `errnum`

A variable (before used set to 0 by the system) that will hold the error code if `\MaxTime`, `\DIBreak`, or `\DOBreak` is used. The constants `ERR_TP_MAXTIME`, `ERR_TP_DIBREAK`, and `ERR_TP_DOBREAK` can be used to select the reason. If this optional variable is omitted, the error handler will be executed.

Continues on next page

Program execution

The numeric tune message box with tune +/- buttons, icon, header, message lines, init-, increment, max, and minvalue are displayed according to the programmed arguments. Program execution waits until the user has tuned the numeric value and pressed OK or the message box is interrupted by time-out or signal action. The input numeric value and interrupt reason are transferred back to the program.

New message box on `TRAP` level takes focus from message box on basic level.

Predefined data

```
!Icons:
CONST icondata iconNone := 0;
CONST icondata iconInfo := 1;
CONST icondata iconWarning := 2;
CONST icondata iconError := 3;
```

More examples

More examples of the function `UINumTune` are illustrated below.

Example 1

```
VAR errnum err_var;
VAR num tune_answer;
VAR num distance;
...
tune_answer := UINumTune (\Header:=" BWD move on path"
  \Message:="Enter the path overlap ?" \Icon:=iconInfo,
  5, 1 \MinValue:=0 \MaxValue:=10
  \MaxTime:=60 \DIBreak:=di5 \BreakFlag:=err_var);
TEST err_var
  CASE ERR_TP_MAXTIME:
  CASE ERR_TP_DIBREAK:
     ! No operator answer
     distance := 5;
  CASE 0:
     ! Operator answer
     distance := tune_answer;
  DEFAULT:
     ! Not such case defined
ENDTEST
```

The tune message box is displayed and the operator can tune the numeric value and press OK. The message box can also be interrupted with time-out or break by digital input signal. In the program it’s possible to find out the reason and take the appropriate action.

Continues on next page

Error handling

If parameter `\BreakFlag` is not used then these situations can be dealt with by the error handler:

- If there is a time-out (parameter `\MaxTime`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_MAXTIME` and the execution continues in the error handler.
- If digital input is set (parameter `\DIBreak`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_DIBREAK` and the execution continues in the error handler.
- If a digital output is set (parameter `\DOBreak`) before an input from the operator, the system variable `ERRNO` is set to `ERR_TP_DOBREAK` and the execution continues in the error handler.

This situation can only be dealt with by the error handler:

- If there is no client, e.g. a FlexPendant, to take care of the instruction then the system variable `ERRNO` is set to `ERR_TP_NO_CLIENT` and the execution continues in the error handler.
- If the initial value (parameter `\InitValue`) is not specified within the range of the minimum and maximum value (parameters `\MinValue` and `\MaxValue`) then the system variable `ERRNO` is set to `ERR_UI_INITVALUE` and the execution continues in the error handler.
- If the minimum value (parameter `\MinValue`) is greater than the maximum value (parameter `\MaxValue`) then the system variable `ERRNO` is set to `ERR_UI_MAXMIN` and the execution continues in the error handler.

Limitations

Avoid using too small a value for the time-out parameter `\MaxTime` when `UINumTune` is frequently executed, for example in a loop. It can result in unpredictable behavior from the system performance, like slow response of the FlexPendant.

Syntax

```
UINumTune'('
  ['\'Header':=' <expression (IN) of string>]
  ['\'Message':=' <expression (IN) of string> ]
  | ['\'MsgArray':='<array {*} (IN) of string>]
  ['\'Wrap]
  ['\'Icon':=' <expression (IN) of icondata>] ',']
  [InitValue':=' ] <expression (IN) of num> ','
  [Increment':=' ] <expression (IN) of num>
  ['\'MinValue':='<expression (IN) of num>]
  ['\'MaxValue':='<expression(IN) of num>]
  ['\'MaxTime':=' <expression (IN) of num>]
  ['\'DIBreak':=' <variable (VAR) of signaldi>]
  ['\'DOBreak':=' <variable (VAR) of signaldo>]
  ['\'BreakFlag':=' <var or pers (INOUT) of errnum>] ')'
```

A function with return value of the data type `num`.

Continues on next page

Related information

For information about	See
Icon display data	*icondata - Icon display data on page 1121*
User Interaction Message Box type basic	*UIMsgBox - User Message Dialog Box type basic on page 644*
User Interaction Message Box type advanced	*UIMessageBox - User Message Box type advanced on page 1057*
User Interaction Number Entry	*UINumEntry - User Number Entry on page 1064*
User Interaction Alpha Entry	*UIAlphaEntry - User Alpha Entry on page 1032*
User Interaction List View	*UIListView - User List View on page 1050*
System connected to FlexPendant etc.	*UIClientExist - Exist User Client on page 1037*
Clean up the Operator window	*TPErase - Erases text printed on the FlexPendant on page 556*

2.150. ValidIO - Valid I/O signal to access

Usage

`ValidIO` is used to check if the specified I/O signal can be accessed without any error at present.

Basic examples

Basic examples of the function `ValidIO` are illustrated below.

Example 1

```
IF ValidIO(mydosignal) SetDO mydosignal, 1;
```

Set the digital output signal `mydosignal` to `1` if it's I/O unit is up and running.

Return value

Data type: `bool`

Returns `TRUE` is valid signal and the I/O unit for the signal is up and running, else `FALSE`.

Arguments

```
ValidIO (Signal)
```

`Signal`

Data type: `signalxx`

The signal name. Must be of data type `signaldo`, `signaldi`, `signalgo`, `signalgi`, `signalao` or `signalai`.

Program execution

Execution behaviour:

- Check if valid I/O signal
- Check if the I/O unit for the signal is up and running.

No error messages are generated.

Syntax

```
ValidIO '('
  [Signal ':='] <variable (VAR) of anytype>
  ')'
```

A function with a return value of the data type `bool`.

Continues on next page

Related information

For information about	See
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and Output Signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - I/O Principles*
Configuration of I/O	*Technical reference manual - System parameters*
Define I/O signal with alias name	*AliasIO - Define I/O signal with alias name on page 21*

2.151. ValToStr - Converts a value to a string

Usage

`ValToStr` (*Value To String*) is used to convert a value of any data type to a string.

Basic examples

Basic examples of the function `ValToStr` are illustrated below.

Example 1

```
VAR string str;
VAR pos p := [100,200,300];

str := ValToStr(p);
```

The variable `str` is given the value `"[100,200,300]"`.

Example 2

```
str := ValToStr(TRUE);
```

The variable `str` is given the value "`TRUE`".

Example 3

```
str := ValToStr(1.234567890123456789);
```

The variable `str` is given the value `"1.23456789012346"`.

Example 4

```
VAR num numtype:=1.234567890123456789;

str := ValToStr(numtype);
```

The variable `str` is given the value `"1.23457"`.

Example 5

```
VAR dnum dnumtype:=1.234567890123456789;

str := ValToStr(dnumtype);
```

The variable `str` is given the value `"1.23456789012346"`.

Return value

Data type: `string`

The value is converted to a string with standard `RAPID` format. This means, in principle, 6 significant digits. Literal value interpreted as a `dnum` (see example 3) and `dnum` variabels (see example 5) though have 15 significant digits.

A runtime error is generated if the resulting string is too long.

Continues on next page

Arguments

```
ValToStr ( Val )
```

`Val`

Value

Data type: `anytype`

A value of any data type. All types of value data with structure atomic, record, record component, array, or array element can be used.

Syntax

```
ValToStr'('
  [ Val ':=' ] <expression (IN) of anytype>
  ')'
```

A function with a return value of the data type `string`.

Related information

For information about	See
String functions	*Technical reference manual - RAPID overview*, section *RAPID summary - String functions*
Definition of string	*string - Strings on page 1195*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*

2.152. VectMagn - Magnitude of a pos vector

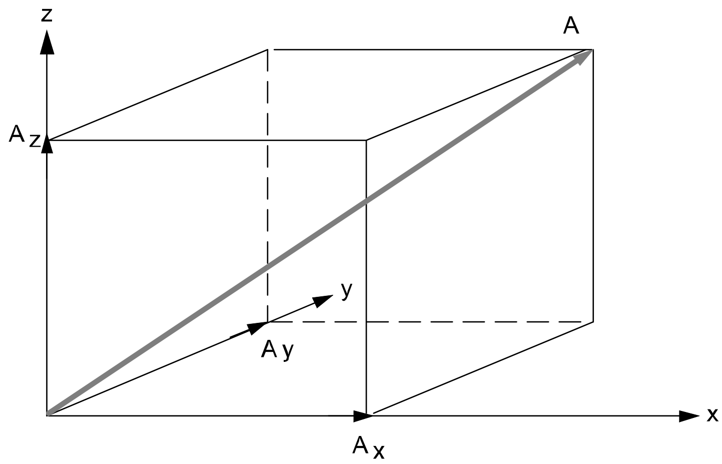
Usage

`VectMagn` (*Vector Magnitude*) is used to calculate the magnitude of a `pos` vector.

Basic examples

Basic examples of the function `VectMagn` are illustrated below.

Example 1



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A vector **A** can be written as the sum of its components in the three orthogonal directions:

$$A = A_x x + A_y y + A_z z$$

The magnitude of **A** is:

$$|A| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

The vector is described by the data type `pos` and the magnitude by the data type `num`:

```
VAR num magnitude;
VAR pos vector;
...
vector := [1,1,1];
magnitude := VectMagn(vector);
```

Return value

Data type: `num`

The magnitude of the vector (data type `pos`).

Arguments

```
VectMagn (Vector)
```

`Vector`

Data type: `pos`

The vector described by the data type `pos`.

Continues on next page

Syntax

```
VectMagn'('
  [Vector ':='] <expression (IN) of pos>
  ')'
```

A function with a return value of the data type `num`.

Related information

For information about	See
Mathematical instructions and functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Mathematics*

3 Data types

3.1. aiotrigg - Analog I/O trigger condition

Usage

`aiotrigg` (*Analog I/O Trigger*) is used to define the condition to generate an interrupt for an analog input or output signal.

Description

Data of the type `aiotrigg` defines the way a low and a high threshold will be used to determine whether the logical value of an analog signal satisfies a condition to generate an interrupt.

Basic examples

Basic examples of the data type `aiotrigg` are illustrated below.

Example 1

```
VAR intnum sig1int;
CONNECT sig1int WITH iroutine1;
ISignalAI \Single, ai1, AIO_BETWEEN, 1.5, 0.5, 0, sig1int;
```

Orders an interrupt which is to occur the first time the logical value of the analog input signal `ai1` is between `0.5` and `1.5`. A call is then made to the `iroutine1` trap routine.

Predefined data

The following symbolic constants of the data type `aiotrigg` are predefined and can be used when specifying a condition for the instructions`ISignalAI` and `ISignalAO`.

Value	Symbolic constant	Comment
1	`AIO_ABOVE_HIGH`	Signal will generate interrupts if above specified high value
2	`AIO_BELOW_HIGH`	Signal will generate interrupts if below specified high value
3	`AIO_ABOVE_LOW`	Signal will generate interrupts if above specified low value
4	`AIO_BELOW_LOW`	Signal will generate interrupts if below specified low value
5	`AIO_BETWEEN`	Signal will generate interrupts if between specified low and high values
6	`AIO_OUTSIDE`	Signal will generate interrupts if below specified low value or above specified high value
7	`AIO_ALWAYS`	Signal will always generate interrupts

Characteristics

`aiotrigg` is an alias data type for `num` and consequently inherits its characteristics.

Continues on next page

Related information

For information about	See
Interrupt from analog input signal	*ISignalAI - Interrupts from analog input signal on page 171*
Interrupt from analog output signal	*ISignalAO - Interrupts from analog output signal on page 182*
Data types in general, alias data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*

3.2. bool - Logical values

Usage

`bool` is used for logical values (true/false).

Description

The value of data of the type `bool` can be either `TRUE` or `FALSE`.

Basic examples

Basic examples of the data type `bool` are illustrated below.

Example 1

```
flag1 := TRUE;
```

flag is assigned the value TRUE.

Example 2

```
VAR bool highvalue;
VAR num reg1;
...
highvalue := reg1 > 100;
```

`highvalue` is assigned the value `TRUE` if `reg1` is greater than `100`; otherwise, `FALSE` is assigned.

Example 3

```
IF highvalue Set do1;
```

The `do1` signal is set if `highvalue` is `TRUE`.

Example 4

```
highvalue := reg1 > 100;
mediumvalue := reg1 > 20 AND NOT highvalue;
```

`mediumvalue` is assigned the value `TRUE` if `reg1` is between `20` and `100`.

Related information

For information about	See
Logical expressions	*Technical reference manual - RAPID overview*, section *Basic characteristics - Expressions*
Operations using logical values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Expressions*

3.3. btnres - Push button result data

Usage

`btnres` (*button result*) is used for representing the user selection of the push button display on the User Device such as the FlexPendant.

Description

A `btnres` constant is intended to be used when checking the result value from the instruction `UIMsgBox` and the return value from the functions `UIMessageBox` and `UIListView`.

Basic examples

Basic examples of the data type `btnres` are illustrated below.

Example 1

```
VAR btnres answer;

UIMsgBox "More ?" \Buttons:=btnYesNo \Result:= answer;
IF answer= resYes THEN
  ...
ELSEIF answer =ResNo THEN
  ...
ENDIF
```

The standard button enumeration `btnYesNo` will give one Yes and one No push button on the user interface. The user selection will be stored in the variable `answer`.

Predefined data

The following constants of the data type `btnres` are predefined in the system

Value	Constants	Button answer
0	`resUnkwn`	Unknown result
1	`resOK`	OK
2	`resAbort`	Abort
3	`resRetry`	Retry
4	`resIgnore`	Ignore
5	`resCancel`	Cancel
6	`resYes`	Yes
7	`resNo`	No

It is possible to work with user defined push buttons that answer with the functions `UIMessageBox` and `UIListView`.

Characteristics

`btnres` is an alias data type for `num` and consequently inherits its characteristics.

Continues on next page

Related information

For information about	See
User Interaction Message Box	*UIMsgBox - User Message Dialog Box type basic on page 644*
User Interaction Message Box	*UIMessageBox - User Message Box type advanced on page 1057*
User Interaction List View	*UIListView - User List View on page 1050*
Alias data type button data	*buttondata - Push button data on page 1089*

3.4. busstate - State of I/O bus

Usage

`busstate` is used to mirror which state an I/O bus is currently in.

Description

A `busstate` constant is intended to be used when checking the return value from the instruction `IOBusState`.

Basic examples

Basic example of the data type `busstate` is illustrated below.

Example 1

```
VAR busstate bstate;

IOBusState "IBS", bstate \Phys;
TEST bstate
CASE IOBUS_PHYS_STATE_RUNNING:
  ! Possible to access some signal on the IBS bus
DEFAULT:
  ! Actions for not up and running IBS bus
ENDTEST
```

Predefined data

The predefined symbolic constants of the data type `busstate` can be viewed in instruction `IOBusState`.

Characteristics

`busstate` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Get current state of I/O bus	*IOBusState - Get current state of I/O bus on page 156*
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and Output Signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - I/O Principles*
Configuration of I/O	*Technical reference manual - System parameters*

3.5. buttondata - Push button data

Usage

`buttondata` is used for representing a standard push button combination for display on the User Device such as the FlexPendant.

Description

A `buttondata` constant is used for representing response push buttons in instruction `UIMsgBox` and functions `UIMessageBox` and `UIListView`.

Basic examples

Basic examples of the data type `buttondata` are illustrated below.

Example 1

```
VAR btnres answer;
UIMsgBox "More ?" \Buttons:=btnYesNo \Result:= answer;
IF answer= resYes THEN
...
ELSE
...
ENDIF
```

The standard button enumeration `btnYesNo` will give one Yes and one No push button.

Predefined data

The following constants of the data type `buttondata` are predefined in the system.

Value	Constants	Button displayed
- 1	`btnNone`	No button
0	`btnOK`	OK
1	`btnAbrtRtryIgn`	Abort, Retry and Ignore
2	`btnOKCancel`	OK and Cancel
3	`btnRetryCancel`	Retry and Cancel
4	`btnYesNo`	Yes and No
5	`btnYesNoCancel`	Yes, No and Cancel

It is possible to display user defined push buttons with the functions `UIMessageBox` and `UIListView`.

Characteristics

`buttondata` is an alias data type for `num` and consequently inherits its characteristics.

Continues on next page

Related information

For information about	See
User Interaction Message Box	*UIMsgBox - User Message Dialog Box type basic on page 644*
User Interaction Message Box	*UIMessageBox - User Message Box type advanced on page 1057*
User Interaction List View	*UIListView - User List View on page 1050*
Alias data type button result	*btnres - Push button result data on page 1086*
Data types in general, alias data types	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Data Types*

3.6. byte - Integer values 0 - 255

Usage

`byte` is used for integer values (0 - 255) according to the range of a byte.

This data type is used in conjunction with instructions and functions that handle the bit manipulations and convert features.

Description

Data of the type `byte` represents an integer byte value.

Basic examples

Basic examples of the data type `byte` are illustrated below.

Example 1

```
VAR byte data1 := 130;
```

Definition of a variable `data1` with a decimal value 130.

Example 2

```
CONST num parity_bit := 8;
VAR byte data1 := 130;
BitClear data1, parity_bit;
```

Bit number 8 (`parity_bit`) in the variable `data1` will be set to 0, e.g. the content of the variable `data1` will be changed from 130 to 2 (integer representation).

Error handling

If an argument of the type `byte` has a value that is not in the range between 0 and 255, an error is returned on program execution.

Characteristics

`byte` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Alias data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*
Bit functions	*Technical reference manual - RAPID overview*, section *RAPID summary - Bit functions*

3.7. clock - Time measurement

Usage

`Clock` is used for time measurement. A clock functions like a stopwatch used for timing.

Description

Data of the type `clock` stores a time measurement in seconds and has a resolution of 0.01 seconds.

Basic examples

Basic examples of the data type `clock` are illustrated below.

Example 1

```
VAR clock myclock;
ClkReset myclock;
```

The clock, `myclock,` is declared and reset. Before using `ClkReset`, `ClkStart`, `ClkStop`, and `ClkRead`, you must declare a variable of data type `clock` in your program.

Limitations

The maximum time that can be stored in a clock variable is approximately 49 days (4,294,967 seconds). The instructions `ClkStart`, `ClkStop`, and `ClkRead` report clock overflows in the very unlikely event that one occurs.

A clock must be declared as a `VAR` variable type, not as a `persistent` variable type.

Characteristics

`clock` is a non-value data type and cannot be used in value-oriented operations.

Related information

For information about	See
Summary of Time and Date Instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - System & time*
Non-value data type characteristics	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*

3.8. confdata - Robot configuration data

Usage

`confdata` is used to define the axis configurations of the robot.

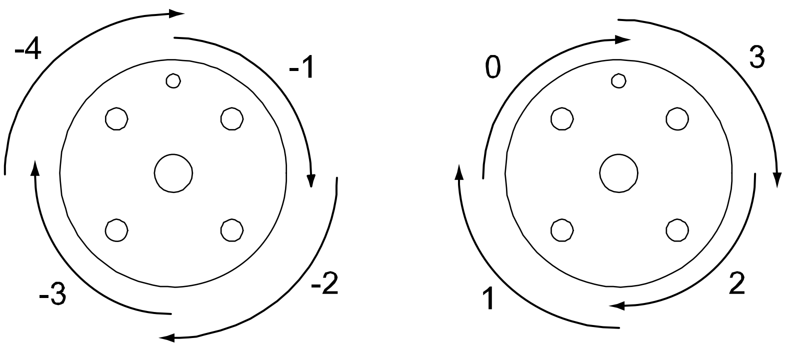
Description

All positions of the robot are defined and stored using rectangular coordinates. When calculating the corresponding axis positions, there will often be two or more possible solutions. This means that the robot is able to achieve the same position, i.e. the tool is in the same position and with the same orientation with several different positions or configurations of the robots axes.

Some robot types use iterative numerical methods to determine the robot axes positions. In these cases the configuration parameters may be used to define good starting values for the joints to be used by the iterative procedure.

To unambiguously denote one of these possible configurations, the robot configuration is specified using four axis values. For a rotating axis, the value defines the current quadrant of the robot axis. The quadrants are numbered 0, 1, 2, etc. (they can also be negative). The quadrant number is connected to the current joint angle of the axis. For each axis, quadrant 0 is the first quarter revolution, 0 to 90°, in a positive direction from the zero position; quadrant 1 is the next revolution, 90 to 180°, etc. Quadrant -1 is the revolution 0° to (-90°), etc. (see figure below).

The figure shows the configuration quadrants for axis 6.



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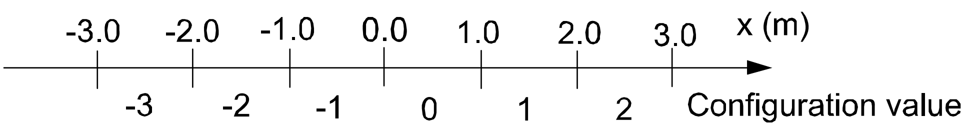
For a linear axis, the value defines a meter interval for the robot axis. For each axis, value 0 means a position between 0 and 1 meters and 1 means a position between 1 and 2 meters. For negative values, -1 means a position between -1 and 0 meters, etc. (see figure below).

The figure shows configuration values for a linear axis.



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Robot configuration data for IRB 140, 6600, 6650, 7600

There are three singularities within the robot's working range (See *RAPID reference manual - RAPID summary*, section *Motion and I/O principles - Singularities*).

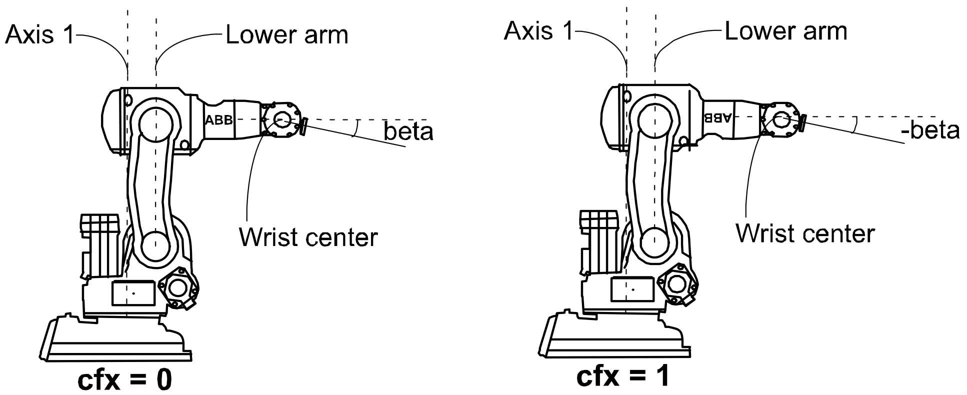
- `cf1` is the quadrant number for axis 1.
- `cf4` is the quadrant number for axis 4.
- `cf6` is the quadrant number for axis 6.

`cfx` is used to select one of eight possible robot configurations numbered from 0 through 7. The table below describes each one of them in terms of how the robot is positioned relative to the three singularities.

cfx	Wrist center relative to axis 1	Wrist center relative to lower arm	Axis 5 angle
0	In front of	In front of	Positive
1	In front of	In front of	Negative
2	In front of	Behind	Positive
3	In front of	Behind	Negative
4	Behind	In front of	Positive
5	Behind	In front of	Negative
6	Behind	Behind	Positive
7	Behind	Behind	Negative

The pictures below give an example of how the same tool position and orientation is attained by using the eight different configurations.

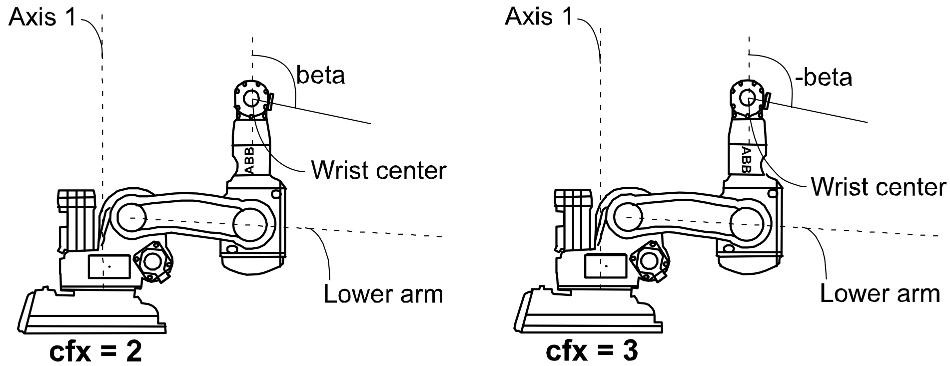
The following figure shows an example of robot configuration 0 and 1. Note the different signs of the axis 5 angle.



xx0500002400

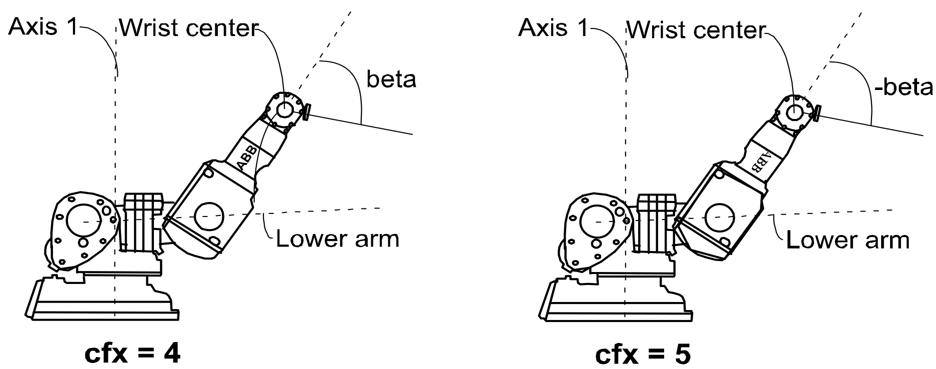
Continues on next page

The following figure shows an example of robot configuration 2 and 3. Note the different signs of the axis 5 angle.



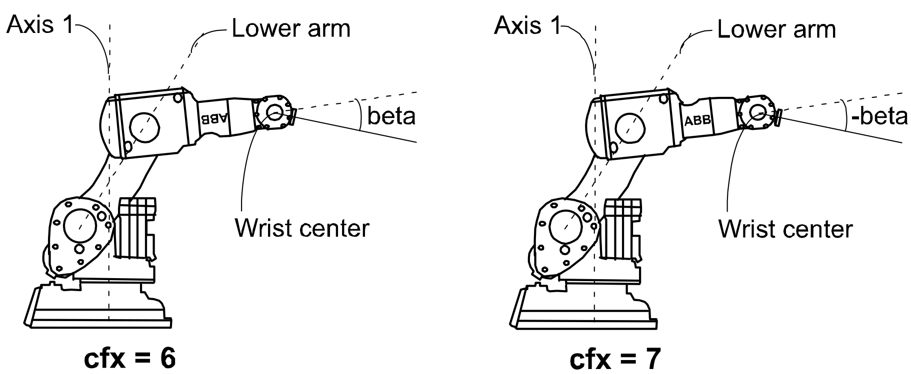
xx0500002401

The following figure shows an example of robot configuration 4 and 5. Note the different signs of the axis 5 angle.



xx0500002402

The following figure shows an example of robot configuration 6 and 7. Note the different signs of the axis 5 angle.



xx0500002403

Robot configuration data for IRB 340

Only the configuration parameter `cf4` is used.

Robot configuration data for IRB 260, 660

Only the configuration parameter `cf6` is used.

Continues on next page

Robot configuration data for IRB 1400, 2400, 3400, 4400, 6400

Only the three configuration parameters `cf1`, `cf4`, and `cf6` are used.

Robot configuration data for IRB 5400

All four configuration parameters are used. `cf1`, `cf4`, `cf6` for joints 1, 4, and 6 respectively and `cfx` for joint 5.

Robot configuration data for IRB 5404, 5406

The robots have two rotation axes (arms 1 and 2) and one linear axis (arm 3).

- `cf1` is used for the rotating axis 1
- `cfx` is used for the rotating axis 2
- `cf4` and `cf6` are not used

Robot configuration data for IRB 5413, 5414, 5423

The robots have two linear axes (arms 1 and 2) and one or two rotating axes (arms 4 and 5). (Arm 3 locked).

- `cf1` is used for the linear axis 1
- `cfx` is used for the linear axis 2
- `cf4` is used for the rotating axis 4
- `cf6` is not used

Robot configuration data for IRB 840

The robot has three linear axes (arms 1, 2 and 3) and one rotating axis (arm 4).

- `cf1` is used for the linear axis 1
- `cfx` is used for the linear axis 2
- `cf4` is used for the rotating axis 4
- `cf6` is not used

Because of the robot's mainly linear structure, the correct setting of the configuration parameters `c1`, `cx` is of less importance.

Components

`cf1`

Data type: `num`

Rotating axis:

The current quadrant of axis 1, expressed as a positive or negative integer.

Linear axis:

The current meter interval of axis 1, expressed as a positive or negative integer.

Continues on next page

`cf4`

Data type: `num`

Rotating axis:

The current quadrant of axis 4, expressed as a positive or negative integer.

Linear axis:

The current meter interval of axis 4, expressed as a positive or negative integer.

`cf6`

Data type: `num`

Rotating axis:

The current quadrant of axis 6, expressed as a positive or negative integer.

Linear axis:

The current meter interval of axis 6, expressed as a positive or negative integer.

`cfx`

Data type: `num`

Rotating axis:

For the IRB 140, the current robot configuration, expressed as an integer in the range from 0 to 7.

For the IRB 5400, the current quadrant of axis 5, expressed as a positive or negative integer.

For other robots, using the current quadrant of axis 2, expressed as a positive or negative integer.

Linear axis:

The current meter interval of axis 2, expressed as a positive or negative integer.

Basic examples

Basic examples of the data type `confdata` are illustrated below.

Example 1

```
VAR confdata conf15 := [1, -1, 0, 0]
```

A robot configuration `conf15` for robot type IRB 5400 is defined as follows:

- The axis configuration of the robot axis 1 is quadrant 1, i.e. 90-180º.
- The axis configuration of the robot axis 4 is quadrant `-1`, i.e. 0-(-90º).
- The axis configuration of the robot axis 6 is quadrant `0`, i.e. 0 - 90º.
- The axis configuration of the robot axis 5 is quadrant `0`, i.e. 0 - 90º.

Structure

```
< dataobject of confdata >
  < cf1 of num >
  < cf4 of num >
  < cf6 of num >
  < cfx of num >
```


Continues on next page

Related information

For information about	See
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
Handling configuration data	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Robot configuration*
Position data	*robtarget - Position data on page 1176*

3.9. corrdescr - Correction generator descriptor

Usage

`corrdescr` (*Correction generator descriptor*) is used by correction generators. A correction generator adds geometric offsets in the path coordinate system.

Description

Data of the type `corrdescr` contains a reference to a correction generator.

Connection to a correction generator is done by the instruction `CorrCon` and the descriptor (the reference to the correction generator) can be used to deliver geometric offsets in the path coordinate system with the instruction `CorrWrite`.

Offsets provided earlier can be removed by disconnecting a correction generator with the instruction `CorrDiscon`. All connected correction generators can be removed with the instruction `CorrClear`.

The function `CorrRead` returns the sum of all the delivered offsets so far (includes all connected correction generators).

Basic examples

Basic examples of the data type `corrdescr` are illustrated below.

Example 1

```
VAR corrdescr id;
VAR pos offset;
...
CorrCon id;
offset := [1, 2 ,3];
CorrWrite id, offset;
```

A correction generator is connected with the instruction `CorrCon` and referenced by the descriptor `id`. Offsets are then delivered to the correction generator (with reference `id`) using the instruction `CorrWrite`.

Characteristics

`corrdescr` is a non-value data type.

Continues on next page

Related information

For information about	See
Connects to a correction generator	*CorrCon - Connects to a correction generator on page 71*
Disconnects from a correction generator	*CorrDiscon - Disconnects from a correction generator on page 76*
Writes to a correction generator	*CorrWrite - Writes to a correction generator on page 77*
Reads the current total offsets	*CorrRead - Reads the current total offsets on page 803*
Removes all correction generators	*CorrClear - Removes all correction generators on page 70*
Characteristics of non-value data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*

3.10. datapos - Enclosing block for a data object

Usage

`datapos` is the enclosing block to a data object (internal system data) retrieved with the function `GetNextSym`.

Description

Data of the type `datapos` contains information of where a certain object is defined in the system. It is used for instructions `GetDataVal` and `SetDataVal`.

Basic examples

Basic examples of the data type `datapos` are illustrated below.

Example 1

```
VAR datapos block;
VAR string name;
VAR bool truevar:=TRUE;
...
SetDataSearch "bool" \Object:="my.*" \InMod:="mymod"\LocalSym;
WHILE GetNextSym(name,block) DO
  SetDataVal name\Block:=block,truevar;
ENDWHILE
```

This session will set all local `bool` data objects that begin with `my` in the module `mymod` to `TRUE`.

Characteristics

`datapos` is a non-value data type.

Related information

For information about	See
Define a symbol set in a search session	*SetDataSearch - Define the symbol set in a search sequence on page 433*
Get next matching symbol	*GetNextSym - Get next matching symbol on page 855*
Get the value of a data object	*GetDataVal - Get the value of a data object on page 110*
Set the value of a data object	*SetDataVal - Set the value of a data object on page 437*
Set the value of many object	*SetAllDataVal - Set a value to all data objects in a defined set on page 429*

3.11. dionum - Digital values (0 - 1)

Usage

`dionum` *(digital input output numeric)* is used for digital values (0 or 1).

This data type is used in conjunction with instructions and functions that handle digital input or output signals.

Description

Data of the type `dionum` represents a digital value 0 or 1.

Basic examples

Basic examples of the data type `dionum` are illustrated below.

Example 1

```
CONST dionum close := 1;
SetDO grip1, close;
```

Definition of a constant `close` with a value equal to `1`. The signal `grip1` is then set to `close`, i.e. `1`.

Predefined data

The constants `high`, `low`, and `edge` are predefined in the system module `base.sys`:

```
CONST dionum low:=0;
CONST dionum high:=1;
CONST dionum edge:=2;
```

The constants `low` and `high` are designed for IO instructions.

`Edge` can be used together with the interrupt instructions `ISignalDI` and `ISignalDO`.

Characteristics

`dionum` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Summary input/output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and output signals*
Configuration of I/O	*Technical reference manual - System parameters*
Alias data types	*Technical reference manual - RAPID overview*, section *Basic Characteristics- Data types*

3.12. dir - File directory structure

Usage

`dir` (*directory*) is used to traverse directory structures.

Description

Data of the type `dir` contains a reference to a directory on disk or network. It can be linked to the physical directory by means of the instruction `OpenDir` and then used for reading.

Basic examples

Basic examples of the data type `dir` are illustrated below.

Example 1

```
PROC lsdir(string dirname)
  VAR dir directory;
  VAR string filename;
  OpenDir directory, dirname;
  WHILE ReadDir(directory, filename) DO
     TPWrite filename;
  ENDWHILE
  CloseDir directory;
ENDPROC
```

This example prints out the names of all files or subdirectories under the specified directory.

Characteristics

`dir` is a non-value data type and cannot be used in value-oriented operations.

Related information

For information about	See
Open a directory	*OpenDir - Open a directory on page 285*
Make a directory	*MakeDir - Create a new directory on page 218*
Read a directory	*ReadDir - Read next entry in a directory on page 944*
Close a directory	*CloseDir - Close a directory on page 56*
Remove a directory	*RemoveDir - Delete a directory on page 355*
Remove a file	*RemoveFile - Delete a file on page 356*
Rename a file	*RenameFile - Rename a file on page 357*
Check file type	*IsFile - Check the type of a file on page 878*

3.13. dnum - Double numeric values

Usage

`dnum` is used for numeric values, for example counters. It can handle larger integer values than data type `num` but its characteristics and function is the same as for `num`.

Description

The value of the `dnum` data type can be:

- An integer, for example -5
- A decimal number, for example 3.45

It can also be written exponentially, for example 2E3 (= 2*10^3 = 2000), 2.5E-2 (= 0.025).

Integers between -4503599627370496 and +4503599627370496 are always stored as exact integers.

Basic examples

Basic examples of the data type `dnum` are illustrated below.

Example 1

```
VAR dnum reg1;
...
reg1:=1000000;
```

`reg1` is assigned the value `1000000`.

Example 2

```
VAR dnum hex;
Var dnum bin;
VAR dnum oct;
! Hexadecimal representation of decimal value 4294967295
hex := 0xFFFFFFFF;
! Binary representation of decimal value 255
bin := 0b11111111;
! Octal representation of decimal value 255
oct := 0o377;
```

Example 3

```
VAR dnum a:=0;
VAR dnum b:=0;
a := 10 DIV 3;
b := 10 MOD 3;
```

Integer division where `a` is assigned an integer (=3) and `b` is assigned the remainder (=1).

Limitations

Literal values between -4503599627370496 to 4503599627370496 assigned to a `dnum` variable are stored as exact integers.

If a literal value that has been interpreted as a `num` is assigned/used as a `dnum`, it is automatically converted to a `dnum`.

Continues on next page

Related information

For information about	See
Numeric values using data type `num`	*num - Numeric values on page 1146*
Numeric expressions	*Technical reference manual - RAPID overview,* section *Basic RAPID programming*
Operations using numeric values	*Technical reference manual - RAPID overview,* section *Basic RAPID programming*

3.14. errdomain - Error domain

Usage

`errdomain` (*error domain*) is used to specify an error domain.

Description

Data of the type `errdomain` represents the domain where the error, warning, or state changed is logged.

Basic examples

Basic examples of the data type `errdomain` are illustrated below.

Example 1

```
VAR errdomain err_domain;
VAR num err_number;
VAR errtype err_type;
VAR trapdata err_data;
...
TRAP trap_err
  GetTrapData err_data;
  ReadErrData err_data, err_domain, err_number, err_type;
ENDTRAP
```

When an error is trapped to the trap routine `trap_err`, the error domain, the error number, and the error type are saved into appropriate variables.

Predefined data

The following predefined constants can be used to specify an error domain.

Name	Error Domain	Value
COMMON_ERR	All error and state changed domains	0
OP_STATE	Operational state change	1
SYSTEM_ERR	System errors	2
HARDWARE_ERR	Hardware errors	3
PROGRAM_ERR	Program errors	4
MOTION_ERR	Motion errors	5
OPERATOR_ERR	Operator errors - Obsolete, not used anymore	6
IO_COM_ERR	I/O and Communication errors	7
USER_DEF_ERR	User defined errors (raised by RAPID)	8
OPTION_PROD_ERR	Optional product errors - Obsolete, not used any more	9
PROCESS_ERR	Process errors	11
CFG_ERR	Configuration error	12

Characteristics

`errdomain` is an alias data type for num and consequently inherits its characteristics.

Continues on next page

Related information

For information about	See
Ordering an interrupt on errors	*IError - Orders an interrupt on errors on page 126*
Error numbers	*Operating manual - Trouble shooting*
Alias data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*

3.15. errnum - Error number

Usage

`errnum` is used to describe all recoverable (non fatal) errors that occur during program execution, such as division by zero.

Description

If the robot detects an error during program execution, this can be dealt with in the error handler of the routine. Examples of such errors are values that are too high and division by zero. The system variable `ERRNO`, of type `errnum`, is thus assigned different values depending on the nature of an error. The error handler may be able to correct an error by reading this variable and then program execution can continue in the correct way.

An error can also be created from within the program using the `RAISE` instruction. This particular type of error can be detected in the error handler by specifying an error number (within the range 1-90 or booked with instruction `BookErrNo`) as an argument to `RAISE`.

Basic examples

Basic examples of the data type `errnum` are illustrated below.

Example 1

```
reg1 := reg2 / reg3;
...
ERROR
  IF ERRNO = ERR_DIVZERO THEN
    reg3 := 1;
    RETRY;
  ENDIF
```

If `reg3 = 0`, the robot detects an error when division is taking place. This error, however, can be detected and corrected by assigning `reg3` the value `1`. Following this, the division can be performed again and program execution can continue.

Example 2

```
CONST errnum machine_error := 1;
...
IF di1=0 RAISE machine_error;
...
ERROR
  IF ERRNO=machine_error RAISE;
```

An error occurs in a machine (detected by means of the input signal `di1`). A jump is made to the error handler in the routine which, in turn, calls the error handler of the calling routine where the error may possibly be corrected. The constant, `machine_error`, is used to let the error handler know exactly what type of error has occurred.

Continues on next page

Predefined data

The system variable ERRNO can be used to read the latest error that occurred. A number of predefined constants can be used to determine the type of error that has occurred.

Name	Cause of error
ERR_ACC_TOO_LOW	Too low acceleration/deceleration specified in instruction PathAccLim or WorldAccLim
ERR_ALIASIO_DEF	The FromSignal is not defined in the IO configuration or the ToSignal is not declared in the RAPID program or is defined in the IO configuration. Instruction AliasIO
ERR_ALIASIO_TYPE	The signal types for the arguments FromSignal and ToSignal is not the same (signalx). Instruction AliasIO.
ERR_ALRDYCNT	The interrupt variable is already connected to a TRAP routine
ERR_ALRDY_MOVING	The robot is already moving when executing a StartMove or StartMoveRetry instruction
ERR_AO_LIM	Analog signal value outside limit
ERR_ARGDUPCND	More than one present conditional argument for the same parameter
ERR_ARGNAME	Argument is an expression, not present, or of type switch when executing ArgName
ERR_ARGNOTPER	Argument is not a persistent reference
ERR_ARGNOTVAR	Argument is not a variable reference
ERR_ARGVALERR	Argument value error
ERR_AXIS_ACT	Axis is not active
ERR_AXIS_IND	Axis is not independent
ERR_AXIS_MOVING	Axis is moving
ERR_AXIS_PAR	Parameter axis in instruction is wrong
ERR_BUSSTATE	An IOEnable is done, and the bus is in error state or enter error state before the unit is activated
ERR_BWDLIMIT	Limit StepBwdPath
ERR_CALC_NEG	StrDig necative calculation error
ERR_CALC_OVERFLOW	StrDig calculation overflow
ERR_CALC_DIVZERO	StrDig division by zero
ERR_CALLPROC	Procedure call error (not procedure) at runtime (late binding)
ERR_CFG_INTERNAL	Not allowed to read internal parameter - ReadCfgData
ERR_CFG_ILLTYPE	Type mismatch - ReadCfgData, WriteCfgData
ERR_CFG_LIMIT	Data limit - WriteCfgData
ERR_CFG_NOTFND	Not found - ReadCfgData, WriteCfgData
ERR_CFG_OUTOFBOUNDS	If ListNo is -1 at input or bigger then number of available instances - ReadCfgData, WriteCfgData
ERR_CNTNOTVAR	CONNECT target is not a variable reference
ERR_CNV_NOT_ACT	The conveyor is not activated
ERR_CNV_CONNECT	The WaitWobj instruction is already active

Continues on next page

Name	Cause of error
`ERR_CNV_DROPPED`	The object that the instruction `WaitWobj` was waiting for has been dropped.
`ERR_COMM_EXT`	Communication error with the external system.
`ERR_COMM_INIT_FAILED`	Communication interface could not be initialized.
`ERR_DATA_RECV`	The data received from remote system is incorrect.
`ERR_DEV_MAXTIME`	Timeout when executing a `ReadBin`, `ReadNum`, or a `ReadStr` instruction
`ERR_DIPLAG_LIM`	Too big `DipLag` in the instruction `TriggSpeed` connected to current `TriggL/TriggC/TriggJ`
`ERR_DIVZERO`	Division by zero
`ERR_EXECPHR`	An attempt was made to execute an instruction using a place holder
`ERR_FILEACC`	A file is accessed incorrectly
`ERR_FILEEXIST`	A file already exists
`ERR_FILEOPEN`	A file cannot be opened
`ERR_FILNOTFND`	File not found
`ERR_FNCNORET`	No return value
`ERR_FRAME`	Unable to calculate new frame
`ERR_GO_LIM`	Digital group signal value outside limit
`ERR_ILLDIM`	Incorrect array dimension
`ERR_ILLQUAT`	Attempt to use illegal orientation (quaternion) valve
`ERR_ILLRAISE`	Error number in `RAISE` out of range
`ERR_INDCNV_ORDER`	An instruction requires execution of `IndCnvInit` before it is executed.
`ERR_INOISSAFE`	If trying to deactivate a safe interrupt temporarily with `ISleep`.
`ERR_INOMAX`	No more interrupt numbers available
`ERR_INT_NOTVAL`	Not valid integer, decimal value
`ERR_INT_MAXVAL`	Not valid integer, too large or small value
`ERR_INVDIM`	Dimensions are not equal
`ERR_IODISABLE`	Timeout when executing `IODisable`
`ERR_IOENABLE`	Timeout when executing `IOEnable`
`ERR_IOERROR`	I/O Error from instruction `Save`
`ERR_LINKREF`	Reference error in the program task
`ERR_LOADED`	The program module is already loaded
`ERR_LOADID_FATAL`	Only internal use in `LoadId`
`ERR_LOADID_RETRY`	Only internal use in `LoadId`
`ERR_LOADNO_INUSE`	The load session is in use in `StartLoad`
`ERR_LOADNO_NOUSE`	The load session is not in use in `CancelLoad`
`ERR_MAXINTVAL`	The integer value is too large
`ERR_MODULE`	Incorrect module name in instruction `Save` and `EraseModule`
`ERR_MOD_NOTLOADED`	Module not loaded or installed from `ModTime`
`ERR_NAME_INVALID`	If the unit name does not exist or if the unit is not allowed to be disabled

Continues on next page

Name	Cause of error
ERR_NORUNUNIT	If there is no contact with the unit
ERR_NOTARR	Data is not an array
ERR_NOTEQDIM	The array dimension used when calling the routine does not coincide with its parameters
ERR_NOTINTVAL	Not an integer value
ERR_NOTPRES	A parameter is used, despite the fact that the corre-sponding argument was not used at the routine call
ERR_NOTSAVED	Module has been changed since it was loaded into the system
ERR_NOT_MOVETASK	Specify task is a non-motion task
ERR_NUM_LIMIT	Value is not an integer and/or not in the range of -8388607 to +8388608
ERR_OUTOFBND	The array index is outside the permitted limits
ERR_OVERFLOW	Clock overflow
ERR_PATH	Missing destination path in instruction `Save`
ERR_PATHDIST	Too long regain distance for `StartMove` or `StartMoveRetry` instruction
ERR_PATH_STOP	Stop of the movement because of some process error
ERR_PID_MOVESTOP	Only internal use in `LoadId`
ERR_PID_RAISE_PP	Error from `ParIdRobValid` or `ParIdPosValid`
ERR_PRGMEMFULL	Program memory full
ERR_PROCSIGNAL_OFF	Process signal is off
ERR_PROGSTOP	The robot is in program stop state when executing a `StartMove` or `StartMoveRetry` instruction
ERR_RANYBIN_CHK	Check sum error detected at data transfer with instruction `ReadAnyBin`
ERR_RANYBIN_EOF	End of file is detected before all bytes are read in instruction `ReadAnyBin`
ERR_RCVDATA	An attempt was made to read non-numeric data with `ReadNum`
ERR_REFUNKDAT	Reference to entire unknown data object
ERR_REFUNKFUN	Reference to unknown function
ERR_REFUNKPRC	Reference to unknown procedure at linking time or at run time (late binding)
ERR_REFUNKTRP	Reference to unknown trap
ERR_RMQ_DIM	Wrong dimensions, the dimensions of the given data are not equal to the dimensions of the data in the message.
ERR_RMQ_FULL	Destination message queue is full.
ERR_RMQ_INVALID	Destination slot lost or invalid
ERR_RMQ_INVMSG	Invalid message, likely sent from other client then a RAPID task.
ERR_RMQ_MSGSIZE	Size of message is too big. Decrease message size.
ERR_RMQ_NAME	The given slot name is not valid or not found.
ERR_RMQ_NOMSG	No message in queue, likely the results of power fail.

Continues on next page

Name	Cause of error
ERR_RMQ_TIMEOUT	Timeout occurred while waiting for answer in RMQSendWait.
ERR_RMQ_VALUE	The value syntax does not match the data type.
ERR_ROBLIMIT	Axis outside working area or limits exceeded for at least one coupled joint
ERR_SC_WRITE	Error when sending to external computer
ERR_SIGSUPSEARCH	The signal has already a positive value at the beginning of the search process
ERR_STARTMOVE	The robot is in hold state when executing a StartMove or StartMoveRetry instruction
ERR_ADDR_INUSE	The address and port is already in use and can not be used again. Use a different port number or address in SocketBind.
ERR_SOCK_CLOSED	The socket is closed, or is not created
ERR_SOCK_TIMEOUT	The connection was not established within the time-out time
ERR_SPEED_REFRESH_LIM	Override out of limit in SpeedRefresh
ERR_STRTOOLNG	The string is too long
ERR_SYM_ACCESS	Symbol read/write access error
ERR_SYNCMOVEOFF	Timeout from SyncMoveOff
ERR_SYNCMOVEON	Timeout from SyncMoveOn
ERR_SYNTAX	Syntax error in the loaded module
ERR_TASKNAME	Task name not found in the system
ERR_TP_DIBREAK	A read instruction from FlexPendant was interrupted by a digital input
ERR_TP_DOBREAK	A read instruction from FlexPendant was interrupted by a digital output
ERR_TP_MAXTIME	Timeout when executing a read instruction from FlexPendant
ERR_TP_NO_CLIENT	No client to interact with when using a read instruction from FlexPendant
ERR_TRUSTLEVEL	Not allowed to disable I/O unit
ERR_TXTNOEXIST	Wrong table or index in function TextGet
ERR_UI_INITVALUE	Initial value error in function UINumEntry
ERR_UI_MAXMIN	Min value is greater then max value in function UINumEntry
ERR_UI_NOTINT	Value is not an integer when specified that an integer should be used when using UINumEntry
ERR_UISHOW_FATAL	Other error then ERR_UISHOW_FATAL in instruction UIShow
ERR_UISHOW_FULL	No space left on FlexPendant for another application when using instruction UIShow
ERR_UNIT_PAR	Parameter Mech_unit in TestSignDefine is wrong
ERR_UNKINO	Unknown interrupt number
ERR_UNKPROC	Incorrect reference to the load session in instruction WaitLoad
ERR_UNLOAD	Unload error in instruction UnLoad or WaitLoad

Continues on next page

Name	Cause of error
ERR_WAITSYNCTASK	Time-out from WaitSyncTask
ERR_WAIT_MAXTIME	Time-out when executing a WaitDI or WaitUntil instruction
ERR_WHLSEARCH	No search stop
ERR_WOBJ_MOVING	The mechanical unit with work object is moving CalcJointT

Characteristics

errnum is an alias data type for num and consequently inherits its characteristics.

Related information

For information about	See
Error recovery	*Technical reference manual - RAPID overview*
Data types in general, alias data types	*Technical reference manual - RAPID overview*

3.16. errstr - Error string

Usage

`errstr` is used to write text in error messages.

Basic examples

Basic examples of the data type `errstr` are illustrated below.

Example 1

```
VAR errstr arg:= "This is an example";

ErrLog 5100, \W, ERRSTR_TASK, ERRSTR_CONTEXT, arg, ERRSTR_EMPTY,
     ERRSTR_UNUSED;
```

Predefined data

Name	Description
`ERRSTR_EMPTY`	Argument is empty
`ERRSTR_UNUSED`	Argument is not used
`ERRSTR_TASK`	Name of current task
`ERRSTR_CONTEXT`	Context

Characteristics

`errstr` is an alias data type for `string` and consequently inherits its characteristics.

Related information

For information about	See
Data types in general, alias data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data Types*

3.17. errtype - Error type

Usage

`errtype` (*error type*) is used to specify an error type.

Description

Data of the type `errtype` represents the type (state change, warning, error) of an error message.

Basic examples

Basic examples of the data type `errtype` are illustrated below.

Example 1

```
VAR errdomain err_domain;
VAR num err_number;
VAR errtype err_type;
VAR trapdata err_data;
...
TRAP trap_err
  GetTrapData err_data;
  ReadErrData err_data, err_domain, err_number, err_type;
ENDTRAP
```

When an error is trapped to the trap routine `trap_err`, the error domain, the error number, and the error type are saved into appropriate variables.

Predefined data

The following predefined constants can be used to specify an error type.

Name	Error Type	Value
`TYPE_ALL`	Any type of error (state change, warning, error)	0
`TYPE_STATE`	State change (operational message)	1
`TYPE_WARN`	Warning (such as RAPID recoverable error)	2
`TYPE_ERR`	Error	3

Characteristics

`errtype` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Ordering an interrupt on errors	*IError - Orders an interrupt on errors on page 126*
Error numbers	*Operating manual - Trouble shooting*
Alias data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*

3.18. event_type - Event routine type

Usage

`event_type` is used to represent the actual event routine type with a symbolic constant.

Description

With the function `EventType`, it is possible to check if the actual RAPID code is executed because of some specific system event or not.

Basic examples

Basic example of the data type `event_type` is illustrated below.

Example 1

```
VAR event_type my_type;
...
my_type := EventType( );
```

The event routine type that is executed will be stored in the variable `my_type`.

Predefined data

Following constants of type `event_type` are predefined:

RAPID constant	Value	Type of event executed
`EVENT_NONE`	0	No event is executed
`EVENT_POWERON`	1	POWER_ON event
`EVENT_START`	2	START event
`EVENT_STOP`	3	STOP event
`EVENT_QSTOP`	4	QSTOP event
`EVENT_RESTART`	5	RESTART event
`EVENT_RESET`	6	RESET event
`EVENT_STEP`	7	STEP event

Characteristics

`event_type` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Event routines in general	*Technical reference manual - System parameters*, section *Controller - Event Routine*
Get event type	*EventType - Get current event type inside any event routine on page 837*
Data types in general, alias data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*

3.19. exec_level - Execution level

Usage

exec_level is used to specify program execution level.

Description

With the function ExecLevel, it is possible to get the actual execution level for the RAPID code that currently is executed.

Predefined data

The following constants of type exec_level are predefined:

RAPID constant	Value	Execution level
LEVEL_NORMAL	0	Execute on base level
LEVEL_TRAP	1	Execute in TRAP routine
LEVEL_SERVICE	2	Execute in service routine 1)

1) With LEVEL_SERVICE means event routine, service routine (including Call Routine) and interrupt routine from system input signal.

Characteristics

exec_level is an alias data type for num and consequently inherits its characteristics.

Related information

For information about	See
Get current execution level	*ExecLevel - Get execution level on page 840*

3.20. extjoint - Position of external joints

Usage

`extjoint` is used to define the axis positions of external axes, positioners or workpiece manipulators.

Description

The robot can control up to six external axes in addition to its six internal axes, i.e. a total of twelve axes. The six external axes are logically denoted: a, b, c, d, e, f. Each such logical axes can be connected to a physical axis and, in this case, the connection is defined in the system parameters.

Data of the type `extjoint` is used to hold position values for each of the logical axes a - f.

For each logical axis connected to a physical axis, the position is defined as follows:

- For rotating axes– the position is defined as the rotation in degrees from the calibration position.
- For linear axes – the position is defined as the distance in mm from the calibration position.

If a logical axis is not connected to a physical one then the value 9E9 is used as a position value, indicating that the axis is not connected. At the time of execution, the position data of each axis is checked and it is checked whether or not the corresponding axis is connected. If the stored position value does not comply with the actual axis connection, the following applies:

- If the position is not defined in the position data (value is 9E9) then the value will be ignored if the axis is connected and not activated. But if the axis is activated, it will result in an error.
- If the position is defined in the position data, although the axis is not connected, then the value will be ignored.

No movement is performed but no error is generated for an axis with valid position data if the axis is not activated.

If an external axis offset is used (instruction `EOffsOn` or `EOffsSet`) then the positions are specified in the `ExtOffs` coordinate system.

If some external axis is running in independent mode and some new movement shall be performed by the robot and it's external axes then the position data for the external axis in independent mode must not be 9E9 but some arbitrary value (not used but the system).

Continues on next page

Components

`eax_a`

external axis a

Data type: `num`

The position of the external logical axis“ a” expressed in degrees or mm (depending on the type of axis).

`...`

`eax_f`

external axis f

Data type: `num`

The position of the external logical axis“ f” expressed in degrees or mm (depending on the type of axis).

Basic examples

Basic examples of the data type `extjoint` are illustrated below.

Example 1

```
VAR extjoint axpos10 := [ 11, 12.3, 9E9, 9E9, 9E9, 9E9] ;
```

The position of an external positioner, `axpos10`, is defined as follows:

- The position of the external logical axis “a” is set to `11`, expressed in degrees or mm (depending on the type of axis).
- The position of the external logical axis“ b” is set to `12.3`, expressed in degrees or mm (depending on the type of axis).
- Axes c to f are undefined.

Structure

```
< dataobject of extjoint >
  < eax_a of num >
  < eax_b of num >
  < eax_c of num >
  < eax_d of num >
  < eax_e of num >
  < eax_f of num >
```

Related information

For information about	See
Position data	*robtarget - Position data on page 1176* *jointtarget - Joint position data on page 1129*
ExtOffs coordinate system	*EOffsOn - Activates an offset for external axes on page 88*

3.21. handler_type - Type of execution handler

Usage

`handler_type` is used to specify type of execution handler in `RAPID` program routine.

Description

With the function `ExecHandler`, it is possible to check if the actual `RAPID` code is executed in some execution handler in `RAPID` program routine.

Basic examples

Basic example of the data type `handler_type` is illustrated below.

Example 1

```
VAR handler_type my_type;
...
my_type := ExecHandler( );
```

The type of execution handler that the code is executed in, will be stored in the variable `my_type`.

Predefined data

Following constants of type `handler_type` are predefined:

RAPID constant	Value	Type of execution handler
`HANDLER_NONE`	0	Not executed in any handler
`HANDLER_BWD`	1	Executed in `BACKWARD` handler
`HANDLER_ERR`	2	Executed in `ERROR` handler
`HANDLER_UNDO`	3	Executed in `UNDO` handler

Characteristics

`handler_type` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Get type of execution handler	*ExecHandler - Get type of execution handler on page 839*

3.22. icondata - Icon display data

Usage

`icondata` is used for representing standard icons on the User Device such as the FlexPendant.

Description

An `icondata` enumeration constant may be passed to the `Icon` argument in the instruction `UIMsgBox` and functions `UIMessageBox`, `UINumEntry`, `UINumTune`, `UIAlphaEntry`, and `UIListView`.

Basic examples

Basic examples of the data type `icondata` are illustrated below.

Example 1

```
VAR btnres answer;

UIMsgBox "More ?" \Buttons:=btnYesNo \Icon:=iconInfo \Result:=
     answer;
IF answer= resYes THEN
...
ELSEIF answer =ResNo THEN
...
ENDIF
```

The standard button enumeration constant `iconInfo` will give an information icon at the head of the message box on the user interface.

Predefined data

The following constants of the data type `icondata` are predefined in the system:

Value	Constant	Icon
0	`iconNone`	No icon
1	`iconInfo`	Information icon
2	`iconWarning`	Warning icon
3	`iconError`	Error icon

Characteristics

`icondata` is an alias data type for `num` and consequently inherits its characteristics.

Continues on next page

Related information

For information about	See
User Interaction Message Box	*UIMsgBox - User Message Dialog Box type basic on page 644*
User Interaction Message Box	*UIMessageBox - User Message Box type advanced on page 1057*
User Interaction Number Entry	*UINumEntry - User Number Entry on page 1064*
User Interaction Number Tune	*UINumTune - User Number Tune on page 1070*
User Interaction Alpha Entry	*UIAlphaEntry - User Alpha Entry on page 1032*
User Interaction List View	*UIListView - User List View on page 1050*
Data types in general, alias data types	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Data Types*

3.23. identno - Identity for move instructions

Usage

`identno` (*Identity Number*) is used to control synchronizing of two or more coordinated synchronized movements with each other.

The data type `identno` can only be used in a *MultiMove* system with option *Coordinated Robots* and only in program tasks defined as Motion Task.

Description

Move instructions in a MultiMove system must be programmed with parameter `\ID` of data type `identno`, if coordinated synchronized movement, and `\ID` is not allowed in any other cases.

The specified `\ID` number must be the same in all cooperating program tasks. The id number gives a guarantee that the movements are not mixed up at runtime.

In coordinated synchronized mode, there must be the same amount of executed move instructions in all program tasks. The optional parameter `\ID` of data type `identno` will be used to check that associated move instructions are run in parallel before the start of the movements. The `\ID` number must be the same in the move instructions that are run in parallel.

The user does not have to declare any variable of type `identno`, but can use a number directly in the instructions (see *Basic examples*).

Basic examples

Basic examples of the data type `identno` are illustrated below.

Example 1

```
PERS tasks task_list{2} := [["T_ROB1"],["T_ROB2"]];
VAR syncident sync1;
VAR syncident sync2;

PROC proc1()
  ...
  SyncMoveOn sync1, task_list;
  MoveL *\ID:=10,v100,z50,mytool;
  MoveL *\ID:=20,v100,fine,mytool;
  SyncMoveOff sync2;
  ...
ENDPROC
```

Characteristics

`identno` is an alias data type for `num` and thus inherits its properties.

Continues on next page

Related information

For information about	See
Alias data types	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Data types*
Start coordinated synchronized movements	*SyncMoveOn - Start coordinated synchronized movements on page 534*
End coordinated synchronized movements	*SyncMoveOff - End coordinated synchronized movements on page 528*

3.24. intnum - Interrupt identity

Usage

`intnum` (*interrupt numeric*) is used to identify an interrupt.

Description

When a variable of type `intnum` is connected to a trap routine, it is given a specific value identifying the interrupt. This variable is then used in all dealings with the interrupt, such as when ordering or disabling an interrupt.

More than one interrupt identity can be connected to the same trap routine. The system variable `INTNO` can thus be used in a trap routine to determine the type of interrupt that occurs.

Basic examples

Basic examples of the data type `intnum` are illustrated below.

Example 1

```
VAR intnum feeder_error;
...
CONNECT feeder_error WITH correct_feeder;
ISignalDI di1, 1, feeder_error;
```

An interrupt is generated when the input di1 is set to 1. When this happens, a call is made to the correct_feeder trap routine.

Example 2

```
VAR intnum feeder1_error;
VAR intnum feeder2_error;
...
PROC init_interrupt();
...
  CONNECT feeder1_error WITH correct_feeder;
  ISignalDI di1, 1, feeder1_error;
  CONNECT feeder2_error WITH correct_feeder;
  ISignalDI di2, 1, feeder2_error;
...
ENDPROC
...
TRAP correct_feeder
  IF INTNO=feeder1_error THEN
  ...
  ELSE
  ...
  ENDIF
...
ENDTRAP
```

An interrupt is generated when either of the inputs `di1` or `di2` is set to `1`. A call is then made to the `correct_feeder` trap routine. The system variable `INTNO` is used in the trap routine to find out which type of interrupt has occurred.

Continues on next page

Limitations

The maximum number of active variables of type `intnum` at any one time (between `CONNECT` and `IDelete`) is limited to 70.The maximum number of interrupts, in the queue for execution of `TRAP` routine at any one time, is limited to 30.

Characteristics

`Intnum` is an alias data type for `num` and thus inherits its properties.

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID Summary - Interrupts*
Alias data types	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Data Types*
Connecting interrupts	*CONNECT - Connects an interrupt to a trap routine on page 63*

3.25. iodev - Serial channels and files

Usage

`iodev` *(I/O device)* is used for serial channels, such as printers and files.

Description

Data of the type `iodev` contains a reference to a file or serial channel. It can be linked to the physical unit by means of the instruction `Open` and then used for reading and writing.

Basic examples

Basic examples of the data type `iodev` are illustrated below.

Example 1

```
VAR iodev file;
...
Open "HOME:/LOGDIR/INFILE.DOC", file\Read;
input := ReadNum(file);
```

The file `INFILE.DOC` is opened for reading. When reading from the file, `file` is used as a reference instead of the file name.

Characteristics

`iodev` is a non-value data type.

Related information

For information about	See
Communication via serial channels	*Technical reference manual - RAPID overview*, section *RAPID Summary - Communication*
Configuration of serial channels	*Technical reference manual - System parameters*
Characteristics of non-value data types	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Data Types*

3.26. iounit_state - State of I/O unit

Usage

`iounit_state` is used to mirror which state an I/O unit is currently in.

Description

An `iounit_state` constant is intended to be used when checking the return value from the function `IOUnitState`.

Basic examples

Basic examples of the data type `iounit_state` are illustrated below.

Example 1

```
IF (IOUnitState ("UNIT1" \Phys) = IOUNIT_PHYS_STATE_RUNNING) THEN
  ! Possible to access some signal on the I/O unit
ELSE
  ! Read/Write some signal on the I/O unit result in error
ENDIF
```

Test is done if the I/O unit `UNIT1` is up and running.

Predefined data

The predefined symbolic constants of the data type `iounit_state` can be found in function `IOUnitState`.

Characteristics

`iounit_state` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Get current state of I/O unit	*IOUnitState - Get current state of I/O unit on page 875*
Input/Output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and Output Signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - I/O Principles*
Configuration of I/O	*Technical reference manual - System parameters*

3.27. jointtarget - Joint position data

Usage

`jointtarget` is used to define the position that the robot and the external axes will move to with the instruction `MoveAbsJ`.

Description

`jointtarget` defines each individual axis position, for both the robot and the external axes.

Components

`robax`

robot axes

Data type: `robjoint`

Axis positions of the robot axes in degrees.

Axis position is defined as the rotation in degrees for the respective axis (arm) in a positive or negative direction from the axis calibration position.

`extax`

external axes

Data type: `extjoint`

The position of the external axes.

The position `is defin`ed as follows for each individual axis (`eax_a`, `eax_b ... eax_f`):

- For rotating axes, the position is defined as the rotation in degrees from the calibration position.
- For linear axes, the position is defined as the distance in mm from the calibration position.

External axes `eax_a ...` are logical axes. How the logical axis number and the physical axis number are related to each other is defined in the system parameters.

The value 9E9 is defined for axes which are not connected. If the axes defined in the position data differ from the axes that are actually connected on program execution, the following applies:

- If the position is not defined in the position data (value 9E9) the value will be ignored, if the axis is connected and not activated. But if the axis is activated it will result in error.
- If the position is defined in the position data, although the axis is not connected, the value is ignored.

No movement is performed but no error is generated for an axis with valid position data, if the axis isn't activated.

If some external axis is running in independent mode and some new movement shall be performed by the robot and its external axes then the position data for the external axis in independent mode must not be 9E9 but some arbitrary value (not used but the system).

Continues on next page

Basic examples

Basic examples of the data type `jointtarget` are illustrated below.

Example 1

```
CONST jointtarget calib_pos := [ [ 0, 0, 0, 0, 0, 0], [ 0, 9E9,
     9E9, 9E9, 9E9, 9E9] ];
```

The normal calibration position for IRB2400 is defined in `calib_pos` by the data type `jointtarget`. The normal calibration position 0 (degrees or mm) is also defined for the external logical axis a. The external axes b to f are undefined.

Structure

```
< dataobject of jointtarget >
  < robax of robjoint >
     < rax_1 of num >
     < rax_2 of num >
     < rax_3 of num >
     < rax_4 of num >
     < rax_5 of num >
     < rax_6 of num >
  < extax of extjoint >
     < eax_a of num >
     < eax_b of num >
     < eax_c of num >
     < eax_d of num >
     < eax_e of num >
     < eax_f of num >
```

Related information

For information about	See
Move to joint position	*MoveAbsJ - Moves the robot to an absolute joint position on page 230* *MoveExtJ - Move one or several mechanical units without TCP on page 250*
Positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Configuration of external axes	*Application manual - Additional axes and stand alone controller*

3.28. listitem - List item data structure

Usage

`listitem` is used to define menu lines that include text with optional small icons on the User Device such as the FlexPendant.

Description

Data of the type `listitem` allows the user to define menu lines for the function `UIListView`.

Basic example

Basic examples of the data type `listitem` are illustrated below.

Example 1

```
CONST listitem list {3}:=[[stEmpty, "Item1"], [stEmpty, "Item2"],
      [stEmpty, "Item3"]];
```

A menu list with Item1....Item3 to use in function `UIListView`.

Components

The data type has the following components:

`image`

Data type: `string`

The path including file name for the icon image to display (not implemented in this software release).

Use empty string `""` or `stEmpty` if no icon to display.

`text`

Data type: `string`

The text for the menu line to display.

Structure

```
<dataobject of listitem>
  <image of string>
  <text of string>
```

Related information

For information about	See
User Interaction ListView	*UIListView - User List View on page 1050*

3.29. loaddata - Load data

Usage

`loaddata` is used to describe loads attached to the mechanical interface of the robot (the robot's mounting flange).

Load data usually defines the payload (grip load is defined by the instruction `GripLoad`) of the robot, i.e. the load held in the robot gripper. The tool load is specified in the tool data (`tooldata`) which includes load data.

Description

Specified loads are used to set up a model of the dynamics of the robot so that the robot movements can be controlled in the best possible way.

WARNING!

It is important to always define the actual tool load and when used, the payload of the robot too. Incorrect definitions of load data can result in overloading of the robot mechanical structure.

When incorrect load data is specified, it can often lead to the following consequences:

If the value in the specified load data is greater than the true load:

- The robot will not be used to its maximum capacity
- Impaired path accuracy including a risk of overshooting
- Risk of overloading the mechanical structure

If the value in the specified load data is less than the true load:

- Risk of overloading the mechanical structure
- Impaired path accuracy including a risk of overshooting

The payload is connected/disconnected using the instruction `GripLoad`.

Components

`mass`

Data type: `num`

The weight of the load in kg.

`cog`

center of gravity

Data type: `pos`

The center of gravity of the tool load for definition of the tool load coordinate system. If a stationary tool is used then it means the center of gravity for the tool holding the work object.

The center of gravity of the payload for definition of the payload coordinate system. The object coordinate system when a stationary tool is used.

`aom`

axes of moment

Data type: `orient`

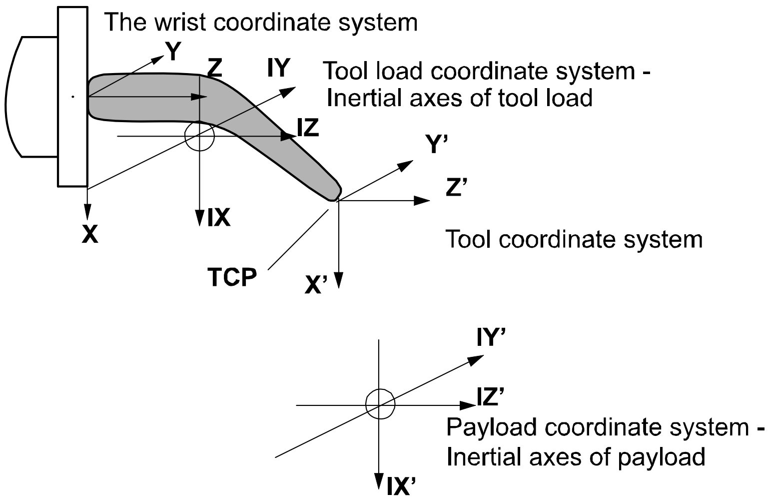
Continues on next page

Tool load

The orientation of the tool load coordinate system defined by the principal inertial axes of the tool load. Expressed in the wrist coordinate system as a quaternion (`q1, q2, q3, q4`). If a stationary tool is used then it means the principal inertial axes for the tool holding the work object.

Payload

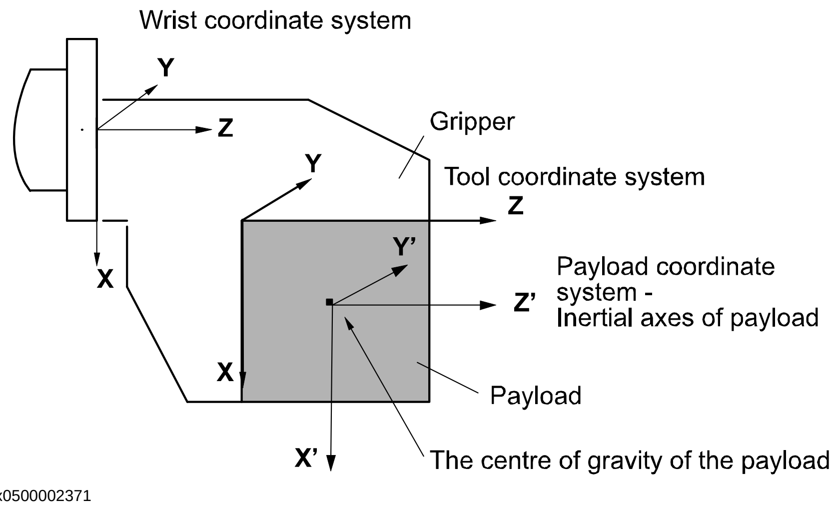
The figure shows restriction on the reorientation of tool load and payload coordinate system.



xx0500002370

The orientation of the payload coordinate system defined by the principal inertial axes of the payload. Expressed in the tool coordinate system as a quaternion (q1, q2, q3, q4). The object coordinate system if a stationary tool is used.

The figure shows the center of gravity and inertial axes of the payload.



xx0500002371

Continues on next page

`ix`

inertia x

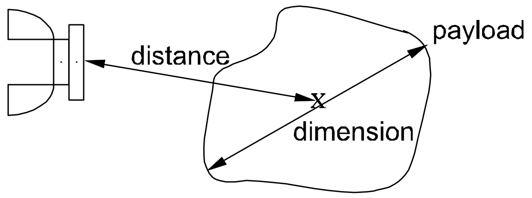
Data type: `num`

The moment of inertia of the load around the x-axis of the tool load or payload coordinate system in kgm^2.

Correct definition of the inertial moments will allow optimal utilization of the path planner and axes control. This may be of special importance when handling large sheets of metal, etc. All inertial moments of inertia `ix`, `iy`, and `iz` equal to 0 kgm^2 imply a point mass.

Normally, the inertial moments must only be defined when the distance from the mounting flange to the center of gravity is less than the dimension of the load (see figure below).

The figure shows that the moment of inertia must normally be defined when the distance is less than the load dimension.



xx0500002372

`iy`

inertia y

Data type: `num`

The inertial moment of the load around the y-axis, expressed in kgm^2.

For more information, see `ix`.

`iz`

inertia z

Data type: `num`

The inertial moment of the load around the z-axis, expressed in kgm^2.

For more information, see `ix`.

Basic examples

Basic examples of the data type `loaddata` are illustrated below.

Example 1

```
PERS loaddata piece1 := [ 5, [50, 0, 50], [1, 0, 0, 0], 0, 0, 0];
```

The payload in the first figure in section *Payload on page 1133* is described using the following values:

- Weight `5` kg.
- The center of gravity is x = `50`, y = `0` and z = `50` mm in the tool coordinate system.
- The payload is a point mass.

Continues on next page

Example 2

```
Set gripper;
WaitTime 0.3;
GripLoad piece1;
```

Connection of the payload, `piece1`, specified at the same time as the robot grips the load `piece1`.

Example 3

```
Reset gripper;
WaitTime 0.3;
GripLoad load0;
```

Disconnection of a payload, specified at the same time as the robot releases a payload.

Limitations

The payload should only be defined as a persistent variable (`PERS`) and not within a routine. Current values are then saved when saving the program and are retrieved on loading.

Arguments of the type `loaddata` in the `GripLoad` instruction should only be an entire persistent (not array element or record component).

Predefined data

The load `load0` defines a payload, with the mass equal to 0 kg, i.e. no load at all. This load is used as the argument in the instruction `GripLoad` to disconnect a payload.

The load `load0` can always be accessed from the program, but cannot be changed (it is stored in the system module `BASE`).

```
PERS loaddata load0 := [ 0.001, [0, 0, 0.001], [1, 0, 0, 0],0, 0
     ,0 ];
```

Structure

```
< dataobject of loaddata >
  < mass of num >
  < cog of pos >
     < x of num >
     < y of num >
     < z of num >
  < aom of orient >
     < q1 of num >
     < q2 of num >
     < q3 of num >
     < q4 of num >
  < ix of num >
  < iy of num >
  < iz of num >
```


Continues on next page

Related information

For information about	See
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*
Definition of tool loads	*tooldata - Tool data on page 1207*
Activation of payload	*GripLoad - Defines the payload for the robot on page 119*

3.30. loadidnum - Type of load identification

Usage

`loadidnum` is used to represent an integer with a symbolic constant.

Description

A `loadidnum` constant is intended to be used for load identification of tool or payload as arguments in instruction `LoadId`. See example below.

Basic examples

Basic examples of the data type `loadidnum` are illustrated below.

Example 1

```
LoadId TOOL_LOAD_ID, MASS_WITH_AX3, gun1;
```

Load identification of tool `gun1` with identification of mass with movements of robot axis 3 with use of predefined constant `MASS_WITH_AX3` of data type `loadidnum`.

Predefined data

The following symbolic constants of the data type `loadidnum` are predefined and can be used as arguments in instruction `LoadId`.

Value	Symbolic constant	Comment
1	`MASS_KNOWN`	Known mass in tool or payload respectively.
2	`MASS_WITH_AX3`	Unknown mass in tool or payload. Identification of mass will be done with movements of axis 3

Characteristics

`loadidnum` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Predefined program Load Identify	*Operating manual - IRC5 with FlexPendant*, section *Programming and testing - Service routines - LoadIdentify, load identification and service routines*
Valid robot type	*ParIdRobValid - Valid robot type for parameter identification on page 916*
Valid robot position	*ParIdPosValid - Valid robot position for parameter identification on page 913*
Load identification with complete example	*LoadId - Load identification of tool or payload on page 212*

3.31. loadsession - Program load session

Usage

`loadsession` is used to define different load sessions of RAPID program modules.

Description

Data of the type `loadsession` is used in the instructions `StartLoad` and `WaitLoad` to identify the load session. `loadsession` only contains a reference to the load session.

Characteristics

`loadsession` is a non-value data type and cannot be used in value-oriented operations.

Related information

For information about	See
Loading program modules during execution	*StartLoad - Load a program module during execution on page 482* *WaitLoad - Connect the loaded module to the task on page 682*
Characteristics of non-value data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*

3.32. mecunit - Mechanical unit

Usage

`mecunit` is used to define the different mechanical units which can be controlled and accessed from the program.

The names of the mechanical units are defined in the system parameters and, consequently, must not be defined in the program.

Description

Data of the type `mecunit` only contains a reference to the mechanical unit.

Limitations

Data of the type `mecunit` must not be defined in the program. However, if it is then an error message will be displayed as soon as an instruction or function that refers to this `mecunit` is executed. The data type can, on the other hand, be used as a parameter when declaring a routine.

Predefined data

All the mechanical units defined in the system parameters are predefined in every program task. But only the mechanical units that are controlled by the actual program task (defined in system parameters *Controller/Task/Use Mechanical Unit Group*) can be used to do any control operations.

Besides that, the predefined variable `ROB_ID` of data type `mecunit` is available in every program task. If an actual program task controls a robot then the alias variable `ROB_ID` contains a reference to one of robot `ROB_1` to ROB_6, which can be used to do control operation on the robot. The variable `ROB_ID` is invalid if the actual program task does not control any robot.

Basic examples

Basic examples of the data type `mecunit` are illustrated below.

Example 1

```
IF TaskRunRob() THEN
  IndReset ROB_ID, 6;
ENDIF
```

If actual program task controls a robot, reset axis `6` for the robot.

Characteristics

`mecunit` is a *non-value* data type. This means that data of this type does not permit value-oriented operations.

Continues on next page

Related information

For information about	See
Check if task run some robot	*TaskRunRob - Check if task controls some robot on page 1014*
Check if task run some mechanical unit	*TaskRunMec - Check if task controls any mechanical unit on page 1013*
Get the name of mechanical units in the system	*GetNextMechUnit - Get name and data for mechanical units on page 852*
Activating/Deactivating mechanical units	*ActUnit - Activates a mechanical unit on page 17* *DeactUnit - Deactivates a mechanical unit on page 79*
Configuration of mechanical units	*Technical reference manual - System parameters*
Characteristics of non-value data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*

3.33. motsetdata - Motion settings data

Usage

`motsetdata` is used to define a number of motion settings that affect all positioning instructions in the program:

- Max. velocity and velocity override
- Acceleration data
- Behavior around singular points
- Management of different robot configurations
- Override of path resolution
- Motion supervision
- Limitation of acceleration/deceleration
- Tool reorientation during circle path

This data type does not normally have to be used since these settings can only be set using the instructions `VelSet`, `AccSet`, `SingArea`, `ConfJ`, `ConfL`, `PathResol`, `MotionSup`, `PathAccLim`, `CirPathMode`, and `WorldAccLim`.

The current values of these motion settings can be accessed using the system variable `C_MOTSET`.

Description

The current motion settings (stored in the system variable `C_MOTSET`) affect all movements.

Components

`vel.oride`

Data type: `veldata/num`

Velocity as a percentage of programmed velocity.

`vel.max`

Data type: `veldata/num`

Maximum velocity in mm/s.

`acc.acc`

Data type: `accdata/num`

Acceleration and deceleration as a percentage of the normal values.

`acc.ramp`

Data type: `accdata/num`

The rate by which acceleration and deceleration increases as a percentage of the normal values.

`sing.wrist`

Data type: `singdata/bool`

The orientation of the tool is allowed to deviate somewhat in order to prevent wrist singularity.

Continues on next page

`sing.arm`

Data type: `singdata/bool`

The orientation of the tool is allowed to deviate somewhat in order to prevent arm singularity (not implemented).

`sing.base`

Data type: `singdata/bool`

The orientation of the tool is not allowed to deviate.

`conf.jsup`

Data type: `confsupdata/bool`

Supervision of joint configuration is active during joint movement.

`conf.lsup`

Data type: `confsupdata/bool`

Supervision of joint configuration is active during linear and circular movement.

`conf.ax1`

Data type: `confsupdata/num`

Maximum permitted deviation in degrees for axis 1 (not used in this version).

`conf.ax4`

Data type: `confsupdata/num`

Maximum permitted deviation in degrees for axis 4 (not used in this version).

`conf.ax6`

Data type: `confsupdata/num`

Maximum permitted deviation in degrees for axis 6 (not used in this version).

`pathresol`

Data type: `num`

Current override in percentage of the configured path resolution.

`motionsup`

Data type: `bool`

Mirror RAPID status (`TRUE` = On and `FALSE` = Off) of motion supervision function.

`tunevalue`

Data type: `num`

Current RAPID override as a percentage of the configured tunevalue for the motion supervision function.

`acclim`

Data type: `bool`

Limitation of tool acceleration along the path. (`TRUE` = limitation and `FALSE` = no limitation).

`accmax`

Data type: `num`

TCP acceleration limitation in m/s^2. If acclim is `FALSE`, the value is always set to -1.

Continues on next page

`decellim`

Data type: `bool`

Limitation of tool deceleration along the path. (`TRUE` = limitation and `FALSE` = no limitation).

`decelmax`

Data type: `num`

TCP deceleration limitation in m/s^2. If `decellim` is `FALSE`, the value is always set to -1.

`cirpathreori`

Data type: `num`

Tool reorientation during circle path:

0 = Standard method with interpolation in path frame

1 = Modified method with interpolation in object frame

2 = Modified method with programmed tool orientation in `CirPoint`

`worldacclim`

Data type: `bool`

Limitation of acceleration in world coordinate system. (`TRUE` = limitation and `FALSE` = no limitation).

`worldaccmax`

Data type: `num`

Limitation of acceleration in world coordinate system in m/s^2. If `worldacclim` is FALSE, the value is always set to -1.

Limitations

One and only one of the components `sing.wrist`, `sing.arm` or `sing.base` may have a value equal to TRUE.

Basic examples

Basic examples of the data type `motsetdata` are illustrated below.

Example 1

```
IF C_MOTSET.vel.oride > 50 THEN
  ...
ELSE
  ...
ENDIF
```

Different parts of the program are executed depending on the current velocity override.

Continues on next page

Predefined data

`C_MOTSET` describes the current motion settings of the robot and can always be accessed from the program. On the other hand, `C_MOTSET` can only be changed using a number of instructions, not by assignment.

The following default values for motion parameters are set

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

```
VAR motsetdata C_MOTSET := [
  [ 100, 500 ],                       -> veldata
  [ 100, 100 ],                       -> accdata
  [ FALSE, FALSE, TRUE ],             -> singdata
  [ TRUE, TRUE, 30, 45, 90 ]          -> confsupdata
  100,                                -> path resolution
  TRUE,                               -> motionsup
  100,                                -> tunevalue
  FALSE,                              -> acclim
  -1,                                 -> accmax
  FALSE,                              -> decellim
  -1,                                 -> decelmax
  0,                                  -> cirpathreori
  FALSE,                              -> worldacclim
  -1],                                -> worldaccmax
```

Structure

```
<dataobject of motsetdata>
  <vel of veldata>    ->Affected by instruction VelSet
     <oride of num>
     <max of num>
  <acc of accdata>    ->Affected by instruction AccSet
     <acc of num>
     <ramp of num>
  <sing of singdata>  ->Affected by instruction SingArea
     <wrist of bool>
     <arm of bool>
     <base of bool>
  <conf of confsupdata> ->Affected by instructions ConfJ and ConfL
     <jsup of bool>
     <lsup of bool>
     <ax1 of num>
     <ax4 of num>
     <ax6 of num>
  <pathresol of num>   ->Affected by instruction PathResol
  <motionsup of bool>  ->Affected by instruction MotionSup
  <tunevalue of num>   ->Affected by instruction MotionSup
  <acclim of bool>     ->Affected by instruction PathAccLim
```


Continues on next page

```
<accmax of num>      ->Affected by instruction PathAccLim
<decellim of bool>   ->Affected by instruction PathAccLim
<decelmax of num>    ->Affected by instruction PathAccLim
<cirpathreori of num> ->Affected by instruction CirPathMode
<worldacclim of bool> ->Affected by instruction WorldAccLim
<worldaccmax of num>  ->Affected by instruction WorldAccLim
```

Related information

For information about	See
Instructions for setting motion parameters	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion settings*

3.34. num - Numeric values

Usage

`Num` is used for numeric values; e.g. counters.

Description

The value of the `num` data type may be

- an integer; e.g. -5,
- a decimal number; e.g. 3.45.

It may also be written exponentially; e.g.2E3 (= 2*10^3 = 2000), 2.5E-2 (= 0.025).

Integers between -8388607 and +8388608 are always stored as exact integers.

Decimal numbers are only approximate numbers and therefore should not be used in *is equal to* or *is not equal to* comparisons. In the case of divisions and operations using decimal numbers, the result will also be a decimal number; i.e. not an exact integer. For example:

```
a := 10;
b := 5;
IF a/b=2 THEN

...
```

As the result of a/b is not an integer, this condition is not necessarily satisfied.

Basic examples

Basic examples of the data type `num` are illustrated below.

Example 1

```
VAR num reg1;
...
reg1 := 3;
```

`reg1` is assigned the value `3`.

Example 2

```
a := 10 DIV 3;
b := 10 MOD 3;
```

Integer division where `a` is assigned an integer (=3) and `b` is assigned the remainder (=1).

Predefined data

There is some predefined data in the system. For example the constant pi (π) is defined in the system module *BASE_SHARED*.

CONST num pi := 3.1415926;

Limitations

Literal values between -8388607 to 8388608 assigned to a `num` variable are stored as exact integers.

If a literal that has been interpreted as a `dnum` is assigned/used as a `num`, it is automatically converted to a `num`.

Continues on next page

Related information

For information about	See
Numeric values using datatype dnum	*dnum - Double numeric values on page 1104*
Numeric expressions	*Technical reference manual - RAPID overview*, section *Basic RAPID programming - Expressions*
Operations using numeric values	*Technical reference manual - RAPID overview*, section *Basic RAPID programming - Expressions*

3.35. opcalc - Arithmetic Operator

Usage

`opcalc` is used to represent an arithmetic operator in arguments to RAPID functions or instructions.

Description

An `opcalc` constant is intended to be used to define the type of arithmetic operation.

Examples

Basic example of the usage of datatype `opcalc` is illustrated below.

Example 1

```
res := StrDigCalc(str1, OpAdd, str2);
```

`res` is assigned the result of the addition operation on the values represented by the strings `str1` and `str2`. `OpAdd` is of datatype `opcalc`.

Predefined data

The following symbolic constants of the data type `opcalc` are predefined and can be used to define the type of arithmetic operation used, for instance, in function `StrDigCalc`.

Constant	Value	Comment
OpAdd	1	Addition (+)
OpSub	2	Substraction (-)
OpMult	3	Multiplication (*)
OpDiv	4	Division (/)
OpMod	5	Modulus(%l)

Characteristics

`opcalc` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Data types in general, alias data types	*Technical reference manual - RA]PID overview*, section *Basic characteristics - Datatypes*
Arithmetic operations on digital strings.	*StrDigCalc - Arithmetic operations with datatype stringdig on page 988*

3.36. opnum - Comparison operator

Usage

`opnum` is used to represent an operator for comparisons in arguments to RAPID functions or instructions.

Description

An `opnum` constant is intended to be used to define the type of comparison when checking values in generic instructions.

Basic examples

Basic examples of the data type `opnum` are illustrated below.

Example 1

```
TriggCheckIO checkgrip, 100, airok, EQ, 1, intno1;
```

Predefined data

The following symbolic constants of the data type `opnum` are predefined and can be used to define the type of comparison used, for instance, in instruction `TriggCheckIO`.

Value	Symbolic constant	Comment
1	`LT`	Less than
2	`LTEQ`	Less than or equal to
3	`EQ`	Equal to
4	`NOTEQ`	Not equal to
5	`GTEQ`	Greater than or equal to
6	`GT`	Greater than

Characteristics

`opnum` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Data types in general, alias data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*
Define I/O check at a fixed position	*TriggCheckIO - Defines IO check at a fixed position on page 577*

3.37. orient - Orientation

Usage

`orient` is used for orientations (such as the orientation of a tool) and rotations (such as the rotation of a coordinate system).

Description

The orientation is described in the form of a quaternion which consists of four elements: `q1`, `q2`, `q3`, and `q4`. For more information on how to calculate these, see below.

Components

The data type `orient` has the following components:

`q1`

Data type: `num`

Quaternion 1.

`q2`

Data type: `num`

Quaternion 2.

`q3`

Data type: `num`

Quaternion 3.

`q4`

Data type: `num`

Quaternion 4.

Basic examples

Basic examples of the data type `orient` are illustrated below.

Example 1

```
VAR orient orient1;
.
orient1 := [1, 0, 0, 0];
```

The `orient1` orientation is assigned the value q1=1, q2-q4=0; this corresponds to no rotation.

Limitations

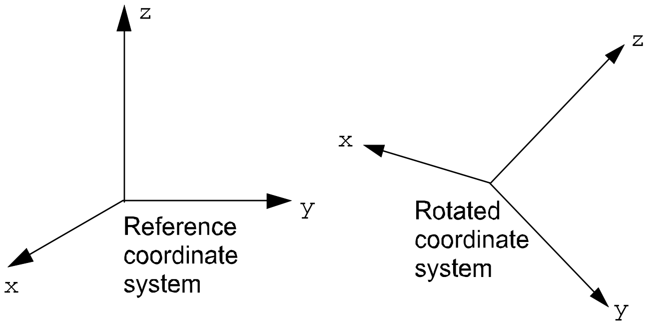
The orientation must be normalized; i.e. the sum of the squares must equal 1:

$$q_1^2+q_2^2+q_3^2+q_4^2 = 1$$

Continues on next page

What is a Quaternion?

The orientation of a coordinate system (such as that of a tool) can be described by a rotational matrix that describes the direction of the axes of the coordinate system in relation to a reference system (see figure below).



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The rotated coordinate systems axes (x, y, z) are vectors which can be expressed in the reference coordinate system as follows:

x = (x1, x2, x3)

y = (y1, y2, y3)

z = (z1, z2, z3)

This means that the x-component of the x-vector in the reference coordinate system will be x1, the y-component will be x2, etc.

These three vectors can be put together in a matrix (a rotational matrix) where each of the vectors form one of the columns:

$$\begin{bmatrix} x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \\ x_3 & y_3 & z_3 \end{bmatrix}$$

.

A quaternion is just a more concise way to describe this rotational matrix; the quaternions are calculated based on the elements of the rotational matrix:

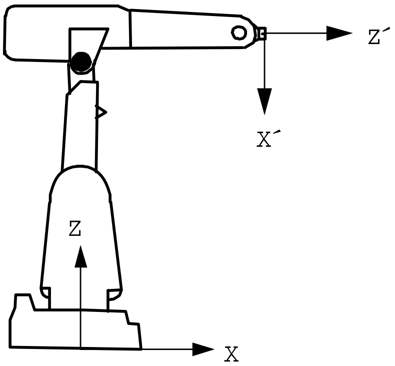
$q1 = \frac{\sqrt{x_1 + y_2 + z_3 + 1}}{2}$.	
$q2 = \frac{\sqrt{x_1 - y_2 - z_3 + 1}}{2}$.	sign q2 = sign (y3-z2)
$q3 = \frac{\sqrt{y_2 - x_1 - z_3 + 1}}{2}$.	sign q3 = sign (z1-x3)
$q4 = \frac{\sqrt{z_3 - x_1 - y_2 + 1}}{2}$.	sign q4 = sign (x2-y1)

Continues on next page

Example 1

A tool is orientated so that its Z'-axis points straight ahead (in the same direction as the X-axis of the base coordinate system). The Y'-axis of the tool corresponds to the Y-axis of the base coordinate system (see figure below). How is the orientation of the tool defined in the position data (`robtarget`)?

The orientation of the tool in a programmed position is normally related to the coordinate system of the work object used. In this example, no work object is used and the base coordinate system is equal to the world coordinate system. Thus, the orientation is related to the base coordinate system.



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The axes will then be related as follows:

x' = -z = (0, 0, -1)

y' = y = (0, 1, 0)

z' = x = (1, 0, 0)

Which corresponds to the following rotational matrix:

$$\begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ -1 & 0 & 0 \end{bmatrix}$$

.

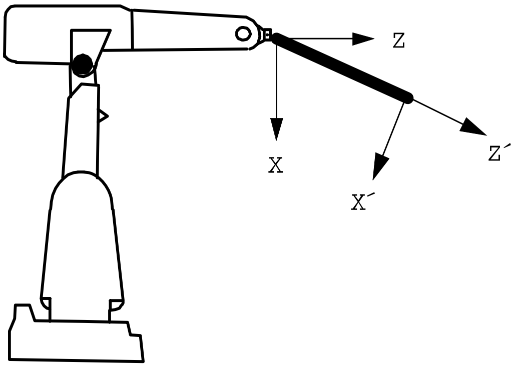
The rotational matrix provides a corresponding quaternion:

$q1 = \frac{\sqrt{0+1+0+1}}{2} = \frac{\sqrt{2}}{2} = 0{,}707$.	
$q2 = \frac{\sqrt{0-1-0+1}}{2} = 0$.	
$q3 = \frac{\sqrt{1-0-0+1}}{2} = \frac{\sqrt{2}}{2} = 0{,}707$.	sign q3 = sign (1+1) = +
$q4 = \frac{\sqrt{0-0-1+1}}{2} = 0$.	

Continues on next page

Example 2

The direction of the tool is rotated 30° about the X'- and Z'-axes in relation to the wrist coordinate system (see figure below). How is the orientation of the tool defined in the tool data?



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The axes will then be related as follows:

x' = (cos30°, 0, -sin30°)

x' = (0, 1, 0)

x' = (sin30°, 0, cos30°)

Which corresponds to the following rotational matrix:

$$\begin{bmatrix} \cos 30° & 0 & \sin 30° \\ 0 & 1 & 0 \\ -\sin 30° & 0 & \cos 30° \end{bmatrix}$$

.

The rotational matrix provides a corresponding quaternion:

$q1 = \frac{\sqrt{\cos 30° + 1 + \cos 30° + 1}}{2} = 0{,}965926$.	
$q2 = \frac{\sqrt{\cos 30° - 1 - \cos 30° + 1}}{2} = 0$.	
$q3 = \frac{\sqrt{1 - \cos 30° - \cos 30° + 1}}{2} = 0{,}258819$.	sign q3 = sign (sin30°+sin30°) = +
$q4 = \frac{\sqrt{\cos 30° - \cos 30° - 1 + 1}}{2} = 0$.	

Structure

```
< dataobject of orient >
  < q1 of num >
  < q2 of num >
  < q3 of num >
  < q4 of num >
```

Related information

For information about	See
Operations on orientations	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Expressions*

3.38. paridnum - Type of parameter identification

Usage

`paridnum` is used to represent an integer with a symbolic constant.

Description

A `paridnum` constant is intended to be used for parameter identification such as load identification of tool or payload or external manipulator load. See example below.

Basic examples

Basic examples of the data type `paridnum` are illustrated below.

Example 1

```
TEST ParIdRobValid (TOOL_LOAD_ID)
  CASE ROB_LOAD_VAL:
  ! Possible to do load identification of tool in actual robot type
  ...
  CASE ROB_LM1_LOAD_VAL:
  ! Only possible to do load identification of tool with
  ! IRB 6400FHD if actual load < 200 kg
  ...
  CASE ROB_NOT_LOAD_VAL:
  ! Not possible to do load identification of tool in actual robot
      type
  ...
ENDTEST
```

Use of predefined constant `TOOL_LOAD_ID` of data type `paridnum`.

Predefined data

The following symbolic constants of the data type `paridnum` are predefined and can be used as arguments in the following instructions, `ParIdRobValid`, `ParIdPosValid, LoadId`, and `ManLoadIdProc`.

Value	Symbolic constant	Comment
1	`TOOL_LOAD_ID`	Identify tool load
2	`PAY_LOAD_ID`	Identify payload (Ref. instruction GripLoad)
3	`IRBP_K`	Identify External Manipulator IRBP K load
4	`IRBP_L`	Identify External Manipulator IRBP L load
4	`IRBP_C`	Identify External Manipulator IRBP C load
4	`IRBP_C_INDEX`	Identify External Manipulator IRBP C_INDEX load
4	`IRBP_T`	Identify External Manipulator IRBP T load
5	`IRBP_R`	Identify External Manipulator IRBP R load
6	`IRBP_A`	Identify External Manipulator IRBP A load
6	`IRBP_B`	Identify External Manipulator IRBP B load
6	`IRBP_D`	Identify External Manipulator IRBP D load

Continues on next page

NOTE!

Only `TOOL_LOAD_ID` and `PAY_LOAD_ID` can be used in user defined RAPID Programs for load identification of the tool respectively the pay load for the robot.

Characteristics

`paridnum` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Predefined program Load Identify	*Operating manual - IRC5 with FlexPendant*, section *Programming and testing - Service routines - LoadIdentify, load identification and service routines*
Valid robot type	*ParIdRobValid - Valid robot type for parameter identification on page 916*
Valid robot position	*ParIdPosValid - Valid robot position for parameter identification on page 913*
Load identification with complete example	*LoadId - Load identification of tool or payload on page 212*
Load identification of external manipulators	*ManLoadIdProc - Load identification of IRBP manipulators on page 219*

3.39. paridvalidnum - Result of ParIdRobValid

Usage

`paridvalidnum` is used to represent an integer with a symbolic constant.

Description

A `paridvalidnum` constant is intended to be used for parameter identification, such as load identification of tool or payload, when checking the return value from function `ParIdRobValid`. See example below.

Basic examples

Basic examples of the data type `paridvalidnum` are illustrated below.

```
TEST ParIdRobValid (PAY_LOAD_ID)
  CASE ROB_LOAD_VAL:
  ! Possible to do load identification of payload in actual robot
  ! type
  ...
  CASE ROB_LM1_LOAD_VAL:
  ! Only possible to do load identification of payload
  ! with IRB 6400FHD if actual load < 200 kg
  ...
  CASE ROB_NOT_LOAD_VAL:
  ! Not possible to do load identification of payload
  ! in actual robot type
  ...
ENDTEST
```

Use of predefined constants `ROB_LOAD_VAL`, `ROB_LM1_LOAD_VAL` and `ROB_NOT_LOAD_VAL` of data type `paridvalidnum`.

Predefined data

The following symbolic constants of the data type `paridvalidnum` are predefined and can be used for checking the return value from function `ParIdRobValid`.

Value	Symbolic constant	Comment
10	ROB_LOAD_VAL	Valid robot type for the current parameter identification
11	ROB_NOT_LOAD_VAL	Not valid robot type for the current parameter identification
12	ROB_LM1_LOAD_VAL	Valid robot type IRB 6400FHD for the current parameter identification if actual load < 200kg

Characteristics

`paridvalidnum` is an alias data type for `num` and inherits its characteristics.

Continues on next page

Related information

For information about	See
Predefined program Load Identify	*Operating manual - IRC5 with FlexPendant*, section *Programming and testing - Service routines - LoadIdentify, load identification and service routines*
Valid robot type	*ParIdRobValid - Valid robot type for parameter identification on page 916*
Valid robot position	*ParIdPosValid - Valid robot position for parameter identification on page 913*
Load identification with complete example	*LoadId - Load identification of tool or payload on page 212*

3.40. pathrecid - Path recorder identifier

Usage

`pathrecid` is used to identify a breakpoint for the path recorder.

Description

The path recorder is a system function for recording the robots executed path. Data of the type `pathrecid` can be linked to a specific path location by means of the instruction `PathRecStart`. The user can then order the recorder to perform a movement back to the path identifier by using the instruction `PathRecMoveBwd`.

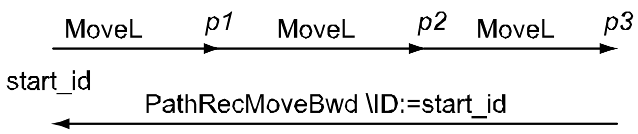
Basic examples

Basic examples of the data type `pathrecid` are illustrated below.

Example 1

```
VAR pathrecid start_id;
CONST robtarget p1 := [...];
CONST robtarget p2 := [...];
CONST robtarget p3 := [...];

PathRecStart start_id;
MoveL p1, vmax, z50, tool1;
MoveL p2, vmax, z50, tool1
MoveL p3, vmax, z50, tool1;
IF(PathRecValidBwd (\ID := start_id)) THEN
  StorePath;
  PathRecMoveBwd \ID:=start_id;
  ...
ENDIF
```



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The example above will start the path recorder and the starting point will be tagged with the path identifier `start_id`. Thereafter, the robot will move forward with traditional move instructions and then move back to the start position again using the recorded path. To be able to run PathRecorder move instructions, the path level has to be changed with `StorePath`.

Characteristics

`pathrecid` is an non-value data type.

Continues on next page

Related information

For information about	See
Start - stop the path recorder	*PathRecStart - Start the path recorder on page 308* *PathRecStop - Stop the path recorder on page 311*
Check for valid recorded path	*PathRecValidBwd - Is there a valid backward path recorded on page 921* *PathRecValidFwd - Is there a valid forward path recorded on page 924*
Play the path recorder backward	*PathRecMoveBwd - Move path recorder backwards on page 298*
Play the path recorder forward	*PathRecMoveFwd - Move path recorder forward on page 305*
Characteristics of non-value data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*

3.41. pos - Positions (only X, Y and Z)

Usage

`pos` is used for positions (only X, Y, and Z).

The `robtarget` data type is used for the robot's position including the orientation of the tool and the configuration of the axes.

Description

Data of the type `pos` describes the coordinates of a position: X, Y, and Z.

Components

The data type `pos` has the following components:

`x`

Data type: `num`

The X-value of the position.

`y`

Data type: `num`

The Y-value of the position.

`z`

Data type: `num`

The Z-value of the position.

Basic examples

Basic examples of the data type `pos` are illustrated below.

Example 1

```
VAR pos pos1;
...
pos1 := [500, 0, 940];
```

The `pos1` position is assigned the value: X=500 mm, Y=0 mm, Z=940 mm.

Example 2

```
pos1.x := pos1.x + 50;
```

The `pos1` position is shifted `50` mm in the X-direction.

Structure

```
< dataobject of pos >
  < x of num >
  < y of num >
  < z of num >
```


Continues on next page

Related information

For information about	See
Operations on positions	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Expressions*
Robot position including orientation	*robtarget - Position data on page 1176*

3.42. pose - Coordinate transformations

Usage

`pose` is used to change from one coordinate system to another.

Description

Data of the type `pose` describes how a coordinate system is displaced and rotated around another coordinate system. The data can, for example, describe how the tool coordinate system is located and oriented in relation to the wrist coordinate system.

Components

The data type has the following components:

`tranS`

translation

Data type: `pos`

The displacement in position (x, y, and z) of the coordinate system.

`rot`

rotation

Data type: `orient`

The rotation of the coordinate system.

Basic examples

Basic examples of the data type `pose` are illustrated below.

```
VAR pose frame1;
...
frame1.trans := [50, 0, 40];
frame1.rot := [1, 0, 0, 0];
```

The `frame1` coordinate transformation is assigned a value that corresponds to a displacement in position, where X=`50` mm, Y=`0` mm, Z=`40` mm; there is, however, no rotation.

Structure

```
< dataobject of pose >
  < trans of pos >
  < rot of orient >
```

Related information

For information about	See
What is a Quaternion?	*orient - Orientation on page 1150*

3.43. progdisp - Program displacement

Usage

`progdisp` is used to store the current program displacement of the robot and the external axes.

This data type does not normally have to be used since the data is set using the instructions `PDispSet`, `PDispOn`, `PDispOff`, `EOffsSet`, `EOffsOn`, and `EOffsOff`. It is only used to temporarily store the current value for later use.

Description

The current values for program displacement can be accessed using the system variable `C_PROGDISP`.

For more information, see the instructions `PDispSet`, `PDispOn`, `EOffsSet`, and `EOffsOn`.

Components

`pdisp`

program displacement

Data type: `pose`

The program displacement for the robot, expressed using a translation and an orientation. The translation is expressed in mm.

`eoffs`

external offset

Data type: `extjoint`

The offset for each of the external axes. If the axis is linear, the value is expressed in mm; if it is rotating, the value is expressed in degrees.

Basic examples

Basic examples of the data type `progdisp` are illustrated below.

Example 1

```
VAR progdisp progdisp1;
...
SearchL sen1, psearch, p10, v100, tool1;
PDispOn \ExeP:=psearch, *, tool1;
EOffsOn \ExeP:=psearch, *;
...
progdisp1:=C_PROGDISP;
PDispOff;
EOffsOff;
...
PDispSet progdisp1.pdisp;
EOffsSet progdisp1.eoffs;
```


Continues on next page

First, a program displacement is activated from a searched position. Then, the current program displacement values are temporary stored in the variable `progdisp1` and the program displacement is deactivated. Later on, re-activation is done using the instructions `PDispSet` and `EOffsSet`.

Predefined data

The system variable `C_PROGDISP` describes the current program displacement of the robot and external axes, and can always be accessed from the program. On the other hand, it can only be changed using a number of instructions, not by assignment.

The following default values for program displacement are set

- at a cold start-up.
- when a new program is loaded.
- when starting program execution from the beginning.

```
VAR progdisp C_PROGDISP :=
  [ [[ 0, 0, 0], [1, 0, 0, 0]],        -> posedata
  [ 0, 0, 0, 0, 0, 0]];                -> extjointdata
```

Structure

```
< dataobject of progdisp >
  < pdisp of pose >
    < trans of pos >
      < x of num >
      < y of num >
      < z of num >
    < rot of orient >
      < q1 of num >
      < q2 of num >
      < q3 of num >
      < q4 of num >
  < eoffs of extjoint >
    < eax_a of num >
    < eax_b of num >
    < eax_c of num >
    < eax_d of num >
    < eax_e of num >
    < eax_f of num >
```

Related information

For information about	See
Instructions for defining program displacement	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion settings*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Coordinate systems*

3.44. rawbytes - Raw data

Usage

`rawbytes` is used as a general data container. It can be used for communication with I/O devices.

Description

`rawbytes` data can be filled with any type of data - `num`, `byte`, `string` - by means of support instructions/functions. In any variable of `rawbytes`, the system also stores the current length of valid bytes.

Basic examples

Basic examples of the data type `rawbytes` are illustrated below.

Example 1

```
VAR rawbytes raw_data;
VAR num integer := 8;
VAR num float := 13.4;

ClearRawBytes raw_data;
PackRawBytes integer, raw_data, 1 \IntX := INT;
PackRawBytes float, raw_data, (RawBytesLen(raw_data)+1) \Float4;
```

In this example the variable `raw_data` of type `rawbytes` is first cleared, i.e. all bytes set to 0 (same as default at declaration). Then in the first 2 bytes the value of `integer` is placed and in the next 4 bytes the value of `float`.

Limitations

A `rawbytes` variable may contain 0 to 1024 bytes.

Structure

`rawbytes` is a non-value data type.

At declaration of `rawbytes` variable, all bytes in `rawbytes` are set to 0 and the current length of valid bytes in the variable is set to 0.

Related information

For information about	See
Get the length of `rawbytes` data	*RawBytesLen - Get the length of rawbytes data on page 940*
Clear the contents of `rawbytes` data	*ClearRawBytes - Clear the contents of rawbytes data on page 49*
Copy the contents of `rawbytes` data	*CopyRawBytes - Copy the contents of rawbytes data on page 67*
Pack DeviceNet header into `rawbytes` data	*PackDNHeader - Pack DeviceNet Header into rawbytes data on page 287*
Pack data into `rawbytes` data	*PackRawBytes - Pack data into rawbytes data on page 290*

Continues on next page

For information about	See
Write `rawbytes` data	*WriteRawBytes - Write rawbytes data on page 725*
Read `rawbytes` data	*ReadRawBytes - Read rawbytes data on page 352*
Unpack data from `rawbytes` data	*UnpackRawBytes - Unpack data from rawbytes data on page 658*

3.45. restartdata - Restart data for trigg signals

Usage

`restartdata` mirrors the pre- and postvalues of specified I/O signals (process signals) at the stop sequence of the robot movements. The I/O signals to supervise are specified in the instruction `TriggStopProc`.

`TriggStopProc` and `restartdata` are intended to be used for restart after program stop (STOP) or emergency stop (QSTOP) of own process instructions defined in RAPID (NOSTEPIN routines).

Definition

The table shows the definition of the time point for reading the pre- and postvalues for the I/O signals.

Type of stop	Read time for I/O signal prevalue	Read time for I/O signal postvalue
STOP on path	When all robot axes are standing still	About 400 ms after the pretime
QSTOP off path	As soon as possible	About 400 ms after the pretime

Description

`restartdata` mirrors the following data after program execution is stopped:

- valid restart data
- robot stopped on path or not
- prevalue of the I/O signals
- postvalue of the I/O signals
- number of flanks between pretime and posttime of the shadow signal for the ongoing process

Components

`restartstop`

valid restartdata after stop

Data type: `bool`

TRUE = Mirror last STOP or QSTOP

FALSE = Invalid restart data. All I/O signals values are set to -1.

`stoponpath`

stop on path

Data type: `bool`

TRUE = The robot is stopped on the path (STOP)

FALSE = The robot is stopped but not on the path (QSTOP)

Continues on next page

`predo1val`

pre do1 value

Data type: `dionum`

The prevalue of the digital signal “do1” specified in the argument `DO1` in instruction `TriggStopProc`.

`postdo1val`

post do1 value

Data type: `dionum`

The postvalue of the digital signal “do1” specified in the argument `DO1` in instruction `TriggStopProc`.

`prego1val`

pre go1 value

Data type: `num`

The prevalue of the digital group signal“ go1” specified in the argument `GO1` in instruction `TriggStopProc`.

`postgo1val`

post go1 value

Data type: `num`

The postvalue of the digital group signal“ go1” specified in the argument `GO1` in instruction `TriggStopProc`.

`prego2val`

pre go2 value

Data type: `num`

The prevalue of the digital group signal“ go2” specified in the argument `GO2` in instruction `TriggStopProc`.

`postgo2val`

post go2 value

Data type: `num`

The postvalue of the digital group signal“ go2” specified in the argument `GO2` in instruction `TriggStopProc`.

`prego3val`

pre go3 value

Data type: `num`

The prevalue of the digital group signal“ go3” specified in the argument `GO3` in instruction `TriggStopProc`.

`postgo3val`

post go3 value

Data type: `num`

The postvalue of the digital group signal“ go3” specified in the argument `GO3` in instruction `TriggStopProc`.

Continues on next page

`prego4val`

pre go4 value

Data type: `num`

The prevalue of the digital group signal“ go4” specified in the argument `GO4` in instruction `TriggStopProc`.

`postgo4val`

post go4 value

Data type: `num`

The postvalue of the digital group signal“ go4” specified in the argument `GO4` in instruction `TriggStopProc`.

`preshadowval`

pre shadow value

Data type: `dionum`

The prevalue of the digital signal “shadow” specified in the argument `ShadowDO` in instruction `TriggStopProc`.

`shadowflanks`

number of shadow flanks

Data type: `num`

The number of value transitions (flanks) of the digital signal “shadow” between the pretime and the posttime. The signal “shadow” is specified in the argument `ShadowDO` in instruction `TriggStopProc`.

`postshadowval`

post shadow value

Data type: `dionum`

The postvalue of the digital signal “shadow” specified in the argument `ShadowDO` in instruction `TriggStopProc`.

Continues on next page

Structure

```
< dataobject of restartdata >
  < restartstop of bool >
  < stoponpath of bool >
  < predo1val of dionum >
  < postdo1val of dionum >
  < prego1val of num >
  < postgo1val of num >
  < prego2val of num >
  < postgo2val of num >
  < prego3val of num >
  < postgo3val of num >
  < prego4val of num >
  < postgo4val of num >
  < preshadowval of dionum >
  < shadowflanks of dionum >
  < postshadowval of dionum >
```

Related information

For information about	See
Predefined process instructions	*TriggL - Linear robot movements with events on page 603* *TriggC - Circular robot movement with events on page 570*
Setup mirror of restart data	*TriggStopProc - Generate restart data for trigg signals at stop on page 629*
Move backwards on path	*StepBwdPath - Move backwards one step on path on page 499*

3.46. rmqheader - RAPID Message Queue Message header

Usage

`rmqheader` (*RAPID Message Queue Header*) is used for reading the data structure of the data in a message of type `rmqmessage`.

Description

The header part of a non-value data type `rmqmessage` converted to the value data type `rmqheader`.

Components

`datatype`

Data type: `string`

The name of the data type used, e.g `num`, `string` or some other value data type.

`ndim`

Number of Dimensions

Data type: `num`

Number of array dimensions.

`dim1`

Size of first dimension

Data type: `num`

The size of the first dimension. 0 if not used.

`dim2`

Size of second dimension

Data type: `num`

The size of the second dimension. 0 if not used.

`dim3`

Size of third dimension

Data type: `num`

The size of the third dimension. 0 if not used.

Examples

Basic examples of the data type `rmqheader` are illustrated below.

Example 1

```
VAR rmqmessage message;
VAR rmqheader header;
...
RMQGetMessage message;
RMQGetMsgHeader message \Header:=header;
```

Copy and convert the `rmqheader` information from an `rmqmessage` message.

Continues on next page

Structure

```
<dataobject of rmqheader>
  <datatype of string>
  <ndim of num>
  <dim1 of num>
  <dim2 of num>
  <dim3 of num>
```

Related information

For information about	See
Description of the RAPID Message Queue functionality	*Application manual - Robot communication and I/O control*, section *RAPID Message Queue*.
Extract the header data from an `rmqmessage`	*RMQGetMsgHeader - Get header information from an RMQ message on page 380*
`RMQ Message`	*rmqmessage - RAPID Message Queue message on page 1173*

3.47. rmqmessage - RAPID Message Queue message

Usage

`rmqmessage` (*RAPID Message Queue Message*) is used for temporary storage of communication data.

Description

The data type `rmqmessage` is the message used to store data in when communicating between different RAPID tasks or Robot Application Builder clients with RMQ functionality. It contains information about the type of data that was sent the dimensions of the data, the identity of the sender and the actual data.

An `rmqmessage` is a big data type (about 3000 bytes big), and it is recommended that the variable is reused to save RAPID memory.

Basic examples

Basic examples of the data type `rmqmessage` are illustrated below.

Example 1

```
VAR rmqmessage rmqmessage1;
VAR string myrecdata;
...
RMQGetMsgData rmqmessage1, myrecdata;
```

The variable `rmqmessage1` is defined and can be used in an RMQ (RAPID Message Queue) command. In this example, the data part within the `rmqmessage1` is copied to the variable `myrecdata`.

Characteristics

`rmqmessage` is a non-value data type and cannot be used in value-oriented operations.

Related information

For information about	See
Description of the RAPID Message Queue functionality	*Application manual - Robot communication and I/O control*, section *RAPID Message Queue*.
`RMQ Header`	*rmqheader - RAPID Message Queue Message header on page 1171*
Extract the header data from an `rmqmessage`	*RMQGetMsgHeader - Get header information from an RMQ message on page 380*
Order and enable interrupts for a specific data type	*IRMQMessage - Orders RMQ interrupts for a data type on page 167*
Get the first message from a RAPID Message Queue.	*RMQGetMessage - Get an RMQ message on page 373*
Send data to the queue of a RAPID task or Robot Application Builder client, and wait for an answer from the client.	*RMQSendWait - Send an RMQ data message and wait for a response on page 390*
Extract the data from an `rmqmessage`	*RMQGetMsgData - Get the data part from an RMQ message on page 377*

3.48. rmqslot - Identity number of an RMQ client

Usage

`rmqslot` (*RAPID Message Queue Slot*) is used when communicating with an RMQ or a Robot Application Builder client.

Description

The `rmqslot` is an identity number of a RAPID Message Queue configured for a RAPID task or the identity number of a Robot Application Builder client.

Basic examples

Basic examples of the data type `rmqslot` are illustrated below.

Example 1

```
VAR rmqslot rmqslot1;
RMQFindSlot rmqslot1, "RMQ_T_ROB1";
...
```

The variable `rmqslot1` is defined and can be used in the instruction `RMQFindSlot` to get the identity number of the RAPID Message Queue "`RMQ_T_ROB1`" configured for the RAPID task "`T_ROB1`".

Characteristics

`rmqslot` is a non-value data type and cannot be used in value-oriented operations.

Related information

For information about	See
Description of the RAPID Message Queue functionality	*Application manual - Robot communication and I/O control*, section *RAPID Message Queue*.
Find the identity number of a RAPID Message Queue task or Robot Application Builder client.	*RMQFindSlot - Find a slot identity from the slot name on page 371*
Send data to the queue of a RAPID task or Robot Application Builder client.	*RMQSendMessage - Send an RMQ data message on page 386*
Send data to a client, and wait for an answer from the client.	*RMQSendWait - Send an RMQ data message and wait for a response on page 390*
Get the slot name from a specified slot identity	*RMQGetSlotName - Get the name of an RMQ client on page 964*

3.49. robjoint - Joint position of robot axes

Usage

`robjoint` is used to define the position in degrees of the robot axes.

Description

Data of the type `robjoint` is used to store axis positions in degrees of the robot axis 1 to 6. Axis position is defined as the rotation in degrees for the respective axis (arm) in a positive or negative direction from the axis calibration position.

Components

`rax_1`

robot axis 1

Data type: `num`

The position of robot axis 1 in degrees from the calibration position.

`...`

`rax_6`

robot axis 6

Data type: `num`

The position of robot axis 6 in degrees from the calibration position.

Structure

```
< dataobject of robjoint >
  < rax_1 of num >
  < rax_2 of num >
  < rax_3 of num >
  < rax_4 of num >
  < rax_5 of num >
  < rax_6 of num >
```

Related information

For information about	See
Joint position data	*jointtarget - Joint position data on page 1129*
Move to joint position	*MoveAbsJ - Moves the robot to an absolute joint position on page 230*

3.50. robtarget - Position data

Usage

`robtarget` (*robot target*) is used to define the position of the robot and external axes.

Description

Position data is used to define the position in the move instructions to which the robot and external axes are to move.

As the robot is able to achieve the same position in several different ways, the axis configuration is also specified. This defines the axis values if these are in any way ambiguous, for example:

- if the robot is in a forward or backward position,
- if axis 4 points downwards or upwards,
- if axis 6 has a negative or positive revolution.

WARNING!

The position is defined based on the coordinate system of the work object, including any program displacement. If the position is programmed with some other work object than the one used in the instruction, the robot will not move in the expected way. Make sure that you use the same work object as the one used when programming move instructions. Incorrect use can injure someone or damage the robot or other equipment.

Components

`trans`

translation

Data type: `pos`

The position (x, y, and z) of the tool center point expressed in mm.

The position is specified in relation to the current object coordinate system, including program displacement. If no work object is specified then this is the world coordinate system.

`rot`

rotation

Data type: `orient`

The orientation of the tool, expressed in the form of a quaternion (q1, q2, q3, and q4).

The orientation is specified in relation to the current object coordinate system including program displacement. If no work object is specified then this is the world coordinate system.

`robconf`

robot configuration

Data type: `confdata`

The axis configuration of the robot (`cf1`, `cf4`, `cf6`, and `cfx`). This is defined in the form of the current quarter revolution of axis 1, axis 4, and axis 6. The first positive quarter revolution 0 to 90° is defined as 0. The meaning of the component `cfx` is dependent on robot type.

For more information, see data type `confdata`.

Continues on next page

`extax`

external axes

Data type: `extjoint`

The position of the external axes.

The position is defined as follows for each individual axis (`eax_a`, `eax_b ... eax_f`):

- For rotating axes, the position is defined as the rotation in degrees from the calibration position.
- For linear axes, the position is defined as the distance in mm from the calibration position.

External axes `eax_a ...` are logical axes. How the logical axis number and the physical axis number are related to each other is defined in the system parameters.

The value 9E9 is defined for axes which are not connected. If the axes defined in the position data differ from the axes that are actually connected at program execution then the following applies:

- If the position is not defined in the position data (value 9E9) then the value will be ignored if the axis is connected and not activated. But if the axis is activated then it will result in an error.
- If the position is defined in the position data although the axis is not connected then the value is ignored.

No movement is performed but no error is generated for an axis with valid position data if the axis is not activated.

If some external axis is running in independent mode and some new movement shall be performed by the robot and it's external axes then the position data for the external axis is independent mode must not be 9E9 but some arbitrary value (not used but the system).

Basic examples

Basic examples of the data type `robtarget` are illustrated below.

Example 1

```
CONST robtarget p15 := [ [600, 500, 225.3], [1, 0, 0, 0], [1, 1,
    0, 0], [ 11, 12.3, 9E9, 9E9, 9E9, 9E9] ];
```

A position `p15` is defined as follows:

- The position of the robot: `x = 600`, `y = 500` and `z = 225.3` mm in the object coordinate system.
- The orientation of the tool in the same direction as the object coordinate system.
- The axis configuration of the robot: axes 1 and 4 in position 90-180°, axis 6 in position 0-90°.
- The position of the external logical axes, a and b, expressed in degrees or mm (depending on the type of axis). Axes c to f are undefined.

Continues on next page

Example 2

```
VAR robtarget p20;
...
p20 := CRobT(\Tool:=tool\wobj:=wobj0);
p20 := Offs(p20,10,0,0);
```

The position `p20` is set to the same position as the current position of the robot by calling the function `CRobT`. The position is then moved `10` mm in the x-direction.

Structure

```
< dataobject of robtarget >
    < trans of pos >
      < x of num >
      < y of num >
      < z of num >
    < rot of orient >
      < q1 of num >
      < q2 of num >
      < q3 of num >
      < q4 of num >
    < robconf of confdata >
      < cf1 of num >
      < cf4 of num >
      < cf6 of num >
      < cfx of num >
    < extax of extjoint >
      < eax_a of num >
      < eax_b of num >
      < eax_c of num >
      < eax_d of num >
      < eax_e of num >
      < eax_f of num >
```

Related information

For information about	See
Move instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Motion*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - Coordinate Systems*
Handling configuration data	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - Robot configuration*
Configuration of external axes	*Application manual - Additional axes and stand alone controller*
What is a quaternion?	*orient - Orientation on page 1150*

3.51. shapedata - World zone shape data

Usage

`shapedata` is used to describe the geometry of a world zone.

Description

World zones can be defined in 4 different geometrical shapes:

- a straight box, with all sides parallel to the world coordinate system and defined by a `WZBoxDef` instruction
- a sphere, defined by a `WZSphDef` instruction
- a cylinder, parallel to the z axis of the world coordinate system and defined by a `WZCylDef` instruction
- a joint space area for robot and/or external axes, defined by the instruction `WZHomeJointDef` or `WZLimJointDef`

The geometry of a world zone is defined by one of the previous instructions and the action of a world zone is defined by the instruction `WZLimSup` or `WZDOSet`.

Basic examples

Basic examples of the data type `shapedata` are illustrated below.

Example 1

```
VAR wzstationary pole;
VAR wzstationary conveyor;
...
PROC ...
  VAR shapedata volume;
  ...
  WZBoxDef \Inside, volume, p_corner1, p_corner2;
  WZLimSup \Stat, conveyor, volume;
  WZCylDef \Inside, volume, p_center, 200, 2500;
  WZLimSup \Stat, pole, volume;
ENDPROC
```

A `conveyor` is defined as a box and the supervision for this area is activated. A `pole` is defined as a cylinder and the supervision of this zone is also activated. If the robot reaches one of these areas, the motion is stopped.

Characteristics

`shapedata` is a non-value data type.

Continues on next page

Related information

For information about	See
World Zones	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion settings*
Define box-shaped world zone	*WZBoxDef - Define a box-shaped world zone on page 732*
Define sphere-shaped world zone	*WZSphDef - Define a sphere-shaped world zone on page 756*
Define cylinder-shaped world zone	*WZCylDef - Define a cylinder-shaped world zone on page 734*
Define a world zone for home joints	*WZHomeJointDef - Define a world zone for home joints on page 746*
Define a world zone for limit joints	*WZLimJointDef - Define a world zone for limitation in joints on page 749*
Activate world zone limit supervision	*WZLimSup - Activate world zone limit supervision on page 753*
Activate world zone digital output set	*WZDOSet - Activate world zone to set digital output on page 738*

3.52. signalxx - Digital and analog signals

Usage

Data types within signalxx are used for digital and analog input and output signals.

The names of the signals are defined in the system parameters and are consequently not to be defined in the program.

Description

Data type	Used for
signalai	analog input signals
signalao	analog output signals
signaldi	digital input signals
signaldo	digital output signals
signalgi	groups of digital input signals
signalgo	groups of digital output signals

Variables of the type signalxo only contain a reference to the signal. The value is set using an instruction, e.g. DOutput.

Variables of the type signalxi contain a reference to a signal as well as the possibility to retrieve the value directly in the program, if used in value context.

The value of an input signal can be read directly in the program, e.g.:

```
! Digital input
IF di1 = 1 THEN ...

! Digital group input
IF gi1 = 5 THEN ...

! Analog input
IF ai1 > 5.2 THEN ...
```

It can also be used in assignments, e.g.:

```
VAR num current_value;

! Digital input
current_value := di1;

! Digital group input
current_value := gi1;

! Analog input
current_value := ai1;
```


Continues on next page

Limitations

Data of the data type `signalxx` must not be defined in the program. However, if this is in fact done then an error message will be displayed as soon as an instruction or function that refers to this signal is executed. The data type can, on the other hand, be used as a parameter when declaring a routine.

Predefined data

The signals defined in the system parameters can always be accessed from the program by using the predefined signal variables (installed data). However, it should be noted that if other data with the same name is defined then these signals cannot be used.

Characteristics

`Signalxo` is a `non-value` data type. Thus, data of this type does not permit value - oriented operations.

`Signalxi` is a semi-value data type.

Error handling

The following recoverable error can be generated. The error can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_NORUNUNIT` if there is no contact with the unit.

Related information

For information about	See
Summary input/output instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Input and output signals*
Input/Output functionality in general	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - I/O principles*
Configuration of I/O	*Technical reference manual - System parameters*
Characteristics of non-value data types	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Data types*

3.53. socketdev - Socket device

Usage

`socketdev` (*socket device*) is used to communicate with other computers on a network or between RAPID task.

Description

The socket device is a handle to a communication link to another computer on a network.

Basic examples

Basic examples of the data type `socketdev` are illustrated below.

Example 1

```
VAR socketdev socket1;
```

The variable `socket1` is defined and can be used in a socket command, e.g. `SocketCreate`.

Limitations

Any number of sockets can be declared but it is only possible to use 8 sockets at the same time.

Characteristics

`socketdev` is a non-value data type.

Related information

For information about	See
Socket communication in general	*Application manual - Robot communication and I/O control*
Create a new socket	*SocketCreate - Create a new socket on page 460*
Characteristics of non-value data types	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Data Types*

3.54. socketstatus - Socket communication status

Usage

`socketstatus` is used for representing status of the socket communication.

Description

Socket status is fetched with the function `SocketGetStatus` and can be used for program flow control or debugging purposes.

Basic examples

Basic examples of the data type `socketstatus` are illustrated below.

Example 1

```
VAR socketdev socket1;
VAR socketstatus state;
...
SocketCreate socket1;
state := SocketGetStatus( socket1 );
```

The socket status `SOCKET_CREATED` will be stored in the variable state.

Predefined data

Following constants of type `socketstatus` are predefined:

RAPID constant	Value	The socket is ...
`SOCKET_CREATED`	1	Created
`SOCKET_CONNECTED`	2	Client connected to a remote host
`SOCKET_BOUND`	3	Server bounded to a local address and port
`SOCKET_LISTENING`	4	Server listening for incoming connections
`SOCKET_CLOSED`	5	Closed

Characteristics

`socketstatus` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Socket communication in general	*Application manual - Robot communication and I/O control*
Get socket status	*SocketGetStatus - Get current socket state on page 973*
Data types in general, alias data types	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Data Types*

3.55. speeddata - Speed data

Usage

`speeddata` is used to specify the velocity at which both the robot and the external axes move.

Description

Speed data defines the velocity:

- at which the tool center point moves,
- the reorientation speed of the tool,
- at which linear or rotating external axes move.

When several different types of movement are combined, one of the velocities often limits all movements. The velocity of the other movements will be reduced in such a way that all movements will finish executing at the same time.

The velocity is also restricted by the performance of the robot. This differs, depending on the type of robot and the path of movement.

Components

`v_tcp`

velocity tcp

Data type: `num`

The velocity of the tool center point (TCP) in mm/s.

If a stationary tool or coordinated external axes are used, the velocity is specified relative to the work object.

`v_ori`

velocity orientation

Data type: `num`

The reorientation velocity of the TCP expressed in degrees/s.

If a stationary tool or coordinated external axes are used, the velocity is specified relative to the work object.

`v_leax`

velocity linear external axes

Data type: `num`

The velocity of linear external axes in mm/s.

`v_reax`

velocity rotational external axes

Data type: `num`

The velocity of rotating external axes in degrees/s.

Continues on next page

Basic examples

Basic examples of the data type `speeddata` are illustrated below.

Example 1

```
VAR speeddata vmedium := [ 1000, 30, 200, 15 ];
```

The speed data `vmedium` is defined with the following velocities:

- `1000` mm/s for the TCP.
- `30` degrees/s for reorientation of the tool.
- `200` mm/s for linear external axes.
- `15` degrees/s for rotating external axes.

```
vmedium.v_tcp := 900;
```

The velocity of the TCP is changed to `900` mm/s.

Limitations

At very slow motion each movement should be short enough to give an interpolation time less than 240 seconds.

Predefined data

A number of speed data are already defined in the system module `BASE_SHARED`.

Predefined speed data to be used for moving the robot and the external axes:

Name	TCP speed	Orientation	Linear ext. axis	Rotating ext. axis
v5	5 mm/s	500°/s	5000 mm/s	1000°/s
v10	10 mm/s	500°/s	5000 mm/s	1000°/s
v20	20 mm/s	500°/s	5000 mm/s	1000°/s
v30	30 mm/s	500°/s	5000 mm/s	1000°/s
v40	40 mm/s	500°/s	5000 mm/s	1000°/s
v50	50 mm/s	500°/s	5000 mm/s	1000°/s
v60	60 mm/s	500°/s	5000 mm/s	1000°/s
v80	80 mm/s	500°/s	5000 mm/s	1000°/s
v100	100 mm/s	500°/s	5000 mm/s	1000°/s
v150	150 mm/s	500°/s	5000 mm/s	1000°/s
v200	200 mm/s	500°/s	5000 mm/s	1000°/s
v300	300 mm/s	500°/s	5000 mm/s	1000°/s
v400	400 mm/s	500°/s	5000 mm/s	1000°/s
v500	500 mm/s	500°/s	5000 mm/s	1000°/s
v600	600 mm/s	500°/s	5000 mm/s	1000°/s
v800	800 mm/s	500°/s	5000 mm/s	1000°/s
v1000	1000 mm/s	500°/s	5000 mm/s	1000°/s
v1500	1500 mm/s	500°/s	5000 mm/s	1000°/s
v2000	2000 mm/s	500°/s	5000 mm/s	1000°/s
v2500	2500 mm/s	500°/s	5000 mm/s	1000°/s
v3000	3000 mm/s	500°/s	5000 mm/s	1000°/s
v4000	4000 mm/s	500°/s	5000 mm/s	1000°/s

Continues on next page

Name	TCP speed	Orientation	Linear ext. axis	Rotating ext. axis
v5000	5000 mm/s	500°/s	5000 mm/s	1000°/s
v6000	6000 mm/s	500°/s	5000 mm/s	1000°/s
v7000	7000 mm/s	500°/s	5000 mm/s	1000°/s
vmax	*)	500°/s	5000 mm/s	1000°/s

*) Max. TCP speed for the used robot type and normal practical TCP values. The RAPID function `MaxRobSpeed` returns the same value. If using extreme big TCP values in tool frame then create own speeddata with bigger TCP speed than returned by `MaxRobSpeed`.

Predefined speeddata to be used for moving rotating external axes with instruction `MoveExtJ`.

Name	TCP speed	Orientation	Linear ext. axis	Rotating ext. axis
vrot1	0 mm/s	0°/s	0 mm/s	1°/s
vrot2	0 mm/s	0°/s	0 mm/s	2°/s
vrot5	0 mm/s	0°/s	0 mm/s	5°/s
vrot10	0 mm/s	0°/s	0 mm/s	10°/s
vrot20	0 mm/s	0°/s	0 mm/s	20°/s
vrot50	0 mm/s	0°/s	0 mm/s	50°/s
vrot100	0 mm/s	0°/s	0 mm/s	100°/s

Predefined speed data to be used for moving linear external axes with instruction `MoveExtJ`.

Name	TCP speed	Orientation	Linear ext. axis	Rotating ext. axis
vlin10	0 mm/s	0°/s	10 mm/s	0°/s
vlin20	0 mm/s	0°/s	20 mm/s	0°/s
vlin50	0 mm/s	0°/s	50 mm/s	0°/s
vlin100	0 mm/s	0°/s	100 mm/s	0°/s
vlin200	0 mm/s	0°/s	200 mm/s	0°/s
vlin500	0 mm/s	0°/s	500 mm/s	0°/s
lin1000	0 mm/s	0°/s	1000 mm/s	0°/s

Structure

```
< dataobject of speeddata >
  < v_tcp of num >
  < v_ori of num >
  < v_leax of num >
  < v_reax of num >
```


Continues on next page

Related information

For information about	See
Positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID Summary - Motion*
Motion/Speed in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution*
Defining maximum velocity	*VelSet - Changes the programmed velocity on page 662*
Max. TCP speed for this robot	*MaxRobSpeed - Maximum robot speed on page 892*

3.56. stoppointdata - Stop point data

Usage

`stoppointdata` is used to specify how a position is to be terminated, i.e. how close to the programmed position the axes must be before moving towards the next position.

Description

A position can be terminated either in the form of a fly-by point or a stop point.

A fly-by point means that the programmed position is never reached. A zone is specified in the instruction for the movement, defining a corner path. Instead of heading for the programmed position, the direction of the motion is formed into the corner path before the position is reached. See data type `zonedata`.

A stop point means that the robot and external axes must reach the specified position before the robot/external axes continues with the next movement. The robot is considered to have reached a stop point when the convergence criteria of the point are satisfied. The convergence criteria are speed and position. It is also possible to specify timing criteria. For stop point `fine`, see also data type `zonedata`.

Three types of stop points can be defined by the `stoppointdata`.

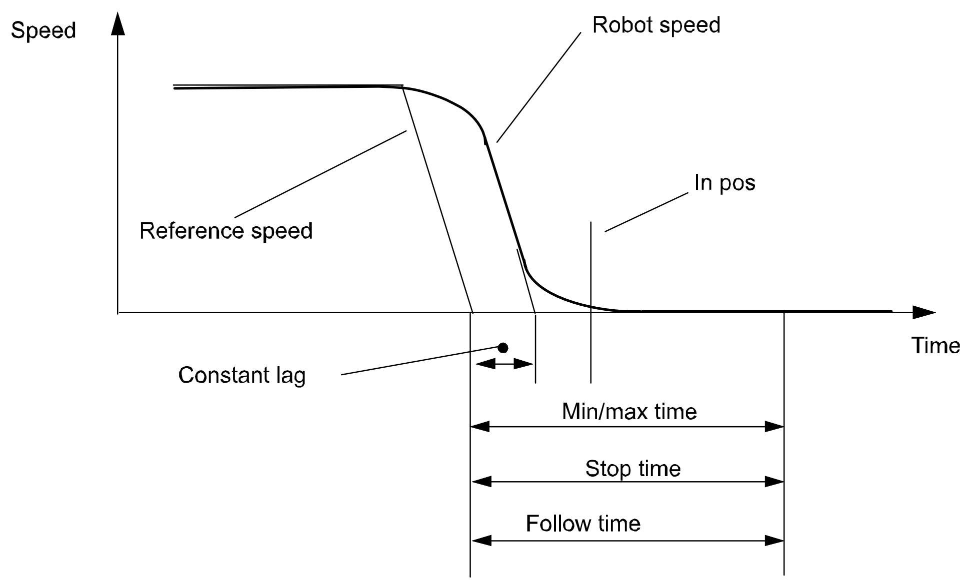
- The **in position** type of stop point is defined as a percentage of the convergence criteria (position and speed) for the predefined stop point `fine`. The in-position type also uses a minimum and a maximum time. The robot waits for at least the minimum time, and at most the maximum time, for the position and speed criteria to be satisfied.
- The **stop time** type of stop point always waits in the stop point for the given time.
- The **follow time** type of stop point is a special type of stop point used to coordinate the robot movement with a conveyor.

The `stoppointdata` also determines how the movement shall be synchronized with the RAPID execution. If the movement is synchronized, the RAPID execution waits for a “in pos” event when the robot is in position. If the movement is not synchronized, the RAPID execution gets a “prefetch” event almost a half second before the physical robot reaches the programmed position. When the program execution gets an “in pos” or a “prefetch” event, it continues with the next instruction. When the “prefetch” event arrives, the robot still has a long way to move. When the“ in pos” event arrives the robot is close to the programmed position.

For the type **stop time** and **follow time**, the next instruction starts its execution at the same time as the stop time and follow time, respectively, start to count down. But for the type **in position**, the next instruction is started when the convergence criteria is fulfilled.

If use of move instructions with argument `\Conc`, no synchronization at all is done, so the actual move instruction execution will be ready at once.

Continues on next page



xx0500002374

In the figure above, the termination of the stop points is described. The robot's speed does not decrease linearly. The robot servo is always ahead of the physical robot. It is shown as the constant lag in the figure above. The constant lag is about 0.1 seconds. The timing elements of `stoppointdata` use the reference speed as trigger. When the reference speed is zero the time measurement starts. Therefore the time in the timing elements always include the constant lag. Consequently there is no sense in using values less than the constant lag.

Components

`type`

type of stop point

Data type: `stoppoint`

The following table defines the type of `stoppoint`.

`1 (inpos)`	The movement terminates as an in-position type of stop point. Enables the `inpos` element in `stoppointdata`. The zone data in the instruction is not used, use `fine` or `z0`.
`2 (stoptime)`	The movement terminates as a stop-time type of stop point. Enables the `stoptime` element in `stoppointdata`. The zone data in the instruction is not used, use `fine` or `z0`.
`3 (followtime)`	The movement terminates as a conveyor follow-time type of fine point. The zone data in the instruction is used when the robot leaves the conveyor. Enables the `followtime` element in `stoppointdata`.

Continues on next page

Data type `stoppoint` is an alias data type for `num`. It is used to choose the type of stop point and which data elements to use in the `stoppointdata`. Predefined constants are:

Value	Symbolic constant	Comment
1	`inpos`	In position type number
2	`stoptime`	Stop time type number
3	`fllwtime`	Follow time type number

`progsynch`

program synchronization

Data type: `bool`

Synchronization with RAPID program execution.

- `TRUE:` The movement is synchronized with RAPID execution. The program does not start to execute the next instruction until the stop point has been reached.
- `FALSE:` The movement is not synchronized with RAPID execution. The program starts the execution of the next instruction before the stop point has been reached.

If use of move instructions with argument `\Conc`, no synchronization at all is done independent of the data in `progsynch`, so the actual move instruction will always be ready at once.

`inpos.position`

position condition for TCP

Data type: `num`

The position condition (the radius) for the TCP in percent of a normal `fine` stop point.

`inpos.speed`

speed condition for TCP

Data type: `num`

The speed condition for the TCP in percent of a normal `fine` stop point.

`inpos.mintime`

minimum wait time

Data type: `num`

The minimum wait time in seconds before in position. Used to make the robot wait at least the specified time in the point. Maximum value is 20.0 seconds.

`inpos.maxtime`

maximum wait time

Data type: `num`

The maximum wait time in seconds for convergence criteria to be satisfied. Used to assure that the robot does not get stuck in the point if the speed and position conditions are set too tight. Maximum value is 20.0 seconds.

Continues on next page

`stoptime`

stop time

Data type: `num`

The time in seconds, the TCP stands still in position before starting the next movement. Valid range 0 - 20 s, resolution 0.001 s.

`followtime`

follow time

Data type: `num`

The time in seconds the TCP follows the conveyor. Valid range 0 - 20 s, resolution 0.001 s.

`signal`

Data type: `string`

Reserved for future use.

`relation`

Data type: `opnum`

Reserved for future use.

`checkvalue`

Data type: `num`

Reserved for future use.

Basic examples

Basic examples of the data type `stoppointdata` are illustrated below.

Inpos

```
VAR stoppointdata my_inpos := [ inpos, TRUE, [ 25, 40, 0.1, 5], 0,
     0, "", 0, 0];
MoveL *, v1000, fine \Inpos:=my_inpos, grip4;
```

The stop point data `my_inpos` is defined by means of the following characteristics:

- The type of stop point is in-position type, `inpos`.
- The stop point will be synchronized with the RAPID program execution, `TRUE`.
- The stop point distance criteria is 25% of the distance defined for the stop point `fine`, `25`.
- The stop point speed criteria is 40% of the speed defined for the stop point `fine`, `40`.
- The minimum time to wait before convergence is 0,1 s, `0.1`.
- The maximum time to wait on convergence is 5 s, `5`.

The robot moves towards the programmed position until one of the criteria position or speeds are satisfied.

```
my_inpos.inpos.position := 40;
MoveL *, v1000, fine \Inpos:=my_inpos, grip4;
```

The stop point distance criteria is adjusted to `40`%.

Continues on next page

Stoptime

```
VAR stoppointdata my_stoptime := [ stoptime, FALSE, [ 0, 0, 0, 0],
    1.45, 0, "", 0, 0];
MoveL *, v1000, fine \Inpos:=my_stoptime, grip4;
```

The stop point data `my_stoptime` is defined by means of the following characteristics:

- The type of stop point is stop-time type, `stoptime`.
- The stop point will not be synchronized with the RAPID program execution, `FALSE`.
- The wait time in position is `1.45` s.

The robot moves towards the programmed position until the prefetch event arrives. The next RAPID instruction executes. If it is a move-instruction then the robot stops for `1.45` seconds before the next movement starts.

```
my_stoptime.stoptime := 6.66;
MoveL *, v1000, fine \Inpos:=my_stoptime, grip4;
```

The stop point stop time is adjusted to `6.66` seconds. If the next RAPID instruction is a move-instruction, the robot stops for `6.66` s.

Followtime

```
VAR stoppointdata my_followtime := [ fllwtime, TRUE, [ 0, 0, 0,
    0], 0, 0.5, "", 0, 0];
MoveL *, v1000, z10 \Inpos:=my_followtime, grip6\wobj:=conveyor1;
```

The stop point data `my_followtime` is defined by means of the following characteristics:

- The type of stop point is follow-time type, `fllwtime`.
- The stop point will be synchronized with the RAPID program execution, `TRUE`.
- The stop point follow time is 0.5 s, `0.5`.

The robot will follow the conveyor for 0.5 s before leaving it with the zone 10 mm, `z10`.

```
my_followtime.followtime := 0.4;
```

The stop point follow time is adjusted to `0.4` s.

Predefined data

A number of stop point data are already defined in the system module `BASE_SHARED`.

In position stop points

Name	Progsynch	Position	Speed	Mintime	Maxtime	Stop-time	Follow-time
inpos20	`TRUE`	20%	20%	0 s	2 s	-	-
inpos50	`TRUE`	50%	50%	0 s	2 s	-	-
inpos100	`TRUE`	100%	100%	0 s	2 s	-	-

(`inpos100` has same convergence criteria as stop point `fine`)

Continues on next page

Stop time stop points

Name	Progsynch	Position	Speed	Mintime	Maxtime	Stop-time	Follow-time
stoptime0_5	`FALSE`	-	-	-	-	0.5 s	-
stoptime1_0	`FALSE`	-	-	-	-	1.0 s	-
stoptime1_5	`FALSE`	-	-	-	-	1.5 s	-

Follow time stop points

Name	Progsynch	Position	Speed	Mintime	Maxtime	Stop-time	Follow-time
fllwtime0_5	`TRUE`	-	-	-	-	-	0.5 s
fllwtime1_0	`TRUE`	-	-	-	-	-	1.0 s
fllwtime1_5	`TRUE`	-	-	-	-	-	1.5 s

Structure

```
< data object of stoppointdata >
  < type of stoppoint >
  < progsynch of bool >
  < inpos of inposdata >
     < position of num >
     < speed of num >
     < mintime of num >
     < maxtime of num >
  < stoptime of num >
  < followtime of num >
  < signal of string >
  < relation of opnum >
  < checkvalue of num >
```

Related information

For information about	See
Positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Movements/Paths in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution*
Stop or fly-by points	*zonedata - Zone data on page 1232*

3.57. string - Strings

Usage

`string` is used for character strings.

Description

A character string consists of a number of characters (a maximum of 80) enclosed by quotation marks (""), e.g. "This is a character string".

If the quotation marks are to be included in the string, they must be written twice, e.g. "This string contains a ""character".

If the back slashes are to be included in the string, it must be written twice, e.g. "This string contains a \\ character".

Basic examples

Basic examples of the data type `string` are illustrated below.

Example 1

```
VAR string text;
...
text := "start welding pipe 1";
TPWrite text;
```

The text `start welding pipe 1` is written on the FlexPendant.

Limitations

A string may have 0 to 80 characters; inclusive of extra quotation marks or back slashes.

A string may contain any of the characters specified by ISO 8859-1 (Latin-1) as well as control characters (non-ISO 8859-1 (Latin-1) characters with a numeric code between 0-255).

Predefined data

A number of predefined string constants are available in the system and can be used together with string functions. See for example `StrMemb`.

<table>
<tr><th>Name</th><th>Character set</th></tr>
<tr><td>STR_DIGIT</td><td><digit> ::=
0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9</td></tr>
<tr><td>STR_UPPER</td><td><upper case letter> ::=
A | B | C | D | E | F | G | H | I | J
| K | L | M | N | O | P | Q | R | S | T
| U | V | W | X | Y | Z | À | Á | Â | Ã
| Ä | Å | Æ | Ç | È | É | Ê | Ë | Ì | Í
| Î | Ï | 1)| Ñ | Ò | Ó | Ô | Õ | Ö | Ø
| Ù | Ú | Û | Ü | 2) | 3)</td></tr>
</table>

Continues on next page

Name	Character set
`STR_LOWER`	<lower case letter> ::= a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | y | z | à | á | â | ã | ä | å | æ | ç | è | é | ê | ë | ì | í | î | ï | 1) | ñ | ò | ó | ô | õ | ö | ø | ù | ú | û | ü | 2) | 3) | ß | ÿ-
`STR_WHITE`	<blank character> ::=

1) Icelandic letter eth.

2) Letter Y with acute accent.

3) Icelandic letter thorn.

The following constants are already defined in the system module `BASE_SHARED`:

```
CONST string diskhome := "HOME:";

! For old programs from S4C system
CONST string ram1disk := "HOME:";

CONST string disktemp := "TEMP:";

CONST string flp1 := "flp1:";

CONST string stSpace := " ";

CONST string stEmpty := "";
```

`stEmpty` can be useful for memory saving if a lot of empty strings are used, for example:

```
TPReadFK reg1, "warm start required", stEmpty, stEmpty, stEmpty,
     stEmpty, "OK";
```

Related information

For information about	See
Operations using strings	*Technical reference manual - RAPID overview*, section *Basic characteristics - Expressions*
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*
Instruction using character set	*StrMemb - Checks if a character belongs to a set on page 1001*

3.58. stringdig - String with only digits

Usage

`stringdig` is used to represent big positive integers in a string with only digits.

This data type is introduced because the data type `num` cannot handle positive integers above 8 388 608 with exact representation.

Description

A `stringdig` can only consist of a number of digits 0 ... 9 enclosed by quotation marks (""), e.g. "0123456789".

The data type `stringdig` can handle positive integers up to 4 294 967 295.

Basic examples

Basic examples of the data type `stringdig` are illustrated below.

Example 1

```
VAR stringdig digits1;
VAR stringdig digits2;
VAR bool flag1;
...
digits1 ="09000000";
digits2 = "9000001";
flag1 := StrDigCmp (digits1, LT, digits2);
```

The data `flag1` will be set to `TRUE` because `09000000` is less than `9000001`.

Characteristics

`stringdig` is an alias data type of `string` and consequently inherits most of its characteristics.

Related information

For information about	See
String values	*Technical reference manual - RAPID overview*, section *Basic characteristics - Basic elements*
Strings	*string - Strings on page 1195*
Numeric values	*num - Numeric values on page 1146*
Comparison operator	*opnum - Comparison operator on page 1149* *StrDigCmp - Compare two strings with only digits on page 991*
Compare strings with only digits	*StrDigCmp - Compare two strings with only digits on page 991*

3.59. switch - Optional parameters

Usage

`switch` is used for optional parameters.

Description

The special type, `switch` may (only) be assigned to optional parameters and provides a means to use switch arguments, i.e. arguments that are only specified by names (not values). A value can not be transmitted to a switch parameter. The only way to use a switch parameter is to check for its presence using the predefined function `Present`.

Basic examples

Basic examples of the data type `switch` are illustrated below.

Example 1

```
PROC my_routine(\switch on | \switch off)
  ....
  IF Present (off) THEN
    ....
  ENDIF
ENDPROC
```

Depending on what arguments the caller of `my_routine` uses, the program flow can be controlled.

Characteristics

`switch` is a non-value data type and can not be used in value-orientated operations.

Related information

For information about	See
Parameters	*Technical reference manual - RAPID overview*, section *Basic characteristics - Routines*.
How to check if an optional parameter is present	*Present - Tests if an optional parameter is used on page 937*

3.60. symnum - Symbolic number

Usage

`symnum` (*Symbolic Number*) is used to represent an integer with a symbolic constant.

Description

A `symnum` constant is intended to be used when checking the return value from the functions `OpMode` and `RunMode`. See example below.

Basic examples

Basic examples of the data type `symnum` are illustrated below.

Example 1

```
IF RunMode() = RUN_CONT_CYCLE THEN
..
ELSE
..
ENDIF
```

Predefined data

The following symbolic constants of the data type `symnum` are predefined and can be used when checking return values from the functions `OpMode` and `RunMode`.

Value	Symbolic constant	Comment
0	`RUN_UNDEF`	Undefined running mode
1	`RUN_CONT_CYCLE`	Continuous or cycle running mode
2	`RUN_INSTR_FWD`	Instruction forward running mode
3	`RUN_INSTR_BWD`	Instruction backward running mode
4	`RUN_SIM`	Simulated running mode
5	`RUN_STEP_MOVE`	Move instructions in forward running mode and logical instructions in continuous running mode

Value	Symbolic constant	Comment
0	`OP_UNDEF`	Undefined operating mode
1	`OP_AUTO`	Automatic operating mode
2	`OP_MAN_PROG`	Manual operating mode max. 250 mm/s
3	`OP_MAN_TEST`	Manual operating mode full speed, 100%

Characteristics

`Symnum` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Data types in general, alias data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*

3.61. syncident - Identity for synchronization point

Usage

`syncident` (*synchronization identity*) is used to specify the name of a synchronization point. The name of the synchronization point will be the name (identity) of the declared data of type `syncident`.

Description

`syncident` is used to identify a point in the program where the actual program task will wait for cooperate program tasks to reach the same synchronization point.

The data name (identity) of the type `syncident` must be the same in all cooperative program tasks.

Data type syncident is used in the instructions `WaitSyncTask`, `SyncMoveOn`, and `SyncMoveOff`.

Basic examples

Basic examples of the data type `syncident` are illustrated below.

Example 1

Program example in program task `ROB1`

```
PERS tasks task_list{3} := [ ["STN1"], ["ROB1"], ["ROB2"] ];
VAR syncident sync1;

WaitSyncTask sync1, task_list;
```

At execution of instruction `WaitSyncTask` in the program task `ROB1`, the execution in that program task will wait until the other program tasks `STN1` and `ROB2` have reached their corresponding `WaitSyncTask` with the same synchronization (meeting) point `sync1`.

Structure

`syncident` is a non-value data type.

Related information

For information about	See
Specify cooperated program tasks	*tasks - RAPID program tasks on page 1204*
Wait for synchronization point with other tasks	*WaitSyncTask - Wait at synchronization point for other program tasks on page 688*
Start coordinated synchronized movements	*SyncMoveOn - Start coordinated synchronized movements on page 534*
End coordinated synchronized movements	*SyncMoveOff - End coordinated synchronized movements on page 528*

3.62. System data - Current RAPID system data settings

Usage

`System data` mirrors the current settings of RAPID system data such as current model motion settings, current error recovery number `ERRNO`, current interrupt number `INTNO`, etc.

These data can be accessed and read by the program. It can be used to read the current status, e.g. the current program displacement.

`C_MOTSET`

The variable `C_MOTSET` of data type `motsetdata` mirrors the current motion settings:

Description	Data type	Changed by	See also
Current motion settings, i.e.:	`motsetdata`	Instructions	*motsetdata - Motion settings data on page 1141*
Velocity override and max velocity		`VelSet`	*VelSet - Changes the programmed velocity on page 662*
Acceleration override		`AccSet`	*AccSet - Reduces the acceleration on page 15*
Movements around singular points		`SingArea`	*SingArea - Defines interpolation around singular points on page 447*
Linear configuration control Joint configuration control		`ConfL` `ConfJ`	*ConfL - Monitors the configuration during linear movement on page 61* *ConfJ - Controls the configuration during joint movement on page 59*
Path resolution		`PathResol`	*PathResol - Override path resolution on page 314*
Tuning motion supervision		`MotionSup`	*MotionSup - Deactivates/Activates motion supervision on page 227*
Reduction of TCP acceleration/deceleration along the movement path		`PathAccLim`	*PathAccLim - Reduce TCP acceleration along the path on page 295*
Modification of the tool orientation during circle interpolation		`CirPathMode`	*CirPathMode - Tool reorientation during circle path on page 38*
Reduction of payload acceleration in world coordinate system		`WorldAccLim`	*WorldAccLim - Control acceleration in world coordinate system on page 707*

`C_PROGDISP`

The variable `C_PROGDISP` of data type `progdisp` mirrors the current program displacement and external axes offset:

Description	Data type	Changed by	See also
Current program displacement for robot axes	`progdisp`	Instructions:	*progdisp - Program displacement on page 1163*
		`PDispSet`	*PDispSet - Activates program displacement using known frame on page 321*
		`PDispOn`	*PDispOn - Activates program displacement on page 317*

Continues on next page

Description	Data type	Changed by	See also
		`PDispOff`	*PDispOff - Deactivates program displacement on page 316*
Current external axes offset		`EOffsSet`	*EOffsSet - Activates an offset for external axes using known values on page 90*
		`EOffsOn`	*EOffsOn - Activates an offset for external axes on page 88*
		`EOffsOff`	*EOffsOff - Deactivates an offset for external axes on page 87*

`ERRNO`

The variable `ERRNO` of data type `errnum` mirrors the current error recovery number:

Description	Data type	Changed by	See also
The latest error that occurred	`errnum`	The system	*Technical reference manual - RAPID overview*, section *RAPID summary - Error recovery* *intnum - Interrupt identity on page 1125*

`INTNO`

The variable `INTNO` of data type `intnum` mirrors the current interrupt number:

Description	Data type	Changed by	See also
The latest interrupt that occurred	`intnum`	The system	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupts* *intnum - Interrupt identity on page 1125*

`ROB_ID`

The variable `ROB_ID` of data type `mecunit` contains a reference to the TCP-robot (if any) in the actual program task.

Description	Data type	Changed by	See also
Reference to the robot (if any) in the actual program task. Always check before use with `TaskRunRob ()`	`mecunit`	The system	*mecunit - Mechanical unit on page 1139*

3.63. taskid - Task identification

Usage

`taskid` is used to identify available program tasks in the system.

The names of the program tasks are defined in the system parameters and, consequently, must not be defined in the program.

Description

Data of the type `taskid` only contains a reference to the program task.

Limitations

Data of the type `taskid` must not be defined in the program. The data type can, on the other hand, be used as a parameter when declaring a routine.

Predefined data

The program tasks defined in the system parameters can always be accessed from the program (installed data).

For all program tasks in the system, predefined variables of the data type `taskid` will be available. The variable identity will be "taskname"+"Id", e.g. for the `T_ROB1` task the variable identity will be `T_ROB1Id`, `T_ROB2` - `T_ROB2Id` etc.

Characteristics

`taskid` is a non-value data type. This means that data of this type does not permit value-oriented operations.

Related information

For information about	See
Saving program modules	*Save - Save a program module on page 396*
Configuration of program tasks	*Technical reference manual - System parameters*
Characteristics of non-value data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*

3.64. tasks - RAPID program tasks

Usage

`tasks` is used to specify several RAPID program tasks.

Description

To specify several RAPID program tasks, the name of each task can be given as a string. An array of data type `tasks` can then hold all the task names.

This task list can then be used in the instructions `WaitSyncTask` and `SyncMoveOn`.

NOTE!

The instructions above demand that the data is defined as system global `PERS` variables available in all the cooperated tasks.

Components

The data type has the following components.

`taskname`

Data type: `string`

The name of a RAPID program task specified in a string.

Basic examples

Basic examples of the data type `tasks` are illustrated below.

Example 1

Program example in program task `T_ROB1`

```
PERS tasks task_list{3} := [ ["T_STN1"], ["T_ROB1"], ["T_ROB2"] ];
VAR syncident sync1;

WaitSyncTask sync1, task_list;
```

At execution of instruction `WaitSyncTask` in the program task `T_ROB1`, the execution in that program task will wait until all the other program tasks `T_STN1` and `T_ROB2` have reached their corresponding `WaitSyncTask` with the same synchronization (meeting) point `sync1`.

Structure

```
<dataobject of tasks>
  <taskname of string>
```


Continues on next page

Related information

For information about	See
Identity for synchronization point	*syncident - Identity for synchronization point on page 1200*
Wait for synchronization point with other tasks	*WaitSyncTask - Wait at synchronization point for other program tasks on page 688*
Start coordinated synchronized movements	*SyncMoveOn - Start coordinated synchronized movements on page 534*
End coordinated synchronized movements	*SyncMoveOff - End coordinated synchronized movements on page 528*

3.65. testsignal - Test signal

Usage

The data type `testsignal` is used when a test of the robot motion system is performed.

Description

A number of predefined test signals are available in the robot system. The `testsignal` data type is available in order to simplify programming of instruction `TestSignDefine`.

Basic examples

Basic examples of the data type `testsignal` are illustrated below.

Example 1

```
TestSignDefine 2, speed, Orbit, 2, 0;
```

The predefined constant `speed` is used to read the actual speed of axis `2` on the manipulator `orbit`.

Predefined data

The following test signals for external manipulator axes are predefined in the system. All data is in SI units and measured on the motor side of the axis.

Symbolic constant	Value	Unit
`speed`	6	rad/s
`torque_ref`	9	Nm
`resolver_angle`	1	rad
`speed_ref`	4	rad/s
`dig_input1`	102	0 or 1
`dig_input2`	103	0 or 1

Characteristics

`testsignal` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Define test signal	*TestSignDefine - Define test signal on page 551*
Read test signal	*TestSignRead - Read test signal value on page 1020*
Reset test signals	*TestSignReset - Reset all test signal definitions on page 553*

3.66. tooldata - Tool data

Usage

`tooldata` is used to describe the characteristics of a tool, e.g. a welding gun or a gripper.

If the tool is fixed in space (a stationary tool), the tool data defines this tool and the gripper holding the work object.

Description

Tool data affects robot movements in the following ways:

- The tool center point (TCP) refers to a point that will satisfy the specified path and velocity performance. If the tool is reorientated or if coordinated external axes are used, only this point will follow the desired path at the programmed velocity.
- If a stationary tool is used, the programmed speed and path will relate to the work object held by the robot.
- Programmed positions refer to the position of the current TCP and the orientation in relation to the tool coordinate system. This means that if, for example, a tool is replaced because it is damaged, the old program can still be used if the tool coordinate system is redefined.

Tool data is also used when jogging the robot to:

- Define the TCP that is not to move when the tool is reorientated.
- Define the tool coordinate system in order to facilitate moving in or rotating in the tool directions.

WARNING!

It is important to always define the actual tool load and, when used, the payload of the robot too. Incorrect definitions of load data can result in overloading of the robot mechanical structure.

When incorrect tool load data is specified, it can often lead to the following consequences:

1. If the value in the specified load is greater than the true load:

- The robot will not be used to its maximum capacity
- Impaired path accuracy including a risk of overshooting

2. If the value in the specified load is less than the true load:

- Risk of overloading the mechanical structure
- Impaired path accuracy including a risk of overshooting

Components

`robhold`

robot hold

Data type: `bool`

Defines whether or not the robot is holding the tool:

- `TRUE:` The robot is holding the tool.
- `FALSE:` The robot is not holding the tool, i.e. a stationary tool.

Continues on next page

`tframe`

tool frame

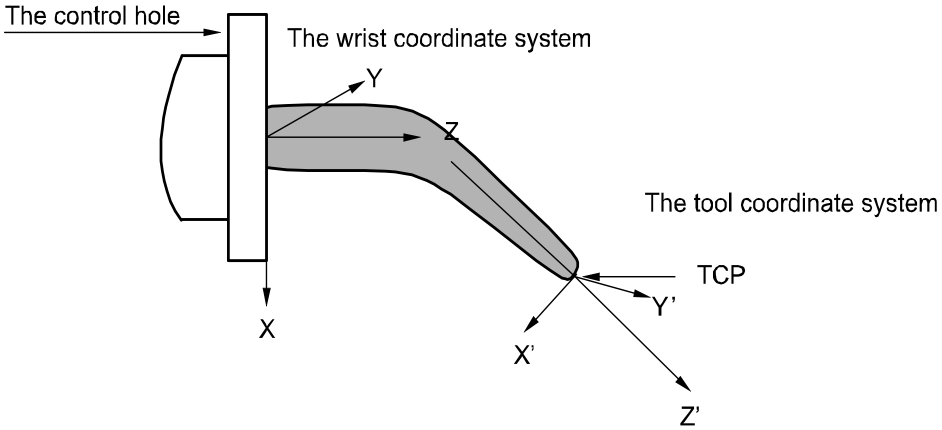
Data type: `pose`

The tool coordinate system, i.e.:

- The position of the TCP (x, y and z) in mm, expressed in the wrist coordinate system (see figure below).
- The orientation of the tool coordinate system, expressed in the wrist coordinate system as a quaternion (q1, q2, q3 and q4) (see figure below).

If a stationary tool is used, the definition is defined in relation to the world coordinate system.

If the direction of the tool is not specified, the tool coordinate system and the wrist coordinate system will coincide.



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`tload`

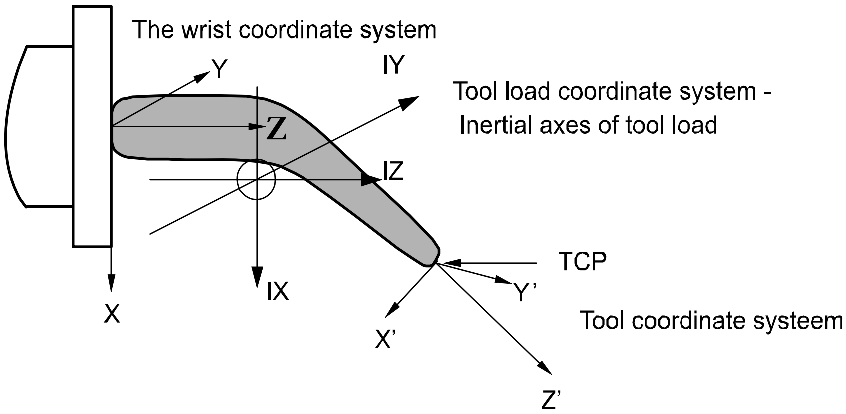
tool load

Data type: `loaddata`

The load of the tool, i.e.:

- The weight of the tool in kg.
- The center of gravity of the tool load (x, y and z) in mm, expressed in the wrist coordinate system
- The moments of inertia of the tool relative to its center of mass around the tool load coordinate axes in kgm^2. If all inertial components are defined as being 0 kgm^2, the tool is handled as a point mass.

Continues on next page



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For more information (such as coordinate system for stationary tool or restrictions), see the data type `loaddata`.

If a stationary tool is used, the load of the gripper holding the work object is defined in `tload`.

NOTE!

Only the load of the tool is to be specified. The payload handled by a gripper is connected and disconnected by means of the instruction `GripLoad`.

Basic examples

Basic examples of the data type `tooldata` are illustrated below.

Example 1

```
PERS tooldata gripper := [ TRUE, [[97.4, 0, 223.1], [0.924, 0,
     0.383 ,0]],  [5, [23, 0, 75], [1, 0, 0, 0], 0, 0, 0]];
```

The tool is described using the following values:

- The robot is holding the tool.
- The TCP is located at a point `223.1` mm straight out from axis 6 and `97.4` mm along the X-axis of the wrist coordinate system.
- The X and Z directions of the tool are rotated 45° in relation to the wrist coordinate system.
- The tool mass is 5 kg.
- The center of gravity is located at a point `75` mm straight out from axis 6 and `23` mm along the X-axis of the wrist coordinate system.
- The load can be considered a point mass, i.e. without any moment of inertia.

```
gripper.tframe.trans.z := 225.2;
```

The TCP of the tool, `gripper`, is adjusted to `225.2` in the z-direction.

Limitations

The tool data should be defined as a persistent variable (`PERS`) and should not be defined within a routine. The current values are then saved when the program is saved and are retrieved on loading.

Arguments of the type tool data in any motion instruction should only be an entire persistent (not array element or record component).

Continues on next page

Predefined data

The tool `tool0` defines the wrist coordinate system, with the origin being the center of the mounting flange. `Tool0` can always be accessed from the program, but can never be changed (it is stored in system module BASE).

```
PERS tooldata tool0 := [ TRUE, [ [0, 0, 0], [1, 0, 0 ,0] ],  [0.001,
      [0, 0, 0.001], [1, 0, 0, 0], 0, 0, 0] ];
```

Structure

```
< dataobject of tooldata >
  < robhold of bool >
  < tframe of pose >
     < trans of pos >
        < x of num >
        < y of num >
        < z of num >
     < rot of orient >
        < q1 of num >
        < q2 of num >
        < q3 of num >
        < q4 of num >
< tload of loaddata >
  < mass of num >
  < cog of pos >
     < x of num >
     < y of num >
     < z of num >
  < aom of orient >
     < q1 of num >
     < q2 of num >
     < q3 of num >
     < q4 of num >
  < ix of num >
  < iy of num >
  < iz of num >
```

Related information

For information about	See
Positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - Coordinate systems*
Definition of payload	*GripLoad - Defines the payload for the robot on page 119*
Definition of load	*loaddata - Load data on page 1132*

3.67. tpnum - FlexPendant window number

Usage

`tpnum` is used to represent the FlexPendant window number with a symbolic constant.

Description

A `tpnum` constant is intended to be used in instruction `TPShow`. See example below.

Basic examples

Basic examples of the datatype `tpnum` are illustrated below.

Example 1

```
TPShow TP_LATEST;
```

The last used FlexPendant Window before the current FlexPendant window will be active after execution of this instruction.

Predefined data

The following symbolic constant of the data type `tpnum` is predefined and can be used in instruction `TPShow`:

Value	Symbolic constant	Comment
2	`TP_LATEST`	Latest used FlexPendant window

Characteristics

`tpnum` is an alias data type for `num` and consequently inherits its characteristics.

Related information

Information about	See
Data types in general, alias data types	*Technical reference manual - RAPID overview*, section *Basic Characteristics - Data Types*
Communicating using the FlexPendant	*Technical reference manual - RAPID overview*, section *RAPID Summary - Communication*
Switch window on the FlexPendant	*TPShow - Switch window on the FlexPendant on page 567*

3.68. trapdata - Interrupt data for current TRAP

Usage

`trapdata` (*trap data*) is used to contain the interrupt data that caused the current `TRAP` routine to be executed.

To be used in `TRAP` routines generated by instruction `IError`, before use of the instruction `ReadErrData`.

Description

Data of the type `trapdata` represents internal information related to the interrupt that caused the current trap routine to be executed. Its content depends on the type of interrupt.

Basic examples

Basic examples of the data type `trapdata` are illustrated below.

Example 1

```
VAR errdomain err_domain;
VAR num err_number;
VAR errtype err_type;
VAR trapdata err_data;
...
TRAP trap_err
  GetTrapData err_data;
  ReadErrData err_data, err_domain, err_number, err_type;
ENDTRAP
```

When an error is trapped to the trap routine `trap_err`, the error domain, the error number, and the error type are saved into appropriate non-value variables of type `trapdata`.

Characteristics

`trapdata` is a non-value data type.

Related information

For information about	See
Summary of interrupts	*Technical reference manual - RAPID overview*, section *RAPID summary - Interrupts*
More information on interrupt management	*Technical reference manual - RAPID overview*, section *Basic characteristics - Interrupts*
Non value data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*
Orders an interrupt on errors	*IError - Orders an interrupt on errors on page 126*
Get interrupt data for current TRAP	*GetTrapData - Get interrupt data for current TRAP on page 115*
Gets information about an error	*ReadErrData - Gets information about an error on page 349*

3.69. triggdata - Positioning events, trigg

Usage

`triggdata` is used to store data about a positioning event during a robot movement.

A positioning event can take the form of setting an output signal or running an interrupt routine at a specific position along the movement path of the robot.

Description

To define the conditions for the respective measures at a positioning event, variables of the type `triggdata` are used. The data contents of the variable are formed in the program using one of the instructions `TriggIO`, `TriggEquip`, `TriggCheckIO` or `TriggInt`, and are used by one of the instructions `TriggL`, `TriggC` or `TriggJ`.

Basic examples

Basic examples of the data type `triggdata` are illustrated below.

Example 1

```
VAR triggdata gunoff;
TriggIO gunoff, 0,5 \DOp:=gun, 0;
TriggL p1, v500, gunoff, fine, gun1;
```

The digital output signal `gun` is set to the value `0` when the TCP is at a position `0,5` mm before the point `p1`.

Characteristics

`triggdata` is a non-value data type.

Related information

For information about	See
Definition of triggs	*TriggIO - Define a fixed position or time I/O event near a stop point on page 592* *TriggEquip - Define a fixed position and time I/O event on the path on page 582* *TriggCheckIO - Defines IO check at a fixed position on page 577* *TriggInt - Defines a position related interrupt on page 588*
Use of triggs	*TriggL - Linear robot movements with events on page 603* *TriggC - Circular robot movement with events on page 570* *TriggJ - Axis-wise robot movements with events on page 597*
Characteristics of non-value data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*

3.70. triggios - Positioning events, trigg

Usage

`triggios`is used to store data about a positioning event during a robot movement. When the positioning event is distributed at a specific position on the path, an output signal is set to a specified value.

Description

`triggios` is used to define conditions and actions for setting a digital output signal, a group of digital output signals or an analog output signal at a fixed position along the robot's movement path.

Components

`used`

Data type: `bool`

Defines whether or not the array element should be used or not.

`distance`

Data type: `num`

Defines the position on the path where the I/O event shall occur. Specified as the distance in mm (positive value) from the end point of the movement path if component `start` is set to FALSE.

`start`

Data type: `bool`

Set to TRUE when the distance starts at the movement start point instead of the end point.

`equiplag`

Equipment Lag

Data type: `num`

Specify the lag for the external equipment in s.

For compensation of external equipment lag, use a positive argument value. Positive value means that the I/O signal is set by the robot system at a specified time before the TCP physically reaches the specified distance in relation to the movement start or end point.

Negative value means that the I/O signal is set by the robot system at a specified time after that the TCP has physically passed the specified distance in relation to the movement start or end point.

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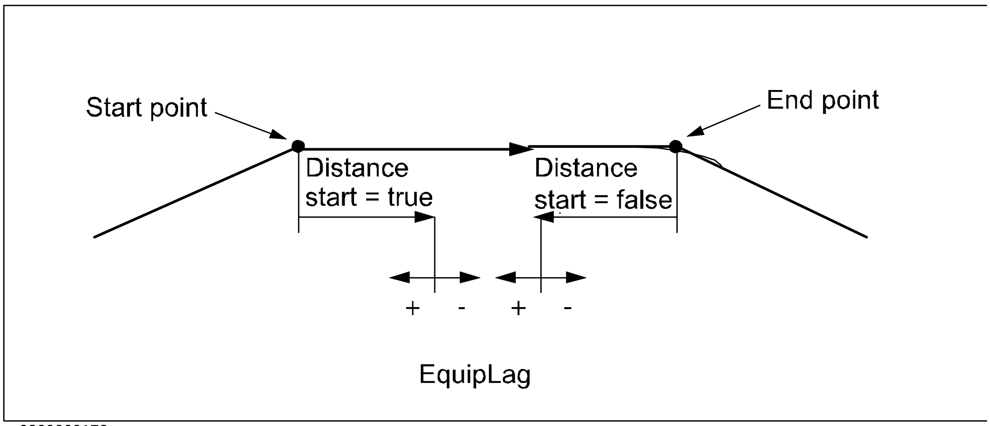
The figure shows use of component `equiplag`.



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`signalname`

Data type: `string`

The name of the signal that shall be changed. It have to be a digital output signal, group of digital output signals or an analog output signal.

`setvalue`

Data type: `num`

Desired value of output signal (within the allowed range for the current signal).

`xxx`

Data type: `num`

Component is not used right now. Added to be able to add functionality in future releases, and still be able to be compatible.

Examples

Example of the data type `triggios` is illustrated below.

Example 1

```
VAR triggios gunon{1};

gunon{1}.used:=TRUE;
gunon{1}.distance:=3;
gunon{1}.start:=TRUE;
gunon{1}.signalname:="gun";
gunon{1}.equiplag:=0;
gunon{1}.setvalue:=1;

MoveJ p1, v500, z50, gun1;
TriggLIOs p2, v500, \TriggData1:=gunon, z50, gun1;
MoveL p3, v500, z50, gun1;
```

The signal `gun` is set when the TCP is 3 mm after point `p1`.

Continues on next page

3.70. triggios - Positioning events, trigg
RobotWare - OS
Continued

Structure

```
<dataobject of triggios>
  <used of bool>
  <distance of num>
  <start of bool>
  <equiplag of num>
  <signalname of string>
  <setvalue of num>
  <xxx of num>
```

Related information

For information about	See
Positioning events, trigg	*triggiosdnum - Positioning events, trigg on page 1217*
Linear robot movements with I/O events	*TriggLIOs - Linear robot movements with I/O events on page 610*

3.71. triggiosdnum - Positioning events, trigg

Usage

`triggiosdnum` is used to store data about a positioning event during a robot movement. When the positioning event is distributed at a specific position on the path, an output signal is set to a specified value.

Description

`triggiosdnum` is used to define conditions and actions for setting a digital output signal, a group of digital output signals or an analog output signal at a fixed position along the robot's movement path.

Components

`used`

Data type: `bool`

Defines whether or not the array element should be used or not.

`distance`

Data type: `num`

Defines the position on the path where the I/O event shall occur. Specified as the distance in mm (positive value) from the end point of the movement path if component `start` is set to FALSE.

`start`

Data type: `bool`

Set to TRUE when the distance starts at the movement start point instead of the end point.

`equiplag`

Equipment Lag

Data type: `num`

Specifies the lag for the external equipment in s.

For compensation of external equipment lag, use a positive argument value. Positive value means that the I/O signal is set by the robot system at a specified time before the TCP physically reaches the specified distance in relation to the movement start or end point.

Negative value means that the I/O signal is set by the robot system at a specified time after the TCP has physically passed the specified distance in relation to the movement start or end point.

`signalname`

Data type: `string`

The name of the signal that shall be changed. It has to be a digital output signal, group of digital output signals or an analog output signal.

`setvalue`

Data type: `dnum`

Desired value of output signal (within the allowed range for the current signal).

Continues on next page

xxx

Data type: `num`

Component is not used right now. Added to be able to add functionality in future releases, and still be able to be compatible.

Examples

Example of the data type `triggiosdnum` is illustrated below.

Example 1

```
VAR triggiosdnum gunon{1};

gunon{1}.used:=TRUE;
gunon{1}.distance:=3;
gunon{1}.start:=TRUE;
gunon{1}.signalname:="go_gun";
gunon{1}.equiplag:=0;
gunon{1}.setvalue:=123456789;

MoveJ p1, v500, z50, gun1;
TriggLIOs p2, v500, \TriggData3:=gunon, z50, gun1;
MoveL p3, v500, z50, gun1;
```

The signal `go_gun` is set when the TCP is 3 mm after point `p1`.

Structure

```
<dataobject of triggiosdnum>
  <used of bool>
  <distance of num>
  <start of bool>
  <equiplag of num>
  <signalname of string>
  <setvalue of dnum>
  <xxx of num>
```

Related information

For information about	See
Positioning events, trigg	*triggios - Positioning events, trigg on page 1214*
Linear robot movements with I/O events	*TriggLIOs - Linear robot movements with I/O events on page 610*

3.72. triggstrgo - Positioning events, trigg

Usage

`triggstrgo` *(trigg stringdig group output)* is used to store data about a positioning event during a robot movement. When the positioning event is distributed at a specific position on the path, a group of digital output signals is set to a specified value.

Description

`triggstrgo` is used to define conditions and actions for setting a group of digital output signals at a fixed position along the robot's movement path.

Components

`used`

Data type: `bool`

Defines whether or not the array element should be used or not.

`distance`

Data type: `num`

Defines the position on the path where the I/O event shall occur. Specified as the distance in mm (positive value) from the end point of the movement path if component `start` is set to FALSE.

`start`

Data type: `bool`

Set to TRUE when the distance starts at the movement start point instead of the end point.

`equiplag`

Equipment Lag

Data type: `num`

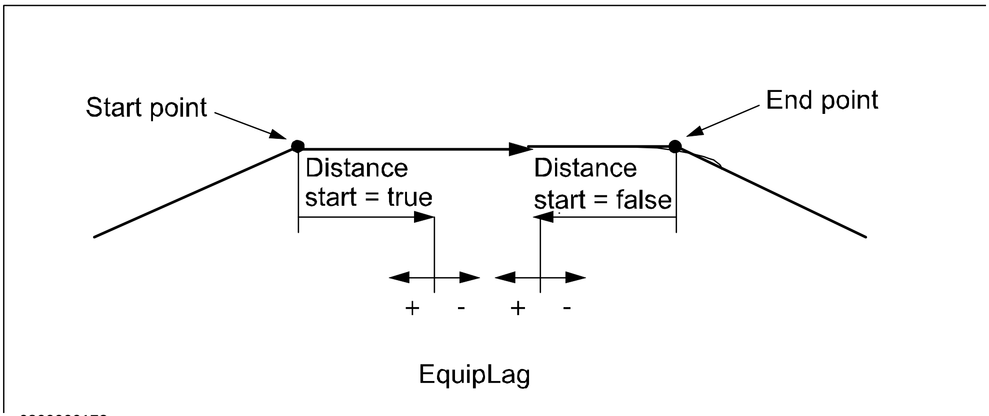
Specify the lag for the external equipment in s.

For compensation of external equipment lag, use a positive argument value. Positive value means that the I/O signal is set by the robot system at a specified time before the TCP physically reaches the specified distance in relation to the movement start or end point.

Negative value means that the I/O signal is set by the robot system at a specified time after that the TCP has physically passed the specified distance in relation to the movement start or end point.

Continues on next page

The figure shows use of component `equiplag`.



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`signalname`

Data type: `string`

The name of the signal that shall be changed. It has to be a name of a group output signal.

`setvalue`

Data type: `stringdig`

Desired value of output signal (within the allowed range for the current digital group output signal). Using `stringdig` data type makes it possible to use values up to 4294967295, which is the maximum value a group of digital signals can have (32 signals in a group signal is max for the system).

`xxx`

Data type: `num`

Component is not used right now. Added to be able to add functionality in future releases, and still be able to be compatible.

Examples

Example of the data type `triggstrgo` is illustrated below.

Example 1

```
VAR triggstrgo gunon{1};

gunon{1}.used:=TRUE;
gunon{1}.distance:=3;
gunon{1}.start:=TRUE;
gunon{1}.signalname:="gun";
gunon{1}.equiplag:=0;
gunon{1}.setvalue:="4294967295";

MoveJ p1, v500, z50, gun1;
TriggLIOs p2, v500, \TriggData2:=gunon, z50, gun1;
MoveL p3, v500, z50, gun1;
```

The signal `gun` is set to value 4294967295 when the TCP is 3 mm after point `p1`.

Continues on next page

Structure

```
<dataobject of triggstrgo>
  <used of bool>
  <distance of num>
  <start of bool>
  <equiplag of num>
  <signalname of string>
  <setvalue of stringdig>
  <xxx of num>
```

Related information

For information about	See
Linear robot movements with I/O events	*TriggLIOs - Linear robot movements with I/O events on page 610*
Compare two strings with only digits	*StrDigCmp - Compare two strings with only digits on page 991*
Arithmetic operations on stringdig data types	*StrDigCalc - Arithmetic operations with datatype stringdig on page 988*

3.73. tunetype - Servo tune type

Usage

`tunetype` is used to represent an integer with a symbolic constant for different types of servo tuning.

Description

A tunetype constant is intended to be used as an argument to the instruction `TuneServo`. See example below.

Basic examples

Basic examples of the data type `tunetype` are illustrated below.

Example 1

```
TuneServo MHA160R1, 1, 110 \Type:= TUNE_KP;
```

Predefined data

The following symbolic constants of the data type `tunetype` are predefined and can be used as arguments for the instruction `TuneServo`.

Value	Symbolic constant	Comment
0	`TUNE_DF`	Reduces overshoots
1	`TUNE_KP`	Affects position control gain
2	`TUNE_KV`	Affects speed control gain
3	`TUNE_TI`	Affects speed control integration time
4	`TUNE_FRIC_LEV`	Affects friction compensation level
5	`TUNE_FRIC_RAMP`	Affects friction compensation ramp
6	`TUNE_DG`	Reduces overshoots
7	`TUNE_DH`	Reduces vibrations with heavy loads
8	`TUNE_DI`	Reduces path errors
9	`TUNE_DK`	Only for ABB internal use
10	`TUNE_DL`	Only for ABB internal use

Characteristics

`tunetype` is an alias data type for `num` and consequently inherits its characteristics.

Related information

For information about	See
Data types in general, alias data types	*Technical reference manual - RAPID overview*, section *Basic characteristics - Data types*
Use of data type tunetype	*TuneServo - Tuning servos on page 638*

3.74. uishownum - Instance ID for UIShow

Usage

`uishownum` is the data type used for parameter `InstanceId` in instruction `UIShow`. It is used to identify a view on the FlexPendant.

Description

When a persistent variable of type `uishownum` is used with the instruction `UIShow`, it is given a specific value identifying the view launched on the FlexPendant. This persistent is then used in all dealings with that view, such as launching the view again, modifying the view, etc.

Examples

Basic examples of the data type `uishownum` are illustrated below.

Example 1

```
CONST string Name:="TpsViewMyAppl.gtpu.dll";
CONST string Type:="ABB.Robotics.SDK.Views.TpsViewMyAppl";
CONST string Cmd1:="Init data string passed to the view";
PERS uishownum myinstance:=0;
VAR num mystatus:=0;
...
! Launch one view of the application MyAppl
UIShow Name, Type \InitCmd:=Cmd1 \InstanceID:=myinstance
     \Status:=mystatus;
```

The code above will launch one view of the application `MyAppl` with init command `Cmd1`. The token used to identify the view is saved in the parameter `myinstance`.

Characteristics

`uishownum` is an alias data type for `num` and thus inherits its properties.

Related information

For information about	See
UIShow	*UIShow - User Interface show on page 651*

3.75. wobjdata - Work object data

Usage

`wobjdata` is used to describe the work object that the robot welds, processes, moves within, etc.

Description

If work objects are defined in a positioning instruction, the position will be based on the coordinates of the work object. The advantages of this are as follows:

- If position data is entered manually, such as in off-line programming, the values can often be taken from a drawing.
- Programs can be reused quickly following changes in the robot installation. If, for example, the fixture is moved, only the user coordinate system has to be redefined.
- Variations in how the work object is attached can be compensated for. For this, however, some sort of sensor will be required to position the work object.

If a stationary tool or coordinated external axes are used, the work object must be defined, since the path and velocity would then be related to the work object instead of the TCP.

Work object data can also be used for jogging:

- The robot can be jogged in the directions of the work object.
- The current position displayed is based on the coordinate system of the work object.

Components

`robhold`

robot hold

Data type: `bool`

Defines whether or not the robot in the actual program task is holding the work object:

- `TRUE:` The robot is holding the work object, i.e. using a stationary tool.
- `FALSE:` The robot is not holding the work object, i.e. the robot is holding the tool.

`ufprog`

user frame programmed

Data type: `bool`

Defines whether or not a fixed user coordinate system is used:

- `TRUE:` Fixed user coordinate system.
- `FALSE:` Movable user coordinate system, i.e. coordinated external axes are used. Also to be used in a MultiMove system in semicoordinated or synchronized coordinated mode.

Continues on next page

`ufmec`

user frame mechanical unit

Data type: `string`

The mechanical unit with which the robot movements are coordinated. Only specified in the case of movable user coordinate systems (`ufprog` is `FALSE`).

Specify the mechanical unit name defined in system parameters, e.g. `orbit_a`.

`uframe`

user frame

Data type: `pose`

The user coordinate system, i.e. the position of the current work surface or fixture (see figure below):

- The position of the origin of the coordinate system (x, y and z) in mm.
- The rotation of the coordinate system, expressed as a quaternion (q1, q2, q3, q4).

If the robot is holding the tool, the user coordinate system is defined in the world coordinate system (in the wrist coordinate system if a stationary tool is used).

For movable user frame (`ufprog` is `FALSE`), the user frame is continuously defined by the system.

`oframe`

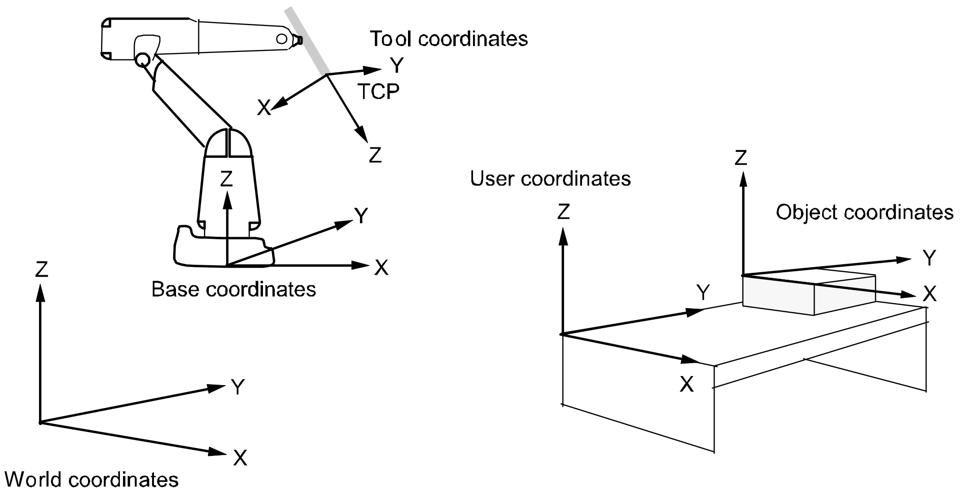
object frame

Data type: `pose`

The object coordinate system, i.e. the position of the current work object (see figure below):

- The position of the origin of the coordinate system (x, y and z) in mm.
- The rotation of the coordinate system, expressed as a quaternion (q1, q2, q3, q4).

The object coordinate system is defined in the user coordinate system.



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Basic examples

Basic examples of the data type `wobjdata` are illustrated below.

Example 1

```
PERS wobjdata wobj2 :=[ FALSE, TRUE, "", [ [300, 600, 200], [1, 0,
     0 ,0] ], [ [0, 200, 30], [1, 0, 0 ,0] ] ];
```

The work object in the figure above is described using the following values:

- The robot is not holding the work object.
- The fixed user coordinate system is used.
- The user coordinate system is not rotated and the coordinates of its origin are x= `300`, y = `600` and z = `200` mm in the world coordinate system.
- The object coordinate system is not rotated and the coordinates of its origin are x= `0`, y= `200` and z= `30` mm in the user coordinate system.

```
wobj2.oframe.trans.z := 38.3;
```

- The position of the work object `wobj2` is adjusted to `38.3` mm in the z-direction.

Limitations

The work object data should be defined as a persistent variable (`PERS`) and should not be defined within a routine. The current values are then saved when the program is saved and are retrieved on loading.

Arguments of the type work object data in any motion instruction should only be an entire persistent (not array element or record component).

Predefined data

The work object data `wobj0` is defined in such a way that the object coordinate system coincides with the world coordinate system. The robot does not hold the work object.

`Wobj0` can always be accessed from the program, but can never be changed (it is stored in system module BASE).

```
PERS wobjdata wobj0 := [ FALSE, TRUE, "", [ [0, 0, 0], [1, 0, 0
     ,0] ],  [ [0, 0, 0], [1, 0, 0 ,0] ] ];
```

Structure

```
< dataobject of wobjdata >
  < robhold of bool >
  < ufprog of bool >
  < ufmec of string >
  < uframe of pose >
     < trans of pos >
        < x of num >
        < y of num >
        < z of num >
     < rot of orient >
        < q1 of num >
        < q2 of num >
        < q3 of num >
        < q4 of num >
```

Continues on next page

```
< oframe of pose >
   < trans of pos >
      < x of num >
      < y of num >
      < z of num >
   < rot of orient >
      < q1 of num >
      < q2 of num >
      < q3 of num >
      < q4 of num >
```

Related information

For information about	See
Positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Coordinate systems	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - Coordinate systems*
Coordinated external axes	*Technical reference manual - RAPID overview*, section *Motion and I/O Principles - Coordinate systems*
Calibration of coordinated axes	*Application manual - Additional axes and stand alone controller* *Application manual - MultiMove*

3.76. wzstationary - Stationary world zone data

Usage

`wzstationary` (*world zone stationary*) is used to identify a stationary world zone and can only be used in an event routine connected to the event POWER ON.

A world zone is supervised during robot movements both during program execution and jogging. If the robot's TCP reaches the world zone or if the robot/external axes reaches the world zone in joints, the movement is stopped or a digital output signal is set or reset.

Description

A `wzstationary` world zone is defined and activated by a `WZLimSup` or a `WZDOSet` instruction.

`WZLimSup` or `WZDOSet` gives the variable or the persistent of data type `wzstationary` a numeric value. The value identifies the world zone.

A stationary world zone is **always active** in motor on state and is only erased by a warm start (switch power off then on). It is not possible to deactivate, activate or erase a stationary world zone via RAPID instructions.

Stationary world zones should be active from power on and should be defined in a POWER ON event routine or a semistatic task

Basic examples

Basic examples of the data type `wzstationary` are illustrated below.

Example 1

```
VAR wzstationary conveyor;
...
PROC ...
  VAR shapedata volume;
  ...
  WZBoxDef \Inside, volume, p_corner1, p_corner2;
  WZLimSup \Stat, conveyor, volume;
ENDPROC
```

A `conveyor` is defined as a straight box (the volume below the belt). If the robot reaches this volume, the movement is stopped.

Limitations

A `wzstationary` data can be defined as a variable (**VAR**) or as a persistent (**PERS**). It can be global in task or local within module, but not local within a routine.

Arguments of the type `wzstationary` should only be entire data (not array element or record component).

An init value for data of the type `wzstationary` is not used by the control system. When there is a need to use a persistent variable in a multi-tasking system, set the init value to 0 in both tasks, e.g. `PERS wzstationary share_workarea := [0];`

More examples

For a complete example see instruction `WZLimSup`.

Continues on next page

Characteristics

`wzstationary` is an alias data type of `wztemporary` and inherits its characteristics.

Related information

For information about	See
World Zones	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - World zones*
World zone shape	*shapedata - World zone shape data on page 1179*
Temporary world zone	*wztemporary - Temporary world zone data on page 1230*
Activate world zone limit supervision	*WZLimSup - Activate world zone limit supervision on page 753*
Activate world zone digital output set	*WZDOSet - Activate world zone to set digital output on page 738*

3.77. wztemporary - Temporary world zone data

Usage

`wztemporary` (*world zone temporary*) is used to identify a temporary world zone and can be used anywhere in the RAPID program for any motion task.

A world zone is supervised during robot movements both during program execution and jogging. If the robot's TCP reaches the world zone or if the robot/external axes reaches the world zone in joints, the movement is stopped or a digital output signal is set or reset.

Description

A `wztemporary` world zone is defined and activated by a `WZLimSup` or a `WZDOSet` instruction.

`WZLimSup` or `WZDOSet` gives the variable or the persistent of data type `wztemporary` a numeric value. The value identifies the world zone.

Once defined and activated, a temporary world zone can be deactivated by `WZDisable`, activated again by `WZEnable`, and erased by `WZFree`.

All temporary world zones in the motion task are automatically erased and all data objects of type `wztemporary` in the motion task are set to 0:

- when a new program is loaded in the motion task
- when starting program execution from the beginning in the motion task

Basic examples

Basic examples of the data type `wztemporary` are illustrated below.

Example 1

```
VAR wztemporary roll;
...
PROC
  VAR shapedata volume;
  CONST pos t_center := [1000, 1000, 1000];
  ...
  WZCylDef \Inside, volume, t_center, 400, 1000;
  WZLimSup \Temp, roll, volume;
ENDPROC
```

A `wztemporary` variable, `roll`, is defined as a cylinder. If the robot reaches this volume, the movement is stopped.

Continues on next page

Limitations

A `wztemporary` data can be defined as a variable (VAR) or as a persistent (PERS). It can be global in a task or local within a module, but not local within a routine.

Arguments of the type `wztemporary` must only be entire data, not an array element or record component.

A temporary world zone must only be defined (`WZLimSup` or `WZDOSet`) and free (`WZFree`) in the motion task. Definitions of temporary world zones in any background is not allowed because it would affect the program execution in the connected motion task. The instructions `WZDisable` and `WZEnable` can be used in the background task. When there is a need to use a persistent variable in a multi-tasking system, set the init value to 0 in both tasks, e.g. PERS wztemporary share_workarea := [0];

More examples

For a complete example see instruction `WZDOSet`.

Structure

```
< dataobject of wztemporary >
  < wz of num >
```

Related information

For information about	See
World Zones	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - World zones*
World zone shape	*shapedata - World zone shape data on page 1179*
Stationary world zone	*wzstationary - Stationary world zone data on page 1228*
Activate world zone limit supervision	*WZLimSup - Activate world zone limit supervision on page 753*
Activate world zone digital output set	*WZDOSet - Activate world zone to set digital output on page 738*
Deactivate world zone	*WZDisable - Deactivate temporary world zone supervision on page 736*
Activate world zone	*WZEnable - Activate temporary world zone supervision on page 742*
Erase world zone	*WZFree - Erase temporary world zone supervision on page 744*

3.78. zonedata - Zone data

Usage

`zonedata` is used to specify how a position is to be terminated, i.e. how close to the programmed position the axes must be before moving towards the next position.

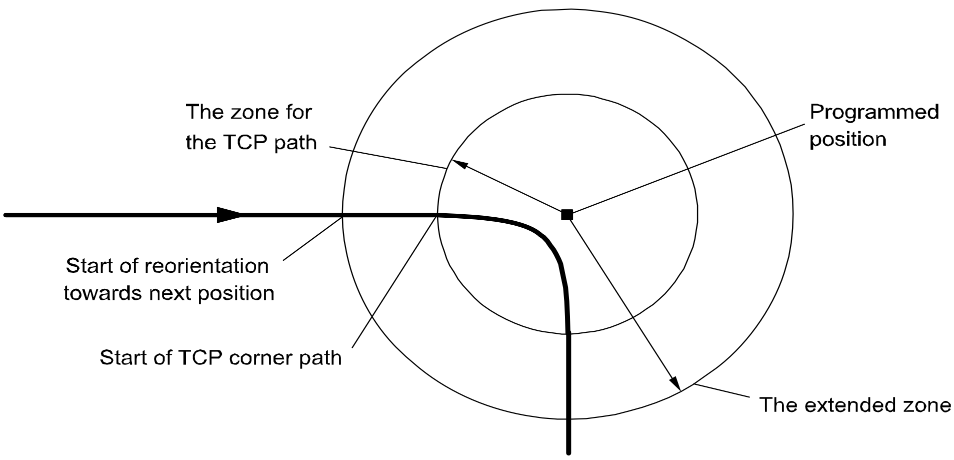
Description

A position can be terminated either in the form of a stop point or a fly-by point.

A stop point means that the robot and external axes must reach the specified position (stand still) before program execution continues with the next instruction. It is also possible to define stop points other than the predefined `fine`. The stop criteria, that tells if the robot is considered to have reached the point, can be manipulated using the `stoppointdata`.

A fly-by point means that the programmed position is never attained. Instead, the direction of motion is changed before the position is reached. Two different zones (ranges) can be defined for each position:

- The zone for the TCP path.
- The extended zone for reorientation of the tool and for external axes.



xx0500002357

Zones function is the same during joint movement, but the zone size may differ somewhat from the one programmed.

The zone size cannot be larger than half the distance to the closest position (forwards or backwards). If a larger zone is specified, the robot automatically reduces it.

The zone for the TCP path

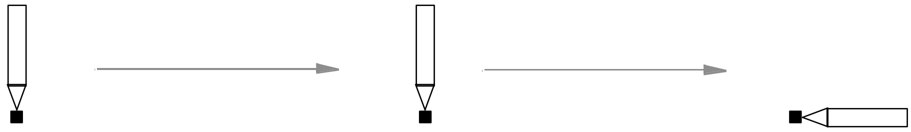
A corner path (parabola) is generated as soon as the edge of the zone is reached (see figure above).

Continues on next page

The zone for reorientation of the tool

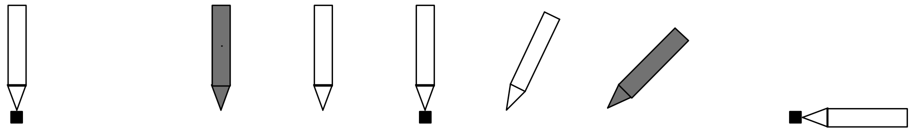
Reorientation starts as soon as the TCP reaches the extended zone. The tool is reoriented in such a way that the orientation is the same leaving the zone as it would have been in the same position if stop points had been programmed. Reorientation will be smoother if the zone size is increased, and there is less of a risk of having to reduce the velocity to carry out the reorientation.

The following figure shows three programmed positions, the last with different tool orientation.



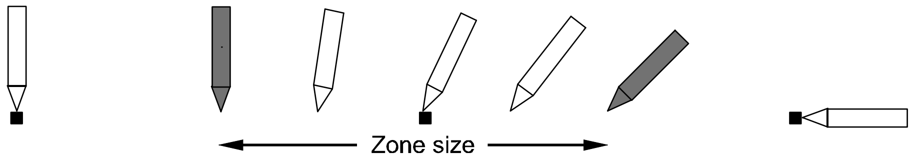
xx0500002358

The following figure shows what program execution would look like if all positions were stop points.



xx0500002359

The following figure shows what program execution would look like if the middle position was a fly-by point.



xx0500002360

The zone for external axes

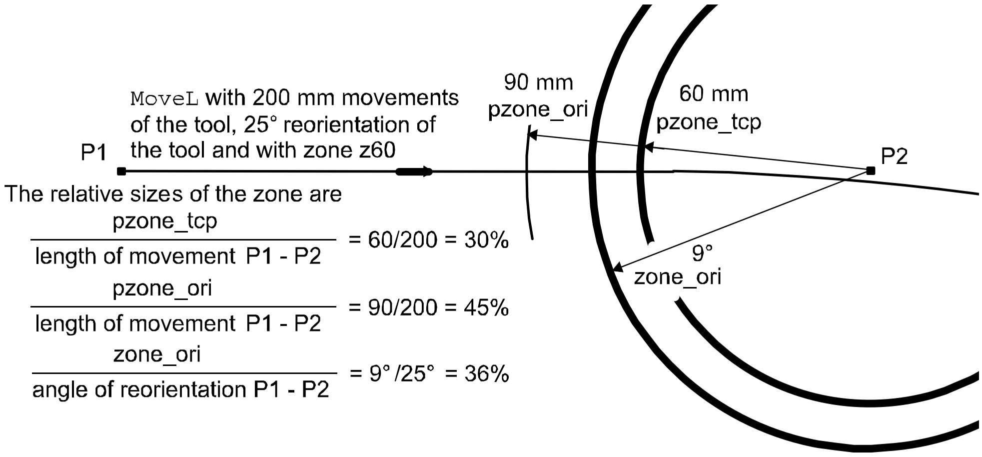
External axes start to move towards the next position as soon as the TCP reaches the extended zone. In this way, a slow axis can start accelerating at an earlier stage and thus execute more smoothly.

Continues on next page

Reduced zone

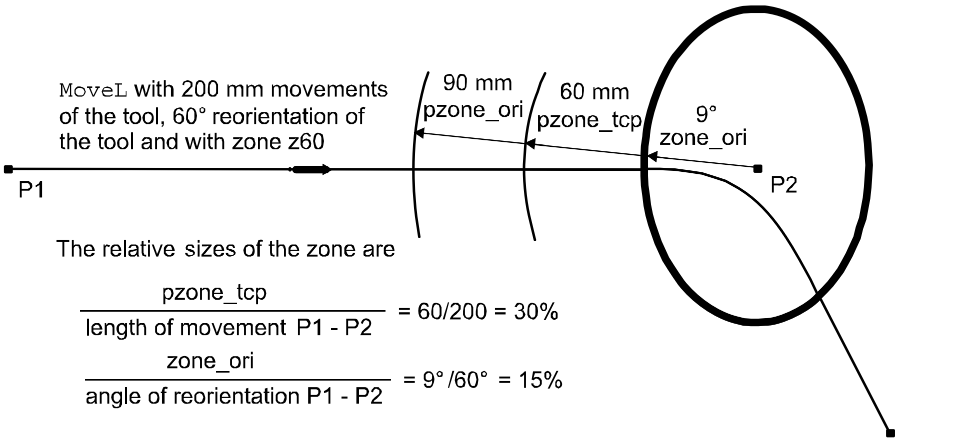
With large reorientations of the tool or with large movements of the external axes, the extended zone and even the TCP zone can be reduced by the robot. The zone will be defined as the smallest relative size of the zone based upon the zone components (see *Components on page 1235*) and the programmed motion.

The following figure shows an example of reduced zone for reorientation of the tool to 36% of the motion due to zone_ori.



xx0500002362

The following figure shows an example of reduced zone for reorientation of the tool and TCP path to 15% of the motion due to zone_ori.



xx0500002363

When external axes are active they affect the relative sizes of the zone according to these formulas:

$$\frac{\text{pzone\_eax}}{\text{length of movement P1 - P2}}$$

$$\frac{\text{zone\_leax}}{\text{length of max linear ext. axis movement P1 - P2}}$$

$$\frac{\text{zone\_reax}}{\text{angle of max reorientation of rotating ext. axis P1 - P2}}$$

xx0500002364

Continues on next page

NOTE!

If the TCP zone is reduced because of `zone_ori`, `zone_leax` or `zone_reax`, the path planner enters a mode that can handle the case of no TCP movement. If there is a TCP movement when in this mode, the speed is not compensated for the curvature of the path in a corner zone. For instance, this will cause a 30% speed reduction in a 90 degree corner. If this is a problem, increase the limiting zone component.

Components

`finep`

fine point

Data type: `bool`

Defines whether the movement is to terminate as a stop point (`fine` point) or as a fly-by point.

- `TRUE:` The movement terminates as a stop point, and the program execution will not continue until robot reach the stop point. The remaining components in the zone data are not used.
- `FALSE:` The movement terminates as a fly-by point, and the program execution continues about 100 ms before the robot reaches the zone.

`pzone_tcp`

path zone TCP

Data type: `num`

The size (the radius) of the TCP zone in mm.

The extended zone will be defined as the smallest relative size of the zone based upon the following components `pzone_ori...zone_reax` and the programmed motion.

`pzone_ori`

path zone orientation

Data type: `num`

The zone size (the radius) for the tool reorientation. The size is defined as the distance of the TCP from the programmed point in mm.

The size must be larger than the corresponding value for `pzone_tcp`. If a lower value is specified, the size is automatically increased to make it the same as `pzone_tcp`.

`pzone_eax`

path zone external axes

Data type: `num`

The zone size (the radius) for external axes. The size is defined as the distance of the TCP from the programmed point in mm.

The size must be larger than the corresponding value for `pzone_tcp`. If a lower value is specified, the size is automatically increased to make it the same as `pzone_tcp`.

Continues on next page

`zone_ori`

zone orientation

Data type: `num`

The zone size for the tool reorientation in degrees. If the robot is holding the work object, this means an angle of rotation for the work object.

`zone_leax`

zone linear external axes

Data type: `num`

The zone size for linear external axes in mm.

`zone_reax`

zone rotational external axes

Data type: `num`

The zone size for rotating external axes in degrees.

Basic examples

Basic examples of the data type `zonedata` are illustrated below.

Example 1

```
VAR zonedata path := [ FALSE, 25, 40, 40, 10, 35, 5 ];
```

The zone data `path` is defined by means of the following characteristics:

- The zone size for the TCP path is `25` mm.
- The zone size for the tool reorientation is `40` mm (TCP movement).
- The zone size for external axes is `40` mm (TCP movement).

If the TCP is standing still, or there is a large reorientation, or there is a large external axis movement with respect to the zone, the following apply instead:

- The zone size for the tool reorientation is `10` degrees.
- The zone size for linear external axes is `35` mm.
- The zone size for rotating external axes is `5` degrees.

```
path.pzone_tcp := 40;
```

The zone size for the TCP path is adjusted to `40` mm.

Predefined data

A number of zone data are already defined in the system module `BASE_SHARED`.

Stop points

Use `zonedata` named `fine`.

Fly-by points

Path zone				Zone		
Name	**TCP path**	**Orientation**	**Ext. axis**	**Orientation**	**Linear axis**	**Rotating axis**
z0	0.3 mm	0.3 mm	0.3 mm	0.03°	0.3 mm	0.03°
z1	1 mm	1 mm	1 mm	0.1°	1 mm	0.1°
z5	5 mm	8 mm	8 mm	0.8°	8 mm	0.8°

Continues on next page

Path zone				Zone		
Name	**TCP path**	**Orientation**	**Ext. axis**	**Orientation**	**Linear axis**	**Rotating axis**
z10	10 mm	15 mm	15 mm	1.5°	15 mm	1.5°
z15	15 mm	23 mm	23 mm	2.3°	23 mm	2.3°
z20	20 mm	30 mm	30 mm	3.0°	30 mm	3.0°
z30	30 mm	45 mm	45 mm	4.5°	45 mm	4.5°
z40	40 mm	60 mm	60 mm	6.0°	60 mm	6.0°
z50	50 mm	75 mm	75 mm	7.5°	75 mm	7.5°
z60	60 mm	90 mm	90 mm	9.0°	90 mm	9.0°
z80	80 mm	120 mm	120 mm	12°	120 mm	12°
z100	100 mm	150 mm	150 mm	15°	150 mm	15°
z150	150 mm	225 mm	225 mm	23°	225 mm	23°
z200	200 mm	300 mm	300 mm	30°	300 mm	30°

Structure

```
< data object of zonedata >
  < finep of bool >
  < pzone_tcp of num >
  < pzone_ori of num >
  < pzone_eax of num >
  < zone_ori of num >
  < zone_leax of num >
  < zone_reax of num >
```

Related information

For information about	See
Positioning instructions	*Technical reference manual - RAPID overview*, section *RAPID summary - Motion*
Movements/Paths in general	*Technical reference manual - RAPID overview*, section *Motion and I/O principles - Positioning during program execution*
Configuration of external axes	*Application manual - Additional axes and stand alone controller*
Other Stop points	*stoppointdata - Stop point data on page 1189*

4 Programming type examples

4.1. ERROR handler with movements

Usage

These type examples describe how to use move instructions in an ERROR handler after an asynchronously raised process or movement error has occurred.

This functionality can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Description

The `ERROR` handler can start a new temporary movement and finally restart the original interrupted and stopped movement. For example, it can be used to go to a service position or to clean the gun after an asynchronously raised process or movement error has occurred.

To reach this functionality, the instructions `StorePath - RestoPath` must be used in the `ERROR` handler. To restart the movement and continue the program execution, several `RAPID` instructions are available.

Type examples

Type examples of the functionality are illustrated below.

Principle

```
...
ERROR
  IF ERRNO = ERR_PATH_STOP THEN
     StorePath;
     ! Move away and back to the interrupted position
     ...
     RestoPath;
     StartMoveRetry;
  ENDIF
ENDPROC
```

At execution of `StartMoveRetry` the robot resumes its movement, any active process is restarted and the program retries its execution. `StartMoveRetry` does the same as `StartMove` plus `RETRY` in one indivisible operation.

Continues on next page

Automatic restart of execution

```
CONST robtarget service_pos := [...];
VAR robtarget stop_pos;
...
ERROR
  IF ERRNO = AW_WELD_ERR THEN
    ! Current movement on motion base path level
    ! is already stopped.
    ! New motion path level for new movements in the ERROR handler
    StorePath;
    ! Store current position from motion base path level
    stop_pos := CRobT(\Tool:=tool1, \WObj:=wobj1);
    ! Do the work to fix the problem
    MoveJ service_pos, v50, fine, tool1, \WObj:=wobj1;
    ...
    ! Move back to the position on the motion base path level
    MoveJ stop_pos, v50, fine, tool1, \WObj:=wobj1;
    ! Go back to motion base path level
    RestoPath;
    ! Restart the stopped movements on motion base path level,
    ! restart the process and retry program execution
    StartMoveRetry;
  ENDIF
ENDPROC
```

This is a type example of how to use automatic asynchronously error recovery after some type of process error during robot movements.

Manual restart of execution

```
...
ERROR
  IF ERRNO = PROC_ERR_XXX THEN
    ! Current movement on motion base path level
    ! is already stopped and in stop move state.
    ! This error must be handle manually.
    ! Reset the stop move state on motion base path level.
    StopMoveReset;
  ENDIF
ENDPROC
```

This is a type example of how to use manual handling of asynchronously error recovery after some type of process error during robot movements.

After the above `ERROR` handler has executed to the end, the program execution stops and the program pointer is at the beginning of the instruction with the process error (also at beginning of any used NOSTEPIN routine). The next program start restarts the program and movement from the position in which the original process error ocurred.

Continues on next page

Program execution

Execution behavior:

- At start execution of the `ERROR` handler, the program leaves its base execution level
- At execution of `StorePath`, the motion system leaves its base execution level
- At execution of `RestoPath`, the motion system returns to its base execution level
- At execution of `StartMoveRetry`, the program returns to its base execution level

Limitations

The following `RAPID` instructions must be used in the `ERROR` handler with move instructions to get it working for automatically error recovery after an asynchronously raised process or path error:

Instruction	Description
`StorePath`	Enter new motion path level
`RestoPath`	Return to motion base path level
`StartMove`Retry	Restart the interrupted movements on the motion base path level. Also restart the process and retry the program execution. Same functionality as `StartMove` + `RETRY`.

The following `RAPID` instruction must be used in the `ERROR` handler to get it working for manually error recovery after an asynchronously raised process or path error:

Instruction	Description
`StopMoveReset`	Enter new motion path level

Related information

For information about	See
To enter a new motion path level	*StorePath - Stores the path when an interrupt occurs on page 521*
To return to motion base path level	*RestoPath - Restores the path after an interrupt on page 362*
To restart the interrupted movement, process and retry program execution.	*StartMoveRetry - Restarts robot movement and execution on page 489*

4.2. Service routines with or without movements

Usage

These type examples describe how to use move instructions in a service routine. Same principle about `StopMove`, `StartMove` and `StopMoveReset` are also valid for service routines without movements (only logical instructions).

Both service routines or other routines (procedures) without parameters can be started manually and perform movements according to these type examples.

This functionality can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks in independent or semi-coordinated mode.

Description

The service routine can start a new temporary movement and, at later program start, restart the original movement. For example, it can be used to go to a service position or manually start cleaning the gun.

To reach this functionality the instructions `StorePath - RestoPath` and `StopMoveReset` must be used in the service routine.

Type examples

Type examples of the functionality are illustrated below.

Principle

```
PROC xxxx()
  StopMove;
  StorePath;
  ! Move away and back to the interrupted position
  ...
  RestoPath;
  StopMoveReset;
ENDPROC
```

`StopMove` is required in order to make sure that the originally stopped movement is not restarted upon a manually "stop program-restart program" sequence during execution of the service routine.

Continues on next page

Stop on path

```
VAR robtarget service_pos := [...];
...
PROC proc_stop_on_path()
  VAR robtarget stop_pos;
  ! Current stopped movements on motion base path level
  ! must not be restarted in the service routine.
  StopMove;
  ! New motion path level for new movements in the service routine.
  StorePath;
  ! Store current position from motion base path level
  stop_pos := CRobT(\Tool:=tool1 \WObj:=wobj1);
  ! Do the work
  MoveJ service_pos, v50, fine, tool1 \WObj:=wobj1;
  ...
  ! Move back to interrupted position on the motion base path level
  MoveJ stop_pos, v50, fine, tool1, \WObj:=wobj1;
  ! Go back to motion base path level
  RestoPath;
  ! Reset the stop move state for the interrupted movement
  ! on motion base path level
  StopMoveReset;
ENDPROC
```

In this type example the movements in the service routine start and end at the position on the path where the program was stopped.

Also note that the tool and work object used are known at the time of programming.

Continues on next page

Stop in next stop point

```
TASK PERS tooldata used_tool := [...];
TASK PERS wobjdata used_wobj := [...];
...
PROC proc_stop_in_stop_point()
  VAR robtarget stop_pos;
  ! Current move instruction on motion base path level continue
  ! to it’s ToPoint and will be finished in a stop point.
  StartMove;
  ! New motion path level for new movements in the service routine
  StorePath;
  ! Get current tool and work object data
  GetSysData used_tool;
  GetSysData used_wobj;
  ! Store current position from motion base path level
  stop_pos := CRobT(\Tool:=used_tool \WObj:=used_wobj);
  ! Do the work
  MoveJ Offs(stop_pos,0,0,20),v50,fine,used_tool\WObj:=used_wobj;
  ...
  ! Move back to interrupted position on the motion base path level
  MoveJ stop_pos, v50, fine, used_tool,\WObj:=used_wobj;
  ! Go back to motion base path level
  RestoPath;
  ! Reset the stop move state for any new movement
  ! on motion base path level
  StopMoveReset;
ENDPROC
```

In this type example the movements in the service routine continue to and end at the `ToPoint` in the interrupted move instructions before the instruction `StorePath` is ready.

Also note that the tool and work object used are unknown at the time of programming.

Program execution

Execution behavior:

- At start execution of the service routine, the program leaves its base execution level
- At execution of `StorePath`, the motion system leaves its base execution level
- At execution of `RestoPath`, the motion system returns to its base execution level
- At execution of `ENDPROC`, the program returns to its base execution level

Continues on next page

Limitations

The following RAPID instructions must be used in the service routine with move instructions to get it working:

Instruction	Description
`StorePath`	Enter new motion path level
`RestoPath`	Return to motion base path level
`StopMoveReset`	Reset the stop move state for the interrupted movement on the motion base path level

Related information

For information about	See
No restart of the already stopped movement on the motion base path level	*StopMove - Stops robot movement on page 515*
Restart of the already stopped movement on the motion base path level	*StopMove - Stops robot movement on page 515*
To enter a new motion path level	*StorePath - Stores the path when an interrupt occurs on page 521*
To return to the motion base path level	*RestoPath - Restores the path after an interrupt on page 362*
Reset the stop move state for the interrupted movement on the motion base path level	*StopMoveReset - Reset the system stop move state on page 519*

4.3. System I/O interrupts with or without movements

Usage

These type examples describe how to use move instructions in a system I/O interrupt routine. Same principle about `StopMove`, `StartMove` and `StopMoveReset` are also valid for system I/O interrupts without movements (only logical instructions).

This functionality can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks in independent or semi-coordinated mode.

Description

The system I/O interrupt routine can start a new temporary movement and, at later program start, restart the original movement. For example, it can be used to go to a service position or to clean the gun when an interrupt occurs.

To reach this functionality the instructions `StorePath - RestoPath` and `StopMoveReset` must be used in the system I/O interrupt routine.

Type examples

Type examples of the functionality are illustrated below.

Principle

```
PROC xxxx()
  StopMove;
  StorePath;
  ! Move away and back to the interrupted position
  ...
  RestoPath;
  StopMoveReset;
ENDPROC
```

`StopMove` is required in order to make sure that the originally stopped movement is not restarted at start of the I/O interrupt routine.

Without `StopMove` or with `StartMove` instead the movement in the I/O interrupt routine will continue at once and end at the `ToPoint` in the interrupted move instruction.

Continues on next page

Stop on path

```
VAR robtarget service_pos := [...];
...
PROC proc_stop_on_path()
  VAR robtarget stop_pos;
  ! Current stopped movements on motion base path level
  ! isn't restarted in the system I/O routine.
  StopMove \Quick;
  ! New motion path level for new movements in the system
  ! I/O routine.
  StorePath;
  ! Store current position from motion base path level
  stop_pos := CRobT(\Tool:=tool1 \WObj:=wobj1);
  ! Do the work
  MoveJ service_pos, v50, fine, tool1 \WObj:=wobj1;
  ...
  ! Move back to interrupted position on the motion base path level
  MoveJ stop_pos, v50, fine, tool1, \WObj:=wobj1;
  ! Go back to motion base path level
  RestoPath;
  ! Reset the stop move state for the interrupted movement
  ! on motion base path level
  StopMoveReset;
ENDPROC
```

In this type example the interrupted movements are stopped at once and are restarted at program start after the system I/O interrupt routine is finished.

Also note that the tool and work object used are known at the time of programming.

Continues on next page

Stop in next stop point

```
TASK PERS tooldata used_tool := [...];
TASK PERS wobjdata used_wobj := [...];
...
PROC proc_stop_in_stop_point()
  VAR robtarget stop_pos;
  ! Current move instruction on motion base path level continue
  ! to it's ToPoint and will be finished in a stop point.
  StartMove;
  ! New motion path level for new movements in the system
  ! I/O routine
  StorePath;
  ! Get current tool and work object data
  GetSysData used_tool;
  GetSysData used_wobj;
  ! Store current position from motion base path level
  stop_pos := CRobT(\Tool:=used_tool \WObj:=used_wobj);
  ! Do the work
  MoveJ Offs(stop_pos,0,0,20),v50,fine,used_tool\WObj:=used_wobj;
  ...
  ! Move back to interrupted position on the motion base path level
  MoveJ stop_pos, v50, fine, used_tool,\WObj:=used_wobj;
  ! Go back to motion base path level
  RestoPath;
  ! Reset the stop move state for new movement
  ! on motion base path level
  StopMoveReset;
ENDPROC
```

In this type example the movements in the system I/O routine continue at once, and end at the `ToPoint` in the interrupted move instructions.

Also note that the tool and work object used are unknown at the time of programming.

Program execution

Execution behavior:

- At start execution of the system I/O routine, the program leaves its base execution level
- At execution of `StorePath`, the motion system leaves its base execution level
- At execution of `RestoPath`, the motion system returns to its base execution level
- At execution of `ENDPROC`, the program returns to its base execution level

Continues on next page

Limitations

The following `RAPID` instructions must be used in the system IO routine with move instructions to get it working:

Instruction	Description
`StorePath`	Enter new motion path level
`RestoPath`	Return to motion base path level
`StopMoveReset`	Reset the stop move state for the interrupted movement on the motion base path level

Related information

For information about	See
No restart of the already stopped movement on the motion base path level	*StopMove - Stops robot movement on page 515*
Restart of the already stopped movement on the motion base path level	*StartMove - Restarts robot movement on page 486*
To enter a new motion path level	*StorePath - Stores the path when an interrupt occurs on page 521*
To return to the motion base path level	*RestoPath - Restores the path after an interrupt on page 362*
Reset the stop move state for the interrupted movement on the motion base path level	*StopMoveReset - Reset the system stop move state on page 519*

4.4. TRAP routines with movements

Usage

These type examples describe how to use move instructions in a `TRAP` routine after an interrupt has occurred.

This functionality can only be used in the main task `T_ROB1` or, if in a MultiMove system, in Motion tasks.

Description

The `TRAP` routine can start a new temporary movement and finally restart the original movement. For example, it can be used to go to a service position or to clean the gun when an interrupt occurs.

To reach this functionality the instructions `StorePath - RestoPath` and `StartMove` must be used in the `TRAP` routine.

Type examples

Type examples of the functionality are illustrated below.

Principle

```
TRAP xxxx
  StopMove;
  StorePath;
  ! Move away and back to the interrupted position
  ...
  RestoPath;
  StartMove;
ENDTRAP
```

If `StopMove` is used, the movement stops at once on the on-going path; otherwise, the movement continues to the `ToPoint` in the actual move instruction.

Continues on next page

Stop in next stop point

```
VAR robtarget service_pos := [...];
...
TRAP trap_in_stop_point
  VAR robtarget stop_pos;
  ! Current move instruction on motion base path level continue
  ! to it's ToPoint and will be finished in a stop point.
  ! New motion path level for new movements in the TRAP
  StorePath;
  ! Store current position from motion base path level
  stop_pos := CRobT(\Tool:=tool1 \WObj:=wobj1);
  ! Do the work
  MoveJ service_pos, v50, fine, tool1 \WObj:=wobj1;
  ...
  ! Move back to interrupted position on the motion base path level
  MoveJ stop_pos, v50, fine, tool1, \WObj:=wobj1;
  ! Go back to motion base path level
  RestoPath;
  ! Restart the interupted movements on motion base path level
  StartMove;
ENDTRAP
```

In this type example the movements in the TRAP routine start and end at the `ToPoint` in the interrupted move instructions. Also note that the tool and work object are known at the time of programming.

Continues on next page

Stop on path at once

```
TASK PERS tooldata used_tool := [...];
TASK PERS wobjdata used_wobj := [...];
...
TRAP trap_stop_at_once
  VAR robtarget stop_pos;
  ! Current move instruction on motion base path level stops
  ! at once
  StopMove;
  ! New motion path level for new movements in the TRAP
  StorePath;
  ! Get current tool and work object data
  GetSysData used_tool;
  GetSysData used_wobj;
  ! Store current position from motion base path level
  stop_pos := CRobT(\Tool:=used_tool \WObj:=used_wobj);
  ! Do the work
  MoveJ Offs(stop_pos,0,0,20),v50,fine,used_tool\WObj:=used_wobj;
  ...
  ! Move back to interrupted position on the motion base path level
  MoveJ stop_pos, v50, fine, used_tool,\WObj:=used_wobj;
  ! Go back to motion base path level
  RestoPath;
  ! Restart the interupted movements on motion base path level
  StartMove;
ENDTRAP
```

In this type example the movements in the TRAP routine start and end at the position on the path where the interrupted move instruction was stopped. Also note that the tool and work object used are unknown at the time of programming.

Program execution

Execution behavior:

- At start execution of the `TRAP` routine, the program leaves its base execution level
- At execution of `StorePath`, the motion system leaves its base execution level
- At execution of `RestoPath`, the motion system returns to its base execution level
- At execution of `ENDTRAP`, the program returns to its base execution level

Limitations

Following `RAPID` instructions must be used in the `TRAP` routine with move instructions to get it working:

Instruction	Description
`StorePath`	Enter new motion path level
`RestoPath`	Return to motion base path level
`StartMove`	Restart the interrupted movements on the motion base path level

Continues on next page

Related information

For information about	See
To stop the current movement at once	*StopMove - Stops robot movement on page 515*
To enter a new motion path level	*StorePath - Stores the path when an interrupt occurs on page 521*
To return to the motion base path level	*RestoPath - Restores the path after an interrupt on page 362*
To restart the interrupted movement	*StartMove - Restarts robot movement on page 486*

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