GE Fanuc Automation

Programmable Control Products

PACSystems™ RX3i

System Manual

GFK-2314C

October 2005

Warnings, Cautions, and Notes as Used in this Publication

Warning

Warning notices are used in this publication to emphasize that hazardous voltages, currents, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use.

In situations where inattention could cause either personal injury or damage to equipment, a Warning notice is used.

Caution

Caution notices are used where equipment might be damaged if care is not taken.

Note

Notes merely call attention to information that is especially significant to understanding and operating the equipment.

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CIMSTAR	Modelmaster	PowerTRAC	VersaPoint
Field Control	Motion Mate	Series 90	VersaPro
GEnet	PACSystems	Series Five	VuMaster
	Proficy	Series One	Workmaster

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Chapter 1 Introduction

This chapter is an overview of PACSystems™ RX3i products and features. The rest of the manual describes PACSystems RX3i products in detail, and explains installation procedures.

Chapter 2, Installation explains how to set up and install RX3i equipment.

Chapter 3, Backplanes describes RX3i Universal and Serial Expansion Backplanes.

Chapter 4, Power Supplies describes RX3i Power Supplies for use in Universal and Serial Expansion Backplanes.

Chapter 5, Serial Bus Transmitter Module and Expansion Cables describes the module and cables used to connect a Universal Backplane with Expansion or Remote Backplanes.

Chapters 6 to 12 provide detailed descriptions, specifications, and wiring diagrams for modules that can be used in RX3i systems:

Chapter 6, Discrete Input Modules
Chapter 7, Discrete Output Modules
Chapter 8, Discrete Mixed Modules
Chapter 9, Analog Input Modules
Chapter 10, Analog Output Modules
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Chapter 12, Analog Mixed Modules
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Chapter 15, High-density Terminal Blocks

Additional information is provided in these appendixes:

Appendix A, Introduction
Appendix B, I/O Cables for 32-Point Modules
Appendix C, Calculating Heat Dissipation
Appendix D, Cable Shield Clamping Assembly

For more information about RX3i products, please refer to the manuals listed below.

GFK-2222B	PACSystems CPU Reference Manual
GFK-2224A	TCP/IP Ethernet Communications for PACSystems
GFK-2225A	PACSystems Station Manager User's Manual

PACSystems RX3i

The PACSystems™ RX3i controller is a member of the PACSystems family of programmable automation controllers (PACs). Like the rest of the PACSystems family, the RX3i features a single control engine and universal programming environment to provide application portability across multiple hardware platforms.

PACSystems RX3i Features

- High-speed processor and patented technology for faster throughput
- A Universal backplane that supports 2 different backplane busses per module slot:
  - High-speed, PCI-based for fast throughput of new advanced I/O
  - Serial backplane for RX3i serial modules and easy migration of Series 90-30 I/O
- Celeron (Pentium® III) 300 MHz CPU for advanced programming and performance with 10 Megabytes of memory
- Memory for ladder logic documentation and machine documentation in the controller to reduce downtime and improve troubleshooting.
- Open communications support
- Variety of discrete, analog, and special-purpose modules.
- Hot insertion in both the PCI Backplane and Serial Backplane for both new and migrated I/O modules
- Isolated 24 VDC terminal for I/O modules and a grounding bar that reduces user wiring

Programming and Configuration

PACSystems equipment is configured and programmed using Machine Edition software, Machine Edition features a common user interface across product families and drag-and-drop editing. Machine Edition also includes a built-in Web server for real-time data delivery during system operation. For more information about programming and configuration, see the *PACSystems CPU Reference Manual*, GFK-2222.

Migration from Series 90-30 to PACSystems RX3i

PACSystems RX3i is designed to facilitate migration of Series 90-30 PLC systems and equipment. System migration is discussed in detail in Appendix C of the *PACSystems CPU Reference Manual* GFK-2222, revision B or later.

Modules for RX3i Systems

The tables in this section list the types of modules that can be included in an RX3i system:

- RX3i Modules (IC695)
- RX3i Modules (IC694)
- Series 90-30 Modules (IC693)

RX3i Modules (IC695)

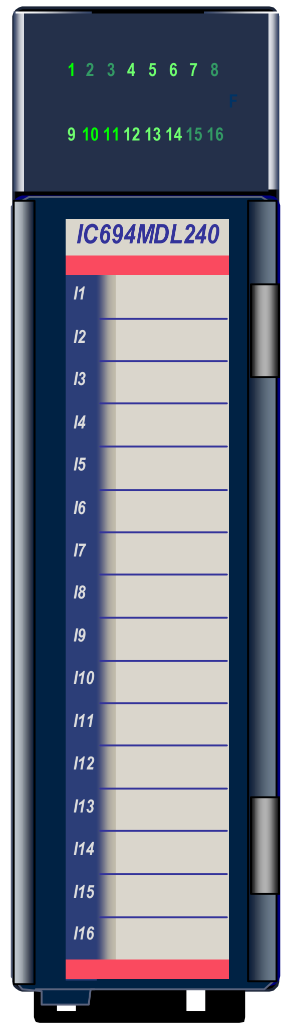
These modules must be installed in a Universal (IC695) Backplane.

Description	***Catalog Number***
CPU, Ethernet, Expansion	
RX3i CPU, 300 MHz, 10 Megabytes of Memory	IC695CPU310
RX3i Power Supply, 120/240 VAC, 125VDC 40 Watts	IC695PSA040
RX3i Power Supply, 24 VDC, 40 Watts	IC695PSD040
RX3i Power Supply, 24 VDC, 40 Watts, Multi-purpose	IC695PSD140
RX3i 120/240 VAC, 125 VDC, 40 Watt, Multi-Purpose Power Supply	IC695PSA140
RX3i Serial Bus Transmitter Module	IC695LRE001
RX3i Ethernet Module	IC695ETM001
RX3i Universal Analog Input Module, 8 Channels	IC695ALG600
RX3i 8-Channel Non-isolated, 4-Channel Differential Analog Input Module	IC695ALG608
RX3i 16-Channel Non-isolated, 8-Channel Differential Analog Input Module	IC695ALG616
RX3i Analog Input Module, 16 Channel Non-Isolated / 8 Channel Differential, HART Communications	IC695ALG626
Analog Input Module, 8 Channel Non-Isolated / 4 Channel Differential, HART Communications	IC695ALG628
RX3i 4-Channel Non-isolated Analog Output Module	IC695ALG704
RX3i 8-Channel Non-isolated Analog Output Module	IC695ALG708
RX3i Output Analog Current/Voltage 8 Channels, HART Communications	IC695ALG728
RX3i Profibus Master Module	IC695PBM300

RX3i Modules (IC694)

IC694 modules are compatible with the RX3i serial bus in Universal Backplanes and RX3i Serial Expansion Backplanes. A wide range of discrete, analog, and special-purpose IC694 modules is available. A typical RX3i I/O module is shown at below.

Most I/O modules feature point LEDs, a removable terminal strip, and a fully-hinged door with an insertable label. The module's wiring diagram is printed on the back of the label. Field wiring can be secured at the bottom of the module using tie-downs.



Some high-density modules have connectors on the front instead of removable terminals.

Descriptions and specifications for the RX3i modules are provided in this manual.

Description	***Catalog Number***
Discrete Input Modules	
RX3i Input Simulator Module	IC694ACC300
RX3i Input 120 VAC 8 Point Isolated	IC694MDL230
RX3i Input 240 VAC 8 Point Isolated	IC694MDL231
RX3i Input 120 VAC16 Point	IC694MDL240
RX3i Input 24 VAC 16 Point	IC694MDL241
RX3i Input 120 VAC 16 Point Isolated	IC694MDL250
RX3i Input 120 VAC 32 Point Grouped	IC694MDL260
RX3i Input 125 VDC 8 Point Pos/Neg Logic	IC694MDL632
RX3i Input 24 VDC 8 Point Pos/Neg Logic	IC694MDL634
RX3i Input 24 VDC16 Point Pos/Neg Logic	IC694MDL645
RX3i Input 24 VDC16 Point Pos/Neg Fast	IC694MDL646
RX3i Input 5/12 VDC (TTL) 32 Point Pos/Neg	IC694MDL654
RX3i Input 24 VDC 32 Point Pos/Neg	IC694MDL655
RX3i Input High-density 24VDC 32 Point	IC694MDL660

continued

RX3i Modules (IC694)

continued

Description	Catalog Number
Discrete Output Modules	
RX3i Output 120 VAC 0.5 A 12 Point	IC694MDL310
RX3i Output 120/240 VAC 2 A 8 Point	IC694MDL330
RX3i Output 120 VAC 0.5 A 16 Point	IC694MDL340
RX3i Output 124/240 VAC Isolated 16 Point	IC694MDL350
RX3i Output 120/240 VAC 2 A 5 Point Isolated	IC694MDL390
RX3i Output 12/24 VDC 0.5 A 8 Point Positive Logic	IC694MDL732
RX3i Output 125 VDC 1 A 6 Point Isolated Pos/Neg	IC694MDL734
RX3i Output 12/24 VDC 0.5 A 16 Point Positive Logic	IC694MDL740
RX3i Output 12/24 VDC 0.5 A 16 Point Negative Logic	IC694MDL741
RX3i Output 12/24 VDC 1 A 16 Point Positive Logic ESCP	IC694MDL742
RX3i Output 5/24 VDC (TTL) 0.5 A 32 Point Negative Logic	IC694MDL752
RX3i Output 12/24 VDC 0.5 A 32 Point Positive Logic	IC694MDL753
RX3i Output High-density 24VDC 32 Point	IC694MDL754
RX3i Output Relay N.O. 4 A 8 Point Isolated	IC694MDL930
RX3i Output Relay N.C. and Form C 3 A 8 Point Isolated	IC694MDL931
RX3i Output Relay N.O. 2 A 16 Point	IC694MDL940
Discrete Mixed Modules	
RX3i High Speed Counter Module GFK-0293	IC694APU300

RX3i Modules (IC694)

continued

Description	Catalog Number
Analog Input Modules	
RX3i Input Analog 4pt Voltage	IC694ALG220
RX3i Input Analog 4pt Current	IC694ALG221
RX3i Input Analog 16sgl/8diff Voltage	IC694ALG222
RX3i Input Analog 16sgl Current	IC694ALG223
Analog Output Modules	
RX3i Output Analog 2pt Voltage	IC694ALG390
RX3i Output Analog 2pt Current	IC694ALG391
RX3i Output Analog Current/Voltage 8pt	IC694ALG392
Analog Mixed I/O Modules	
RX3i Analog Combination Current/Voltage 4in/2out	IC694ALG442
Special Purpose Modules	
RX3i Special I/O Processor	IC694APU305
RX3i I/O Link Interface Module	IC694BEM320
RX3i I/O Link Master Module	IC694BEM321
RX3i FIP Bus Controller 1M	IC694BEM340
RX3i FIP Bus Controller 2.5M	IC694BEM341
RX3i DeviceNet Master Module	IC694DNM200
RX3i DSM314 Motion Controller	IC694DSM314
RX3i DSM324 Motion Controller	IC694DSM324

Series 90-30 (IC693) Modules for RX3i Systems

The following 90-30 modules are compatible with the RX3i serial bus in Universal Backplanes and RX3i Serial Expansion Backplanes and 90-30 Expansion Backplanes.

Description	Catalog Number	Minimum Revision Supported	CE Mark Approved
Discrete Input Modules			
Series 90-30 Input Simulator Module	IC693ACC300	A	D
Series 90-30 Input 120 VAC 8 Point Isolated	IC693MDL230	A	C
Series 90-30 Input 240 VAC 8 Point Isolated	IC693MDL231	A	E
Series 90-30 Input 120 VAC 16 Point	IC693MDL240	A	E
Series 90-30 Input 120 VAC 16 Point Isolated	IC693MDL250	A	
Series 90-30 Input 120 VAC 32 Point Grouped	IC693MDL260	A	
Series 90-30 Input 24 VAC 16 Point	IC693MDL241	A	D
Series 90-30 Input 125 VDC 8 Point Pos/Neg Logic	IC693MDL632	A	D
Series 90-30 Input 24 VDC 8 Point Pos/Neg Logic	IC693MDL634	A	C
Series 90-30 Input 24 VDC 16 Point Pos/Neg Logic	IC693MDL645	A	D
Series 90-30 Input 24 VDC 16 Point Pos/Neg Fast	IC693MDL646	A	C
Series 90-30 Input 48 VDC 16 Point Pos/Neg Fast	IC693MDL648	A	B
Series 90-30 Input 5/12 VDC (TTL) 32 Point Pos/Neg	IC693MDL654	A	E
Series 90-30 Input 24 VDC 32 Point Pos/Neg	IC693MDL655	A	E
Series 90-30 Input High-density 24VDC 32 Point	IC693MDL660		
Series 90-30 Output 120 VAC 0.5 A 12 Point	IC693MDL310	A	D
Series 90-30 Output 120/240 VAC 2 A 8 Point	IC693MDL330	A	F
Series 90-30 Output 120 VAC 0.5 A 16 Point	IC693MDL340	A	D
Series 90-30 Output 124/240 VAC Isolated 16 Point	IC693MDL350	A	
Series 90-30 Output 120/240 VAC 2 A 5 Point Isolated	IC693MDL390	A	E
Series 90-30 Output 12/24 VDC 2 A 8 Point Positive Logic	IC693MDL730	A	E
Series 90-30 Output 12/24 VDC 2 A 8 Point Negative Logic	IC693MDL731	A	E
Series 90-30 Output 12/24 VDC 0.5 A 8 Point Positive Logic	IC693MDL732	A	C
Series 90-30 Output 12/24 VDC 0.5 A 8 Point Negative Logic	IC693MDL733	A	C

continued

Series 90-30 (IC693) Modules for RX3i PACSystems

The following Series 90-30 modules are compatible with the RX3i serial bus in Universal Backplanes and RX3i Serial Expansion Backplanes and 90-30 Expansion Backplanes.

Description	***Catalog Number***	***Minimum Revision Supported***	***CE Mark Approved***
Discrete Output Modules, continued			
Series 90-30 Output 125 VDC 1A 6 Point Isolated Pos/Neg	IC693MDL734	A	D
Series 90-30 Output 12/24 VDC 0.5 A 16 Point Positive Logic	IC693MDL740	A	E
Series 90-30 Output 12/24 VDC 0.5 A 16 Point Negative Logic	IC693MDL741	A	E
Series 90-30 Output 12/24 VDC 1 A 16 Point Positive Logic ESCP	IC693MDL742	A	D
Series 90-30 Output 48 VDC 0.5 A 8 Point Positive Logic	IC693MDL748	A	B
Series 90-30 Output 5/24 VDC (TTL) 0.5 A 32 Point Negative Logic	IC693MDL752	A	D
Series 90-30 Output 12/24 VDC 0.5 A 32 Point Positive Logic	IC693MDL753	A	D
Series 90-30 Output High-density 24VDC 32 Point	IC693MDL754		
Series 90-30 Solenoid Out 11 Pt/24 VDC Out 5 Point Positive Logic	IC693MDL760	A	B
Series 90-30 Output Relay N.O. 4 A 8 Point Isolated	IC693MDL930	A	D
Series 90-30 Output Relay N.C. and Form C 3 A 8 Point Isolated	IC693MDL931	A	D
Series 90-30 Output Relay N.O. 2 A 16 Point	IC693MDL940	A	D
Discrete Mixed Modules			
Series 90-30 High Speed Counter Module GFK-0293	IC694APU300	D	H
Series 90-30 Mixed I/O 8 Point120 VAC In / 8 Point Relay Out	IC693MAR590	A	C
Series 90-30 Mixed I/O 8 Point24 VDC In / 8 Point Relay Out	IC693MDR390	A	C
Analog Input Modules			
Series 90-30 Input Analog 4 Point Voltage	IC693ALG220	A	G and H
Series 90-30 Input Analog 4 Point Current	IC693ALG221	A	G and H
Series 90-30 Input Analog 16 sgl/8 diff Voltage	IC693ALG222	A	C and D
Series 90-30 Input Analog 16 sgl/8 diff Current	IC693ALG223	A	C

Continued …

Series 90-30 (IC693) Modules for RX3i PACSystems

Continued…

Description	***Catalog Number***	***Minimum Revision Supported***	***CE Mark Approved***
Analog Output Modules			
Series 90-30 Output Analog 2 Point Voltage	IC693ALG390	A	F
Series 90-30 Output Analog 2 Point Current	IC693ALG391	A	E
Series 90-30 Output Analog Current/Voltage 8 Point	IC693ALG392	A	B
Analog Mixed I/O Modules			
Series 90-30 Analog Combination Current/Voltage 4 in/2 out	IC693ALG442	B	B
Communication Modules			
Series 90-30 Fanuc I/O Link Module (Master)	IC693BEM321	C	F
Series 90-30 Genius Bus Controller	IC693BEM331	K	
Series 90-30 FIP Bus Controller	IC693BEM340		
Special Purpose Modules			
Series 90-30 Special I/O Processor	IC693APU305	C	
Series 90-30 I/O Link Interface Module	IC693BEM320		
Series 90-30 I/O Link Master Module	IC693BEM321		
Series 90-30 DeviceNet Master Module	IC693DNM200	AA	
Series 90-30 DeviceNet Slave Module	IC693DNS301	AA	
Series 90-30 DSM314 Motion Controller	IC693DSM314	AC	AA
Series 90-30 DSM324i Motion Controller	IC603DSM324		
Series 90-30 Temperature Controller Module	IC693TCM302	*	
Series 90-30 Temperature Controller Module Extended Range	IC693TCM303	*	
Series 90-30 Power Transducer Module	IC693PTM100	A	
Series 90-30 Power Transducer Module	IC693PTM101	A	

Series 90-30 Modules that Cannot Be Used in an RX3i System

The Series 90-30 modules listed below cannot presently be included in a Universal Backplane or in any Expansion or Remote Backplane in an RX3i system. Future firmware releases may enable the RX3i to their functions, check with your GE Fanuc representative on the status.

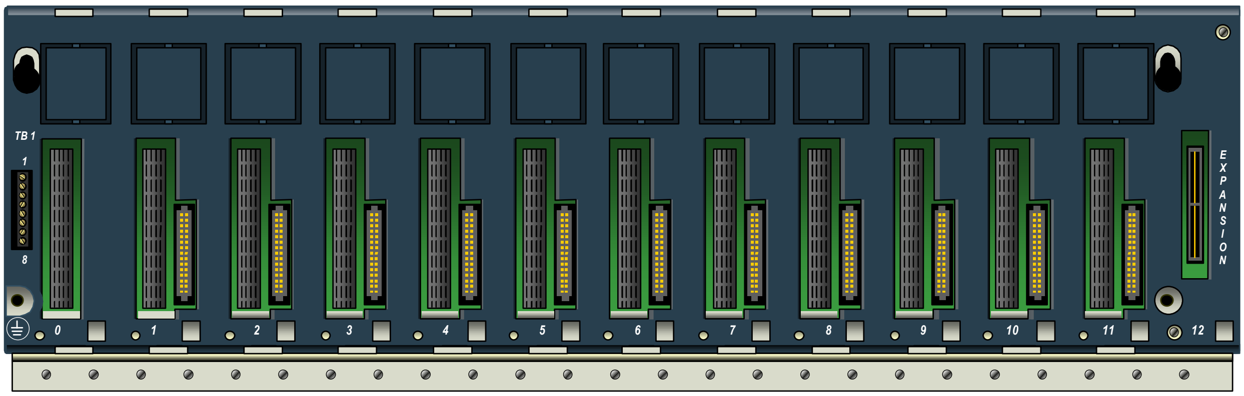
For information about whether another company's Series 90-30-compatible module may be suitable for PACSystems RX3i applications, please contact the manufacturer of the module. That includes Series 90-30 modules that have catalog numbers beginning with HE693.

Description	***Catalog Number***
CIMPLICITY 90-ADS 9030 Module	IC693ADC311
CIMPLICITY 90-ADS 9030 System	IC693ADS301
Axis Position Module (1-Axis)	IC693APU301
Axis Position Module (2-Axis)	IC693APU302
Series 90-30 SDS Bus Interface	IC693BEM310
Remote FIP Interface Module	IC693BEM330
FIP Remote I/O 2.5mhz	IC693BEM332
Remote FIP Interface	IC693BEM333
Genius Bus Controller	IC693BEM334
FIP Remote I/O 2.5mhz	IC693BEM335
Ethernet Network Interface Unit	IC693BEM350
Cscan Interface Module	IC693CDC200
Genius Communications Module	IC693CMM301
Enhanced Genius Communications Module	IC693CMM302
Alspa N80 Communication Module	IC693CMM304
Alspa Enhanced N80 Comm Module	IC693CMM305
Communication Control Module	IC693CMM311
Ethernet Interface Module 3.10	IC693CMM321
Series 90-30 DeviceNet Master	IC693DNM200
Digital Servo Module (2-Axis)	IC693DSM302
Digital Valve Driver Module	IC693DVM300
Power Mate "J "Interface Module	IC693MCM001
Power Mate "J" Interface 2 Axis	IC693MCM002
PM-J 1-Axis International Only	IC693MCS001
PM-J 2-Axis International Only	IC693MCS001

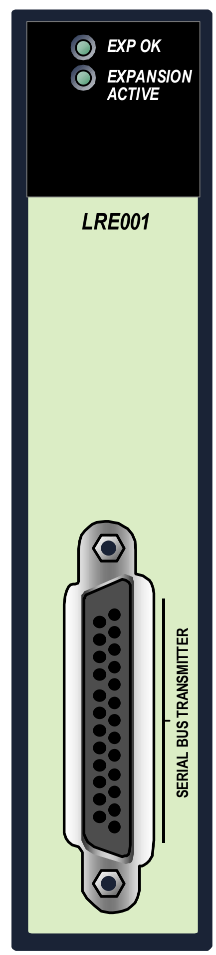
Description	*Catalog Number*
Input 120/240 VAC 8 Point Isolated	IC693MDL232
Input 24 VDC 8 Point Pos Logic	IC693MDL630
Input 24 VDC 8 Point Neg Logic	IC693MDL631
Input 24 VDC 8 Point Neg Logic	IC693MDL633
Input 24 VDC 16 Point Pos Logic	IC693MDL640
Input 24 VDC 16 Point Neg Logic	IC693MDL641
Input 24 VDC 16 Point Pos Logic Fast (1ms)	IC693MDL643
Input 24 VDC 16 Point Neg Logic Fast (1ms)	IC693MDL644
Fanuc Input 24 VDC 32 Point Pos/Neg	IC693MDL652
Fanuc Input 24 VDC 32 Point Pos/Neg Fast	IC693MDL653
Fanuc Output 12/24 VDC 0.3 A 32 Point Neg	IC693MDL750
Fanuc Output 12/24 VDC 0.3 A 32 Point Pos	IC693MDL751
Profibus-DP Master	IC693PBM200
Profibus-DP Slave	IC693PBS201
Programmable Coprocessor W/Epr	IC693PCM30
Programmable Coprocessor Module	IC693PCM300
Programmable Coprocessor Module (64k)	IC693PCM301
Programmable Coprocessor Module (640k)	IC693PCM311
Clamp Pos Module	IC693PMC801
Injection Pos Module	IC693PMI800

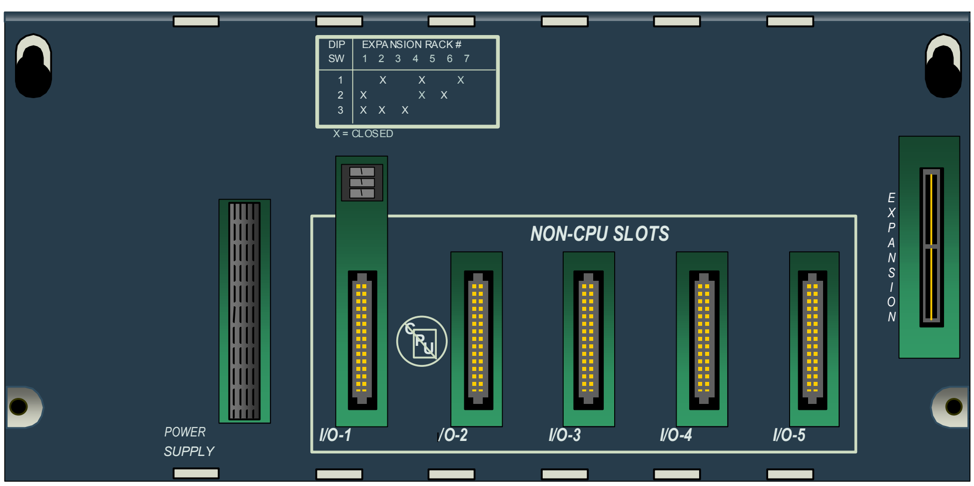
Backplanes and Power Supplies

The RX3i system must include either a 12-slot Universal Backplane IC695CHS012 (shown below) or 16-slot Universal Backplane (IC695CHS016).



If additional modules are required than the Universal Backplane can accommodate, or if some modules must be installed in another location, an RX3i Serial Bus Transmitter Module (IC695LRE001) must be installed in the last slot of the Universal Backplane. A cable from the Bus Transmitter module can link additional Serial Expansion (5-slot version IC694CHS098 shown below) and Remote backplanes to the RX3i system.





Use of Expansion and Remote Backplanes is summarized on the following pages.

For more information about the Serial Bus Transmitter module and cables, refer to chapter 5.

Backplanes for the RX3i System

Universal and Expansion Backplanes that are compatible with RX3i systems are listed below. See chapter 3 of this manual for descriptions and specifications of the RX3i Backplanes. For information about Series 90-30 Expansion Backplanes, refer to the *Series 90-30 I/O Modules Specifications Manual*, GFK-0898.

Backplanes	
RX3i 16-Slot Universal Backplane	IC695CHS016
RX3i 12-Slot Universal Backplane	IC695CHS012
RX3i 10-Slot Serial Expansion Backplane	IC694CHS392
RX3i 5-Slot Serial Expansion Backplane	IC694CHS398
Series 90-30 10-Slot Expansion Backplane	IC693CHS392
Series 90-30 5-Slot Expansion Backplane	IC693CHS398
Series 90-30 10-Slot Remote Expansion Backplane	IC693CHS393
Series 90-30 5-Slot Remote Expansion Backplane	IC693CHS399

Power Supplies for RX3i Systems

Power Supplies for Universal and Serial Expansion Backplanes are listed below. See chapter 4 of this manual for descriptions and specifications of the RX3i Power Supplies. For information about Series 90-30 Power Supplies, refer to the *Series 90-30 I/O Modules Specifications Manual*, GFK-0898.

Description	***Catalog Number***	***Installed in Universal Backplane***	***Installed in Serial Expansion Backplane***
Power Supplies			
RX3i Power Supply, 120/240 VAC, 125VDC, 40 Watts	IC695PSA040	■	
RX3i Power Supplies, 24 VDC, 40 Watts	IC695PSD040, IC695PSD140	■	
RX3i Serial Expansion Power Supply, 120/240 VAC, 125 VDC	IC694PWR321		■
RX3i Serial Expansion Power Supply, 120/240 VAC, 125 VDC, High Capacity	IC694PWR330		■
RX3i Serial Expansion Power Supply, 24 VDC, High Capacity	IC694PWR331		■
Series 90-30 Power Supply for Expansion Backplane, 120/240 VAC, 125 VDC	IC693PWR321		■
Series 90-30 Power Supply for Expansion Backplane, 120/240 VAC, 125 VDC, High Capacity	IC693PWR330		■
Series 90-30 Power Supply for Expansion Backplane, 24 VDC, High Capacity	IC693PWR331		■

Expansion Systems

The PACSystems R3i can include a combination of up to seven Serial Expansion and/or Remote Backplanes. The Expansion Backplanes can be any of the RX3i or Series 90-30 models listed earlier. The Remote Backplanes can be any of the Series 90-30 Remote Backplanes listed in the *Series 90-30 I/O Module Specifications Manual*, GEK-0898.

- If the system includes only Expansion Backplanes, the total distance from the CPU to the last backplane cannot be more than 15 meters (50 feet)
- If the system includes any Remote Backplanes, the total distance from the CPU to the last backplane cannot be more than 213 meters (700 feet).

Remote Backplanes provide the same functionality as Expansion Backplanes over a much greater distance. Remote Backplanes have extra isolation circuitry that lessens the effect of unbalanced ground conditions that can occur when backplanes are located long distances from each other and do not share the same ground system. Communications between the CPU and a Remote Backplane may take slightly longer than communications between the CPU and an Expansion Backplane. This delay is usually small compared to the total CPU scan time.

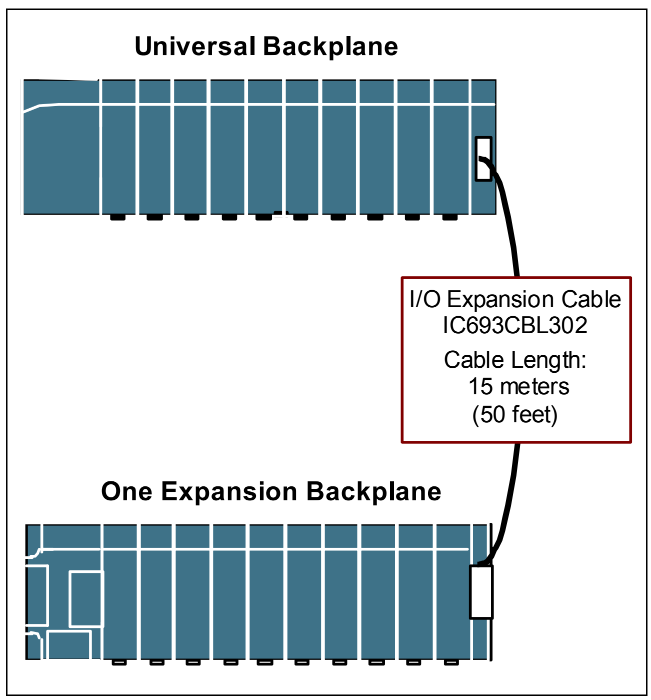
Expansion System with One Expansion or Remote Backplane

An Expansion system can consist of a Universal Backplane with just one Expansion or Remote Backplane

This example includes one Universal Backplane IC695CHS012 and one Expansion Backplane, IC694CHS392. Each Backplane in this example has a DC Power Supply. Together, they accommodate 19 discrete, analog, and special-function modules.

These backplanes are located 15 meters (50 feet) apart. They are connected by Expansion Cable IC693CBL302, which has a built-in terminating resistor.

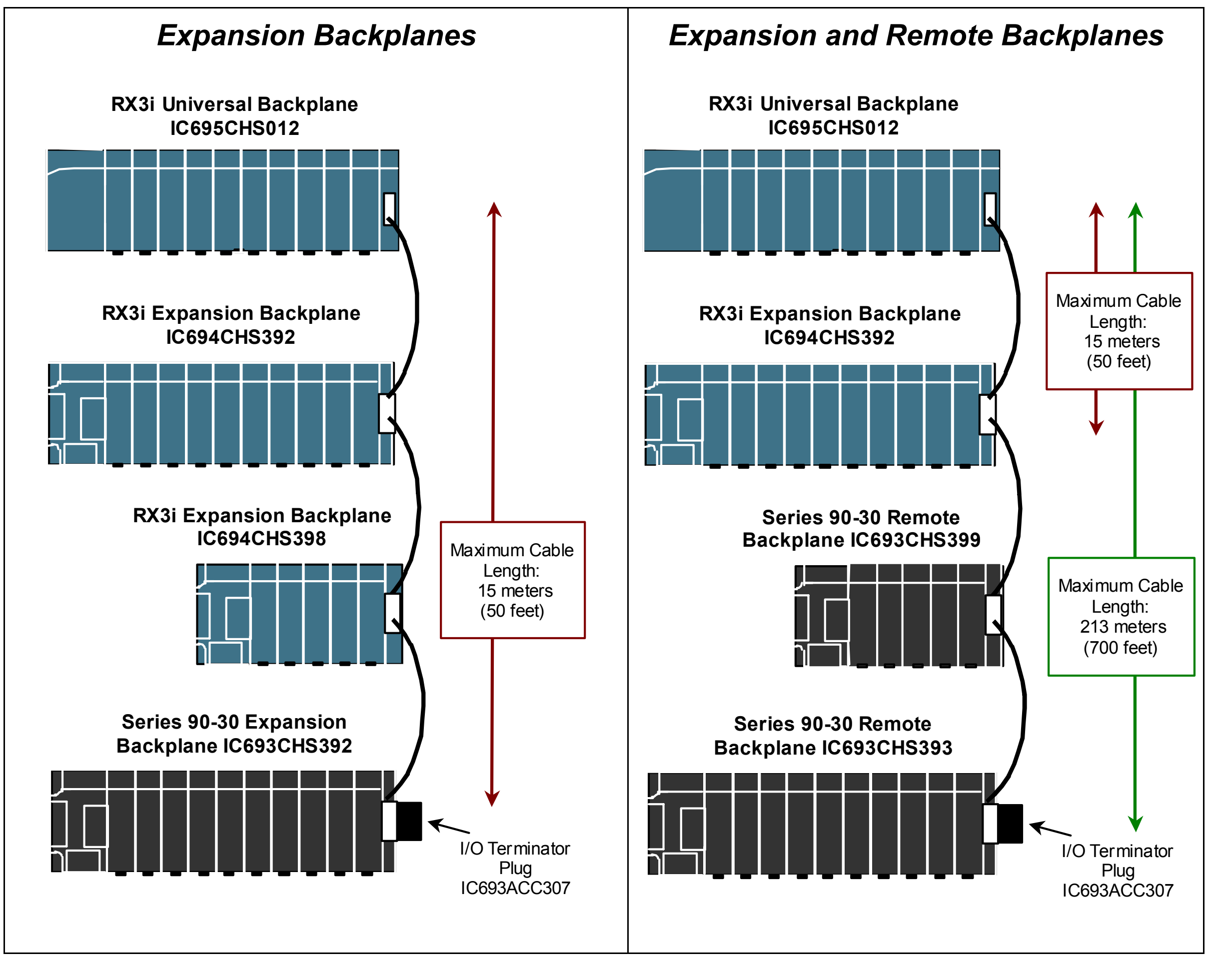
If it were necessary to locate the second backplane more than 15 meters (50 Feet) from the Universal Backplane, a Series 90-30 Remote Backplane could be used with a custom-length cable and external terminating resistor.



Using Multiple Expansion and Remote Backplanes

The next two example systems are similar to each other except for the distance between the backplanes. The example on the left includes two RX3i Expansion Backplanes and a Series 90-30 Expansion Backplane. The Expansion Backplanes can be any combination of RX3i (IC694) and Series 90-30 (IC693) Expansion Backplanes. I/O modules in the system can be any combination of RX3i and Series 90-30 modules.

In the example on the right, two of the backplanes must be installed beyond the 15-meter (50-foot) limit of an Expansion system. Two Series 90-30 Remote Backplanes are used in those locations. All other features of the two example systems are the same, including their I/O modules.



Chapter 2 Installation

This chapter provides general instructions for installing PACSystems RX3i equipment.

- Pre-Installation Check
- System Layout Guidelines
- Enclosures
- System Wiring
- System Grounding
- System Installation

For additional information about system installation, also see:

- Chapter 3, Backplanes, for backplane dimension diagrams
- Chapter 4, Power Supplies, for power supply specifications and wiring diagrams
- Chapters 5 through 14 for module wiring diagrams and specifications
- Chapter 15 for information about 36-pin terminal blocks for some higher-density modules
- Appendix A for general standards information
- Appendix B for information about cables and terminal strips for 32-point modules with front-mounted connectors.
- Appendix C for information about calculating heat dissipation
- Appendix D for information about the Cable Clamping Assembly

Pre-Installation Check

Upon receiving your RX3i equipment, carefully inspect all shipping containers for damage. If any part of the system is damaged, notify the carrier immediately. The damaged shipping container should be saved as evidence for inspection by the carrier.

As the consignee, it is your responsibility to register a claim with the carrier for damage incurred during shipment. However, GE Fanuc will fully cooperate with you, should such action be necessary.

After unpacking the RX3i equipment, **record all serial numbers**. Serial numbers are required if you should need to contact Customer Care during the warranty period. All shipping containers and all packing material should be saved should it be necessary to transport or ship any part of the system.

Verify that all components of the system have been received and that they agree with your order. If the system received does not agree with your order, contact customer service.

If you need technical help, technical support can be reached as listed below:

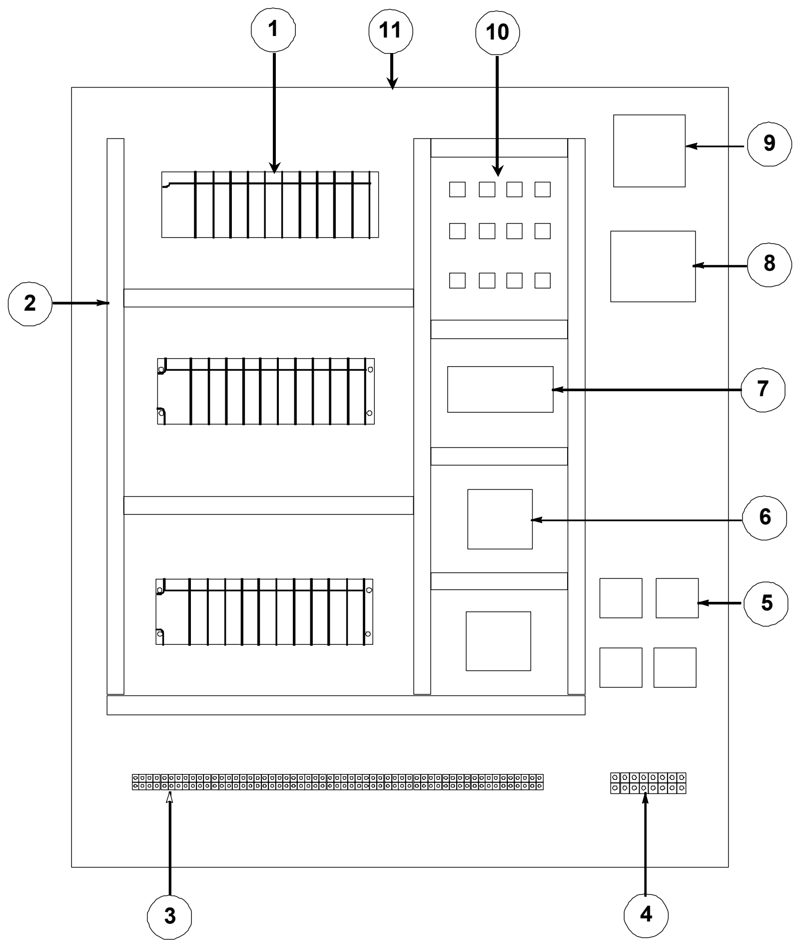
Technical support for control system components described in this manual:

Customer Care Hotline	Toll free: 800-GE FANUC (800-433-2682 International direct dial: 780-420-2197
Internet address	plchotline@cho.ge.com
Fax number	780-420-2197
Web Support	www.gefanuc.com

System Layout Guidelines

A good layout helps minimize the chance of electrical shock to personnel working on the system. It lets maintenance technicians easily access the unit to make measurements, load software, check indicator lights, remove and replace modules, etc. It also makes it easier to trace wiring and locate components while troubleshooting. In addition, proper system layout promotes good heat dissipation and helps eliminate electrical noise from the system. Excess heat and noise are two major causes of electronic component failure.

- Locate RX3i equipment away from other components that generate a lot of heat, such as transformers, power supplies, or power resistors.
- Locate RX3i equipment away from components that generate electrical noise such as relays and contacts.
- Locate RX3i equipment away from high-voltage components and wiring, such as circuit breakers and fusible disconnects, transformers, motor wiring, etc.
- Locate equipment at a convenient level that allows technicians reasonable access for maintaining the system.
- Route sensitive input wires away from electrically-noisy wires such as discrete output and AC wiring. This can be facilitated by grouping I/O modules to keep output modules separated from sensitive Input modules.



6. RX3i
7. Wireway (Wire Duct)
8. Field device connection terminal block
9. Motor connection terminal block
10. Motor starters
11. Circuit board

1. Power supply
2. Control transformer
3. Fusible disconnect or circuit breaker
4. Control relays
5. Protected enclosure

- Allow a 4" clearance space on all four sides of each RX3i backplane for ventilation/cooling.
- Use shielded cable connections with the shield grounded at one end (at source) for all analog modules, including RTD and Thermocouple modules.

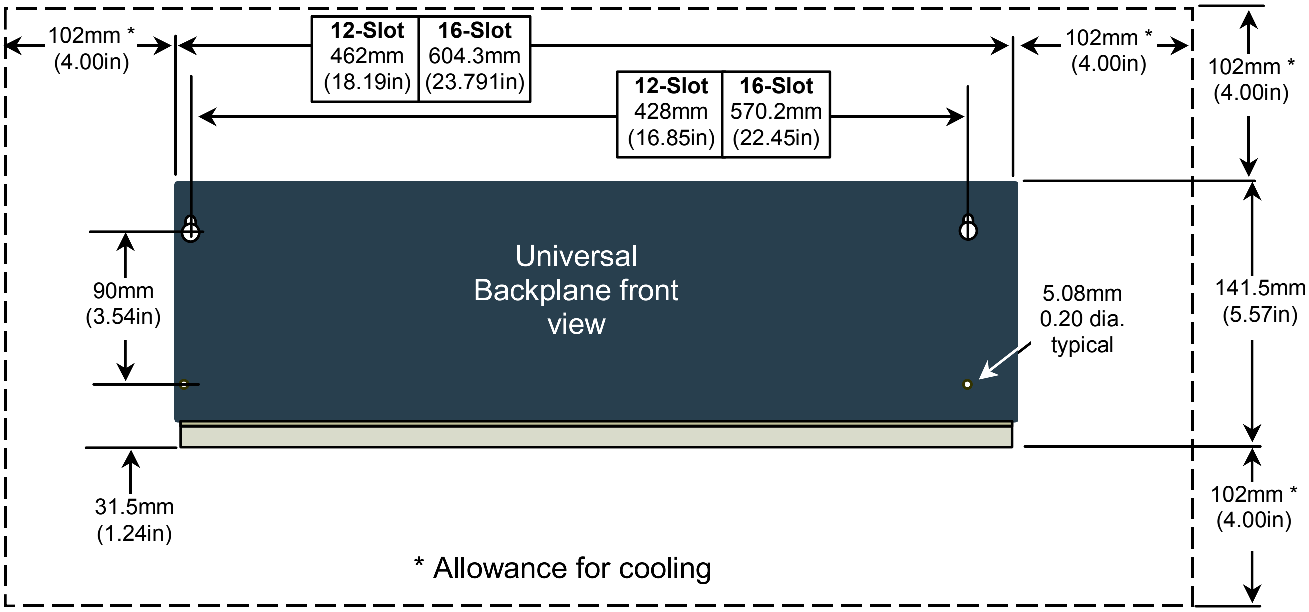
Enclosures

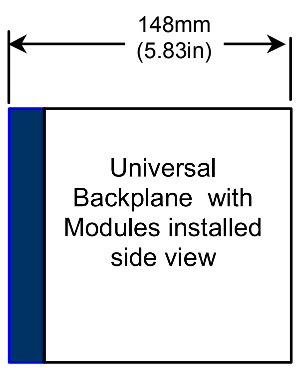
The RX3i system and its components are considered open equipment [having live electrical parts that may be accessible to users] and must be installed in a protective enclosure or incorporated into other assemblies manufactured to provide safety. As a minimum, the enclosure or assemblies shall provide a degree of protection against solid objects up to 12mm (e.g. fingers). This equates to a NEMA/UL Type 1 enclosure or an IP20 rating (IEC60529).

When a RX3i system is installed into an area designated as Class 1 Zone 2 in Europe, compliance with the ATEX Directive requires an enclosure with a higher degree of protection. Refer to “ATEX Class 1 Zone 2 Hazardous Location Requirements” located in Appendix A for specifications.

The enclosure must be able to adequately dissipate the heat generated by all of the components mounted inside so that no components overheat. Heat dissipation is also a factor in determining the need for enclosure cooling options such as fans and air conditioning. A minimum space of at least 102mm (4 inches) is required on all sides of the RX3i backplane for cooling. Additional space may be required, depending on the amount of heat generated by the equipment during operation. Appendix C explains how to calculate heat dissipation for RX3i modules and field devices in an enclosure.

RX3i Universal Backplane Dimensions and Spacing





Side dimension is for standard modules with doors closed.

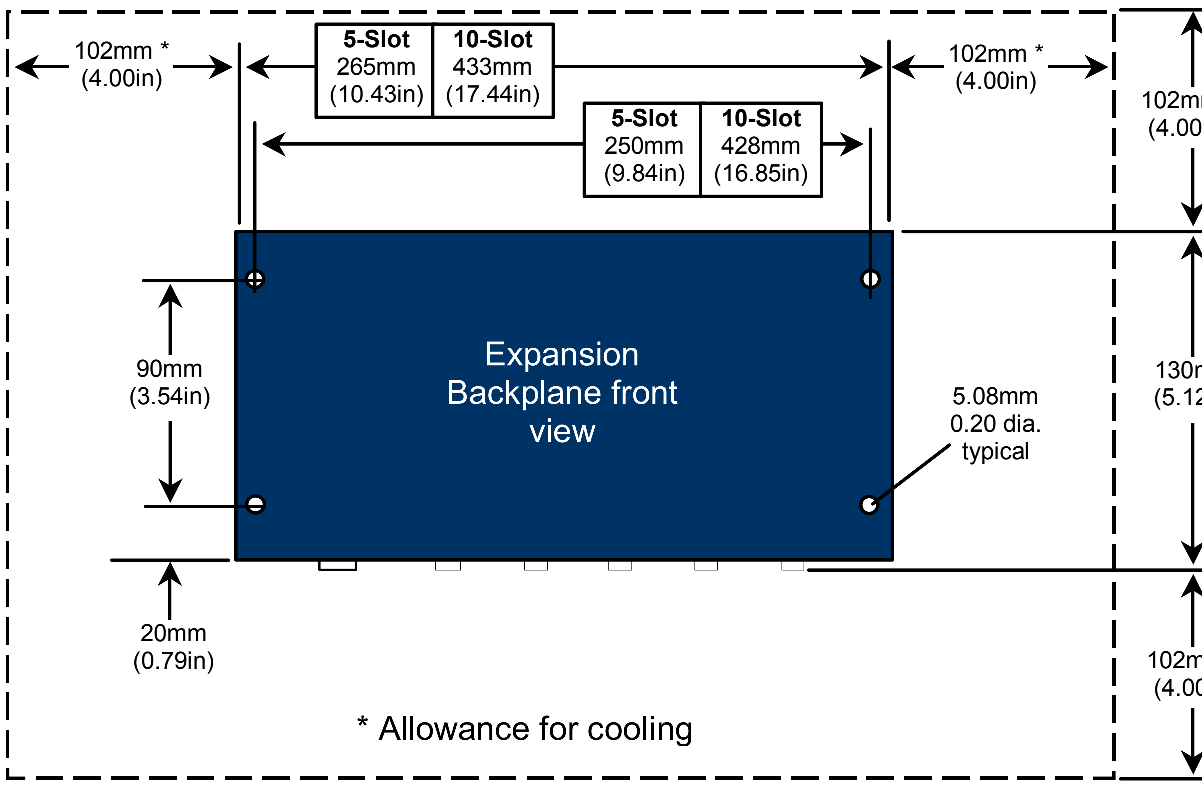
Side dimension does not include extra depth required for cables and connectors.

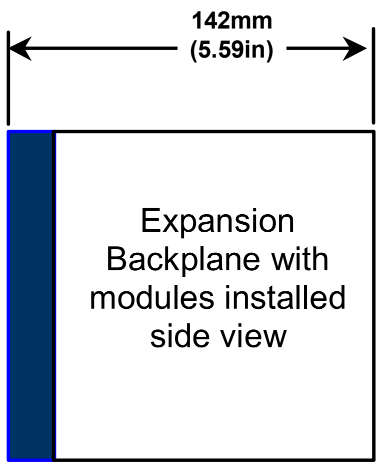
Modules with Extended High-Density Terminal Blocks (such as Terminal Block IC694TBB132) are approximately ½-inch (13mm) deeper overall.

The mounting holes for the 12 slot RX3i Universal Backplane match the 10-slot Series 90-30 Backplane exactly, for easy upgrades.

RX3i Serial Expansion Backplane Dimensions and Spacing

Each backplane has standard attachment flanges for mounting on an electrical panel.





Side dimension is for modules with doors closed.

Side dimension does not include extra depth required for cables and connectors.

Modules with Extended High-Density Terminal Blocks (such as Terminal Block IC694TBB132) are approximately ½-inch (13mm) deeper overall.

System Wiring

General Wiring Information

To avoid possible misrouting of wiring to I/O modules, the following is recommended:

- Label all wires to and from I/O devices. Record circuit identification numbers or other pertinent data on the inserts that go in the module's faceplate door.
- Wires should be dressed so that each field I/O connector is fixed relative to its respective module.

Warning

In addition to information provided here, always follow all wiring and safety codes that apply to your area or your type of equipment. For example, in the United States, most areas have adopted the National Electrical Code standard and specify that all wiring conform to its requirements. In other countries, different codes will apply. For maximum safety to personnel and property you must follow these codes. Failure to do so can lead to personal injury or death, property damage or destruction, or both.

Color Coding Wires

These color codes are commonly used in industrial equipment manufactured in the United States. Where they differ from codes that apply to your area or your type of equipment, follow your applicable codes instead. Besides satisfying code requirements, wire color coding makes testing and troubleshooting safer, faster, and easier.

- Green or green with stripe- Ground
- Black - Primary AC
- Red - Secondary AC
- Blue - DC
- White - Common or neutral
- Yellow - Secondary power source not controlled by the main disconnect. Alerts maintenance personnel that there may be power present (from an external source) even if the equipment is disconnected from its main power source.

Wire Routing

To reduce noise-coupling among PLC wires, electrically-noisy wiring such as AC power wiring and discrete output module wiring should be separated from low-level signal wiring such as DC and analog input module wiring or communications cables. Where practical, group separately the following types of wiring:

- **AC power wiring.** This includes the AC input to the PLC power supply, as well as other AC devices in the control cabinet.
- **Analog Input or Output Module wiring**. This should be shielded to further reduce noise coupling.
- **Discrete Output Module wiring.** These often switch inductive loads that produce noise spikes when switched off.
- **DC Input Module wiring.** Although suppressed internally, these low-level inputs should be further protected against noise coupling by observing these wiring practices.
- **Communications Cables.** Wiring such as Genius bus or serial cables should be kept away from noise-producing wiring.

Where AC or Output wiring bundles must pass near noise-sensitive signal wiring bundles, avoid running them beside each other. If they have to cross, route them a right angle to minimize coupling between them.

Grouping Modules to Keep Wires Segregated

If practical, grouping similar modules together on the backplanes can help keep wiring segregated. For example, one backplane could contain only AC modules, and another only DC modules, with further grouping by input and output types.

System Grounding

All components of a control system and the devices it is controlling must be properly grounded. This is particularly important for the reasons listed below.

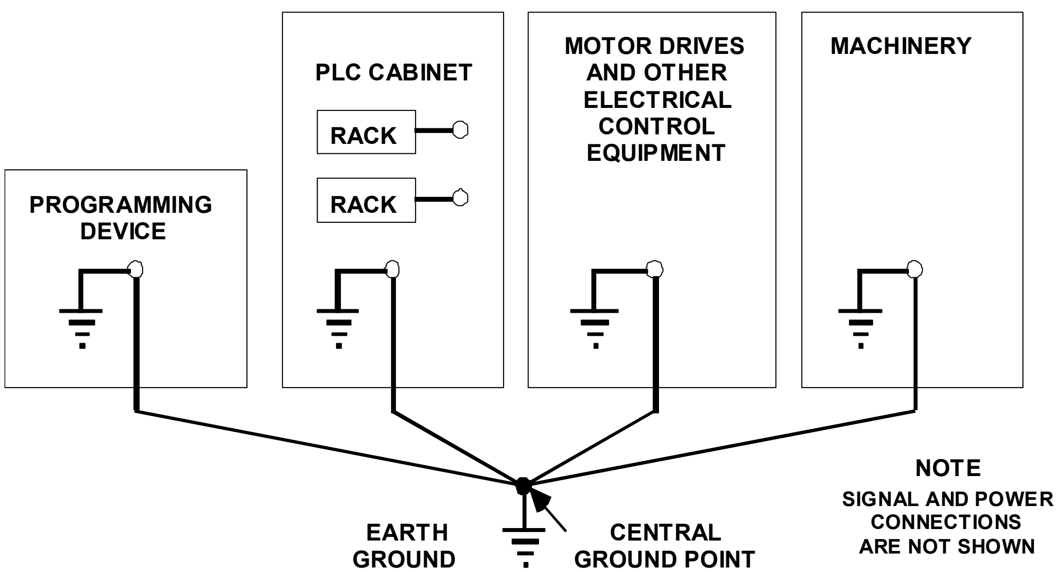
- A low resistance path from all parts of a system to earth minimizes exposure to shock in the event of short circuits or equipment malfunction.
- The RX3i system requires proper grounding for correct operation.
- All backplanes grouped together in the PLC system must have a common ground connection. This is especially important for backplanes that are not mounted in the same control cabinet.

Warning

In addition to observing the grounding procedures described here, it is important to follow local grounding codes. In the United States, most areas have adopted the National Electrical Code standard and specify that all wiring conform to its requirements. In other countries, different codes apply. For maximum safety to personnel and property, follow these codes. Failure to do so can mean injury or death to personnel, damage to property, or both.

In addition to observing the system grounding procedures, periodic inspections of the ground connections should be performed to ensure that the system remains properly grounded.

The PLC equipment, other control equipment, and the machine should be interconnected to maintain a common earth ground reference, also called the machine chassis ground.



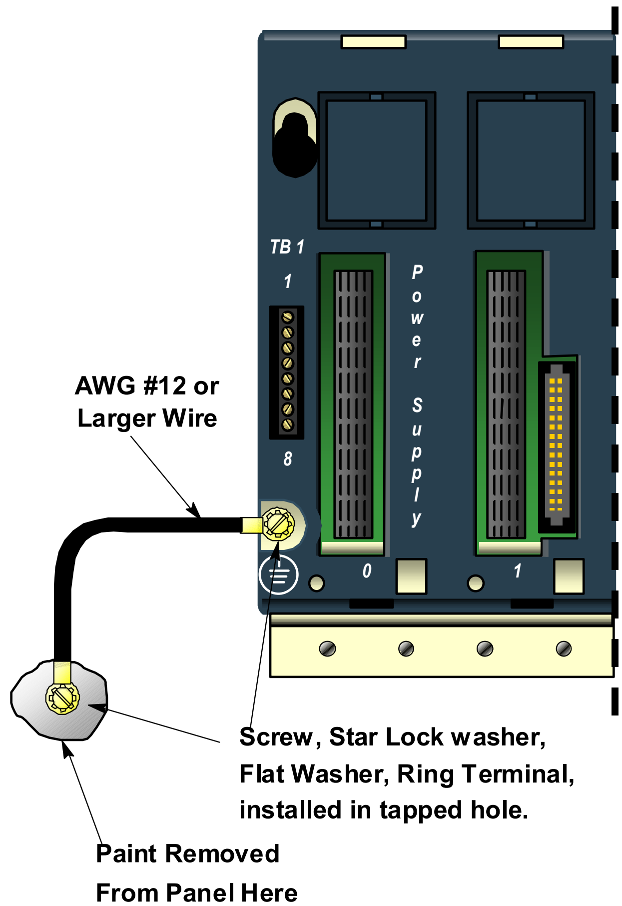
Ground Conductors

Ground conductors should be connected in a tree fashion with branches routed to a central earth ground point, as shown on the previous page. This ensures that no ground conductor carries current from any other branch.

A low inductance path from all parts of a system to earth minimizes emissions and increases immunity to electrical interferences. Ground conductors should be as short and as large in size as possible. Braided straps (maximum 10:1 length to width ratio recommended) or ground cables (typically green insulation with a yellow tracer - AWG #12 (3.3 mm^2) or larger) can be used to minimize resistance. Conductors must always be large enough to carry the maximum short circuit current of the path being considered.

Backplane Safety and EMC Reference Grounding

The backplane's metal back must be grounded using a separate conductor; the backplane mounting screws alone do not provide an adequate ground connection. Use a minimum AWG #12 (3.3 mm^2) wire with a ring terminal and star lock washer. Connect the other end of this ground wire to a tapped hole in the mounting panel using a machine screw, star lock washer, and flat washer. Alternately, if the panel has a ground stud, use a nut and star lock washer for each wire on the ground stud to ensure adequate grounding. Where connections are made to a painted panel, the paint should be removed so clean, bare metal is exposed at the connection point. Terminals and hardware used should be rated to work with the aluminum backplane material.



Warning

All backplanes must be grounded to minimize electrical shock hazard. Failure to do so can result in severe personal injury.

All backplanes grouped together in the PLC system must have a common ground connection. This is especially important for backplanes that are not mounted in the same control cabinet.

Power Supply Grounding See the information on Power Supply Field Wiring later in this chapter.

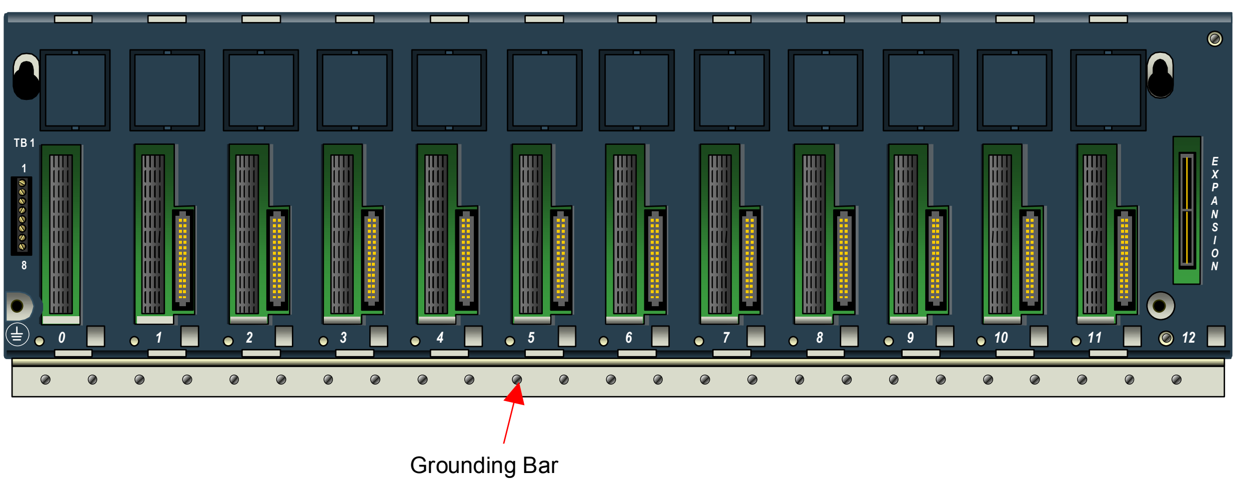
Programmer Grounding

For proper operation, the computer (programmer) running the PLC software must have a ground connection in common with the CPU. Normally, this common ground connection is provided by connecting the programmer's power cord to the same power source (with the same ground reference point) as the backplane. If the programmer ground is at a different potential than the PLC ground, a shock hazard could exist. Also, damage to the ports could occur when the programmer serial cable is connected between the two.

Shield Grounding

In general, the aluminum PLC backplane is used for module shield grounding. On some modules, shield connections to the user terminal connector on the module are routed to the backplane through the module's backplane connector. Other modules, such as the DSM314 require a separate shield ground, as shown in the module descriptions in this manual.

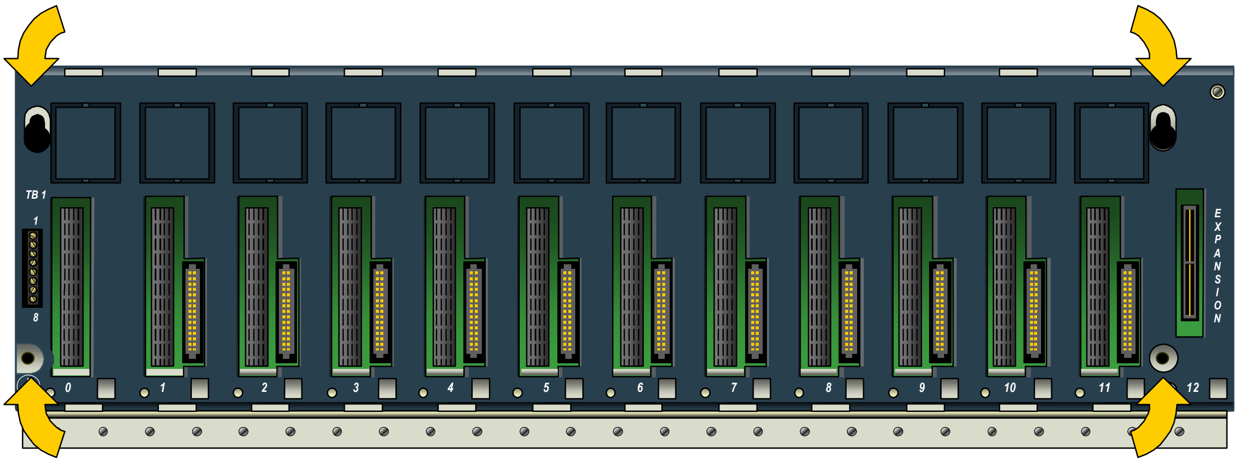
For modules installed in a Universal Backplane, shield grounds can be connected to the Grounding Bar at the bottom of the Backplane using size M3 screws. The recommended torque is 4 in/lb maximum.



System Installation

Universal Backplanes

Mount a Universal Backplane using four good-quality 8-32 x 1/2 (4 x 12mm) machine screws, lock washers and flat washers. Install the screws in the four tapped holes.



The dimensions and mounting clearances for each type of backplane were shown in the previous pages. Vertical mounting is preferred for maximum heat dissipation.

- IC695 Power Supply modules may be installed in any slot. DC Power Supplies IC695PSD040 and IC695PSD140 occupy 1 slot. AC Power Supply IC695PSA040 occupies 2 slots. RX3i (IC694) and Series 90-30 (IC693) Power Supplies cannot be installed in Universal Backplanes.
- An RX3i CPU module can be installed anywhere in the backplane except the Expansion slot. CPU modules occupy 2 slots.
- I/O and option modules can be installed in any available slot except slot 0, which can only accept IC695 Power Supplies, and the Expansion slot. Each I/O slot has two connectors, so either an RX3i PCI-based module or a serial module can be installed in any I/O slot.
- The rightmost slot is the expansion slot. It can only be used for optional Serial Bus Transmitter module IC695LRE001.

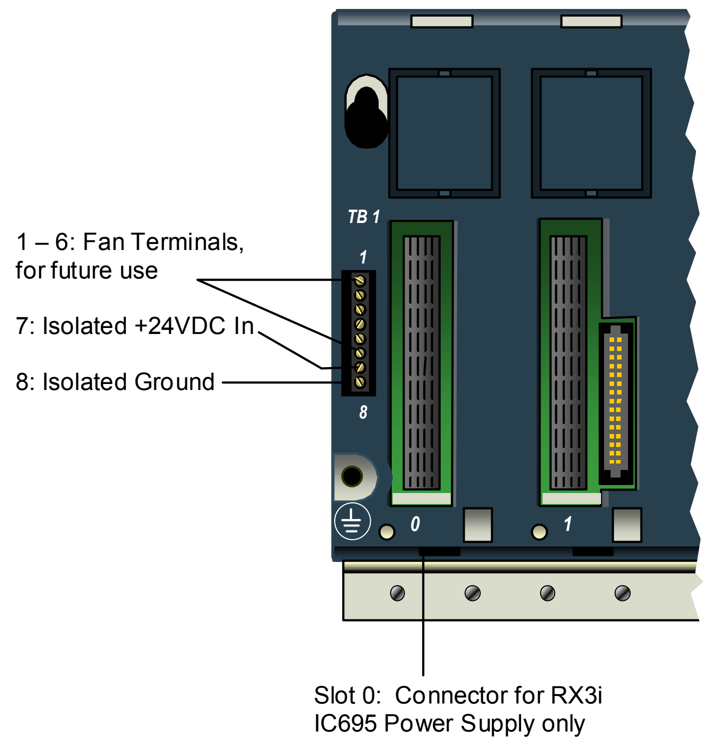
Universal Backplane Terminals (TB1)

Terminals 1 through 6 on the left end of the Universal Backplane are reserved for external fan control (available in future systems).

The RX3i PCI Power Supplies do not provide Isolated +24V output power over the backplane. Terminals 7 and 8 can be used to connect an optional external source of Isolated +24VDC, which is required for some IC693 and IC694 modules as listed in the table of Module Load Requirements in chapter 4.

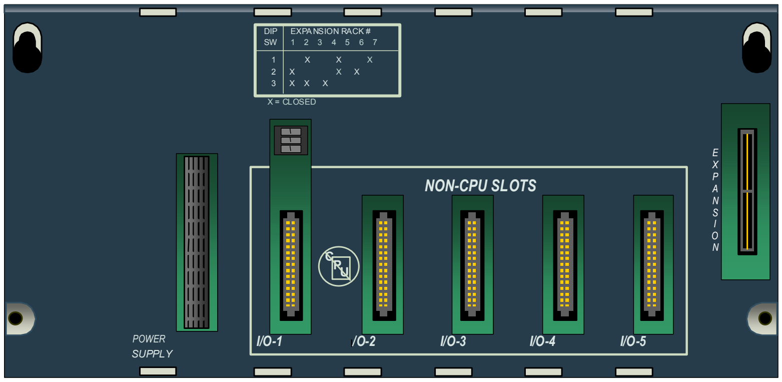
These terminals accept individual wires from 14 to 22 AWG.

If modules that require Isolated +24VDC are installed in an Expansion Backplane instead, an external Isolated +24V power supply is not required.



Expansion Backplanes

To mount an Expansion Backplane on a panel, use four good-quality 8-32 x 1/2 (4 x 12mm) machine screws, lock washers and flat washers. Install the screws in the four tapped holes.



An Expansion Backplane can also be mounted in a 19-inch rack using a mounting bracket as described in this section.

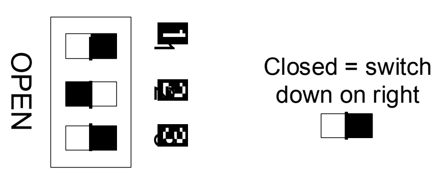
Setting the Rack Number DIP Switch

Each backplane is identified with a unique number called a “Rack Number.” Rack number 0 is always automatically assigned to the backplane with the CPU. Rack numbers must not be duplicated in a system. Backplanes do not need to be sequentially numbered, although for consistency, rack numbers should not be skipped.

Rack Numbers for Expansion and Remote backplanes are set using a DIP switch on the backplane. The following table shows the DIP switch positions for rack number selection.

	Rack Number						
DIP Switch	***1***	***2***	***3***	***4***	***5***	***6***	***7***
1	open	closed	open	closed	open	closed	open
2	closed	open	open	closed	closed	open	open
3	closed	closed	closed	open	open	open	open

For example, these switch settings select rack number 2:

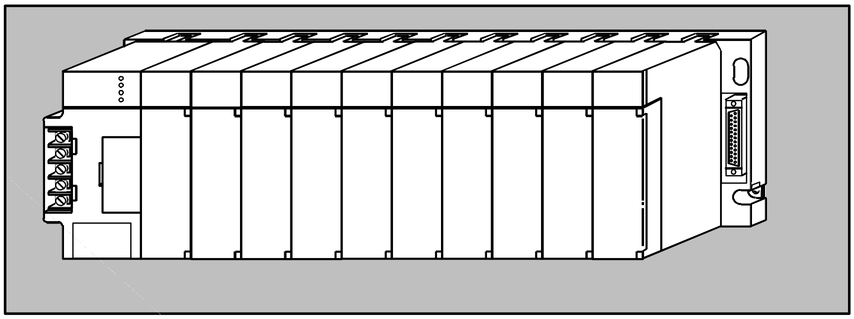


Do not use a pencil to set the DIP switches. Graphite from the pencil can damage the switch.

Recommended Mounting Orientation for Expansion Backplanes

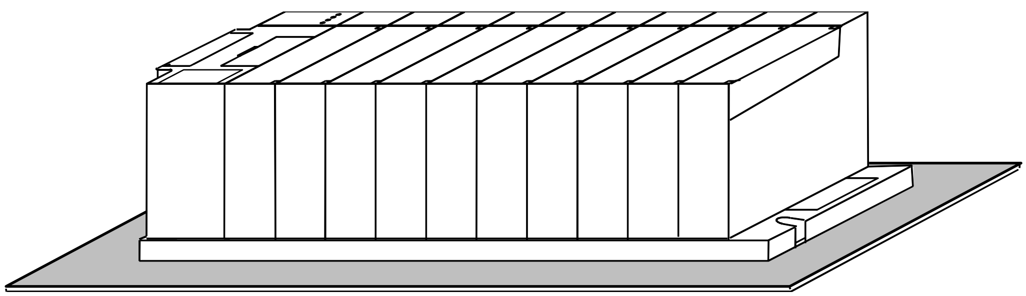
For Expansion and Remote Backplanes, power supply load rating depends on the mounting position of the backplane and the ambient temperature.

The load rating with the Expansion Backplane mounted upright on a panel is100% at 60°C (140°F)



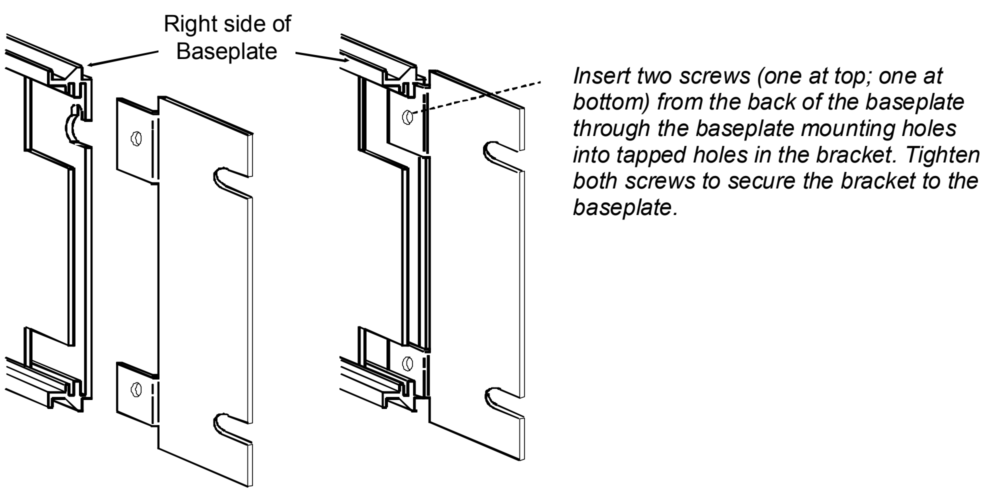
Power supply load ratings with the backplane mounted horizontally are:

- Temperature at 25°C (77°F) – full load
- Temperature at 60°C (140°F) – 50% of full load

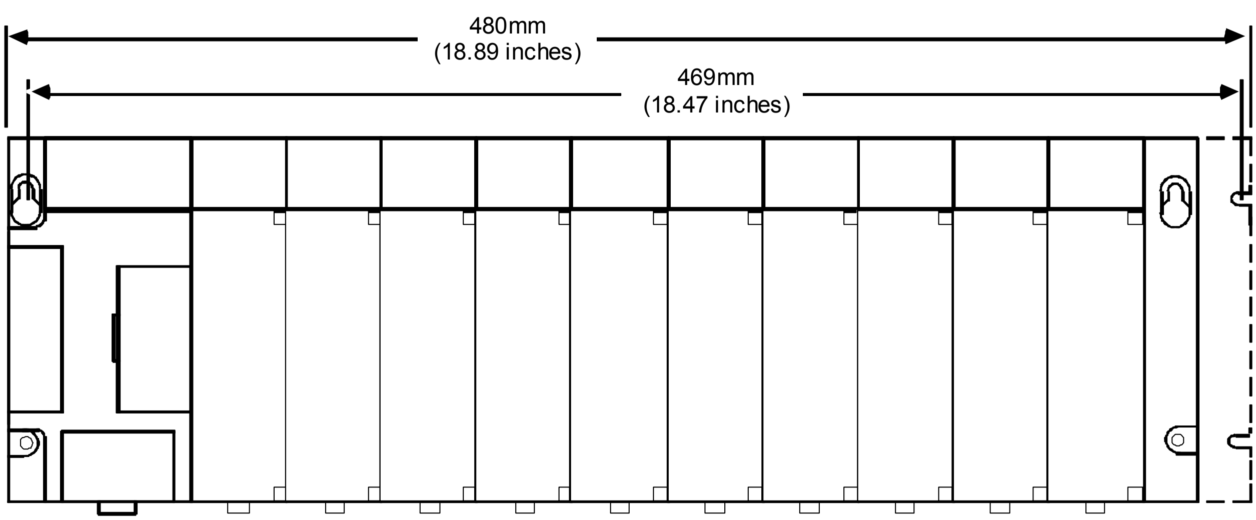


Mounting a Backplane in a 19-Inch Rack

The **IC693ACC308 Front Mount Adapter Bracket** can be used to mount a 12-Slot Universal Backplane (IC695CHS012) or a 10-Slot Expansion Backplane (IC694CHS392) to the front face of a 19" rack. Install the adapter bracket by inserting the tabs at the top and bottom of the adapter bracket into the corresponding slots at the top and bottom of the plastic backplane cover. It is not necessary to remove the cover to install the bracket. With the bracket in place, insert and tighten the two screws (included with the bracket) through the back of the backplane holes into the threaded holes in the bracket.

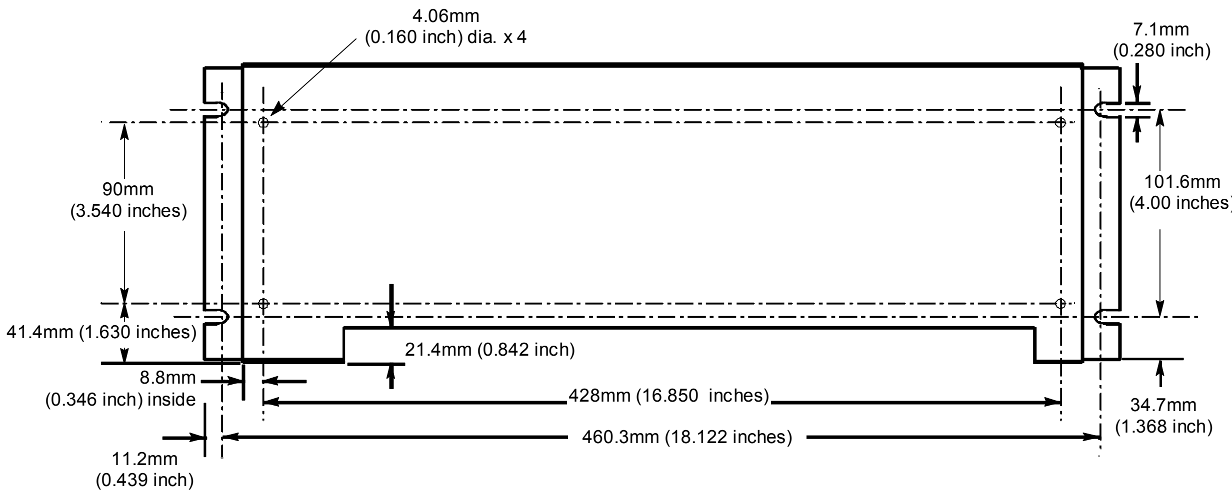


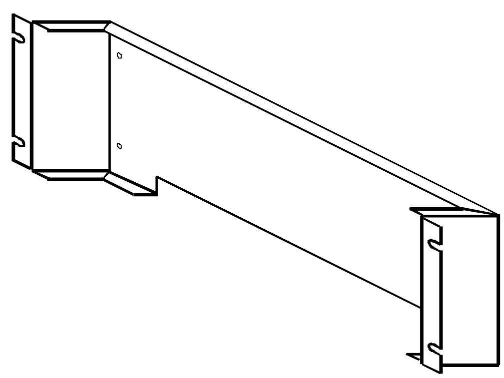
Dimensions for rack mounting a backplane with the IC693ACC308 Front Mount Adapter Bracket are shown below.



The **IC693ACC313 Recessed Mount Adapter Bracket** can be used to recess-mount a 10-Slot Expansion Backplane (IC694CHS392) inside a 19” rack. This bracket cannot be used with a Universal Backplane.

An Expansion Backplane mounts on the rear panel of this adapter bracket using four 8-32 (4mm) screws, nuts, lock washers, and flat washers. The Adapter Bracket bolts through its four slotted holes to the face of the 19” rack using applicable hardware (lock washers recommended).





Grounding Rack-Mounted Expansion Backplanes

If an Expansion Backplane is mounted in a 19-inch rack using an Adapter bracket, the rack must be properly grounded as described in “System Grounding Procedures”. In addition, the backplane should be grounded according to the guidelines in the “Backplane Safety Grounding” section, using a separate ground wire from the PLC backplane.

- For a Recessed Mount Adapter Bracket (IC693ACC313), the ground wire can be installed with the ground attached to the Recessed Mount Adapter Bracket. An additional ground wire should be installed that connects the Adapter Bracket to a solid chassis ground.
- For a Surface Mount Adapter Bracket (IC693ACC308), the ground wire should be run from the backplane to a solid chassis ground on the rack.

Modules

Hot Insertion and Removal

Modules in a Universal Backplane (IC695CHS012 or CHS016) can be installed or removed while power is applied to the system. This includes backplane power and field power supplied to the module.

NOTE: For products that support hot insertion, the module must be properly seated on the carrier with the latch engaged and all pins connected within 2 seconds. For removal, the module must be completely disengaged from the carrier within 2 seconds. It is important that the module not remain partially inserted during the insertion or removal process. There must be at a minimum of two seconds between the removal and insertion of modules.

NOTE: The CPU, IC695CPU310, cannot be installed or removed from a Universal Backplane while power is applied to system. System power must be removed before installing or removing the CPU.

The following warnings must be observed.

Warning

Inserting or removing a module with power applied to the system may cause an electrical arc. This can result in unexpected and potentially dangerous action by field devices. Arcing is an explosion risk in hazardous locations. Be sure that the area is non hazardous or remove system power before removing or inserting a module.

Warning

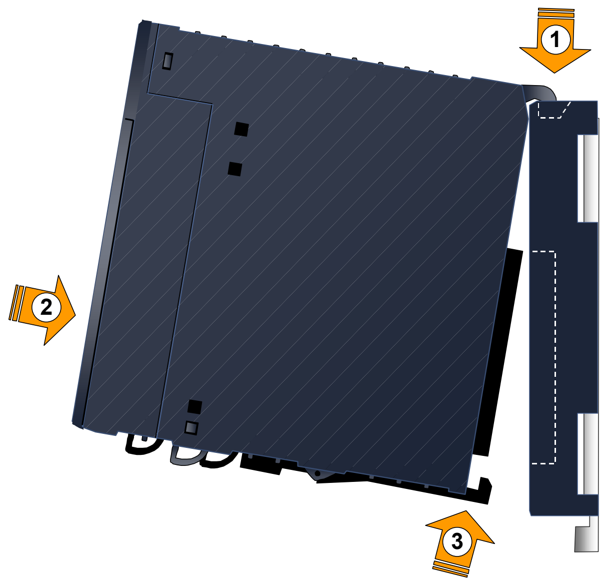
Do not insert or remove modules in RX3i Serial Expansion Backplanes or Series 90-30 Expansion Backplanes with power applied to the backplane. This could cause the PLC to stop or malfunction. Injury to personnel and damage to the module or backplane may result. If the PLC is in RUN mode, I/O data to/from this backplane will not be updated while power is removed.

Installing Modules

WARNING

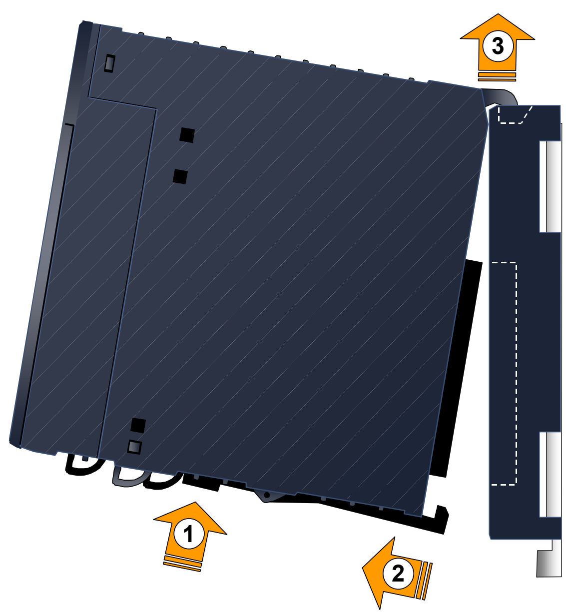
Potentially dangerous voltages may be present on a module's screw terminals even though power to the backplane is turned off. Always be careful handling the module's removable terminal board and any wires connected to it.

- Be sure the module catalog number matches the intended slot configuration.
- Holding the module firmly, align the module with the correct slot and connector.
- Engage the module's rear pivot hook(s) in the notch(es) on the top of the backplane (1).
- Swing the module down (2) until the module's connector engages the backplane's backplane connector, and the release lever(s) on the bottom of the module snaps into place in the bottom module retainer (3).
- Visually inspect the module to be sure it is properly seated.



Removing Modules

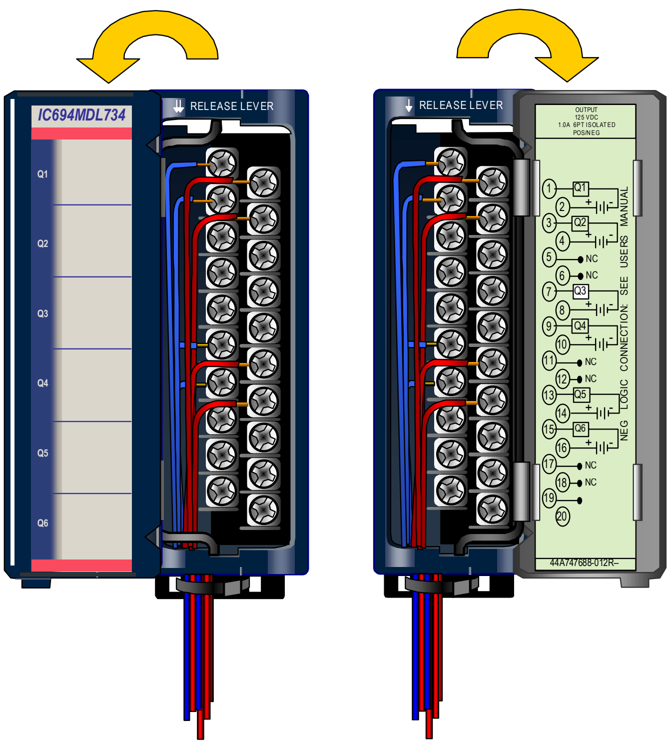
- If the module has a removable terminal board, remove it as described later in this section.
- Locate the release lever(s) at the bottom of the module and firmly press upward (1), toward the module. Wider modules have two release levers that must both be pressed up at the same time.
- While holding the module firmly and fully depressing the release lever(s), pivot the module upward until its connector is out of the backplate (2).
- Lift the module up and away from the backplane to disengage the pivot hook.

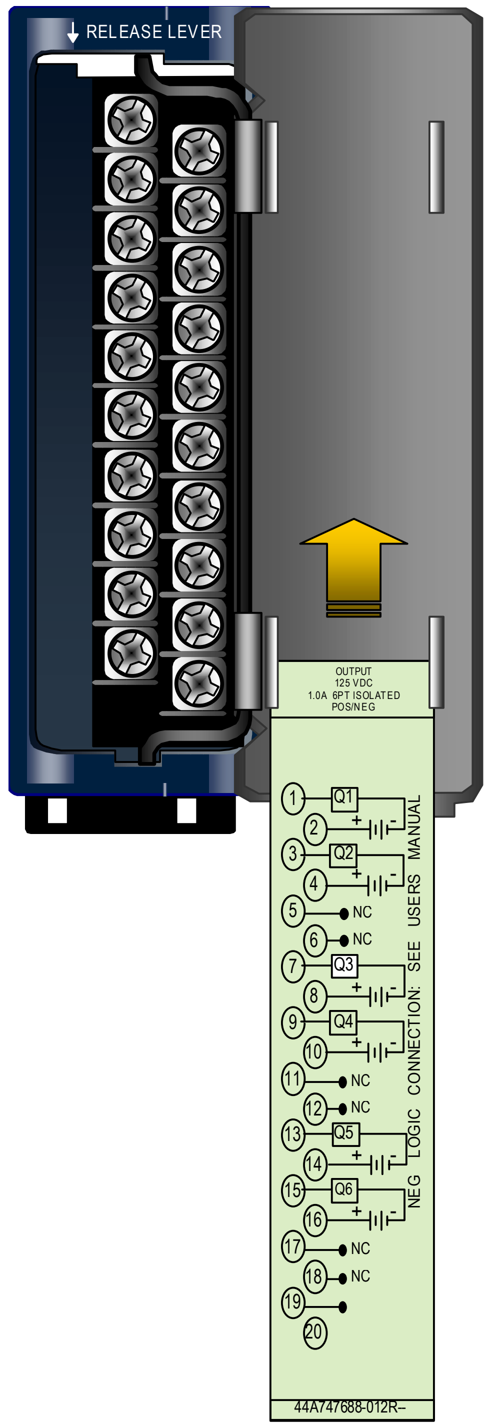


I/O Module Terminal Block Assemblies

Most PACSystems RX3i I/O modules have removable front terminal block assemblies. Each module of this type has an insertable door label with a wiring diagram printed on the back. The front of the label has color bands that indicate the module type, and space to record identifying information about the module's inputs or outputs.

The terminal blocks have fully-hinged doors that can be opened to either the left or right to access wiring.



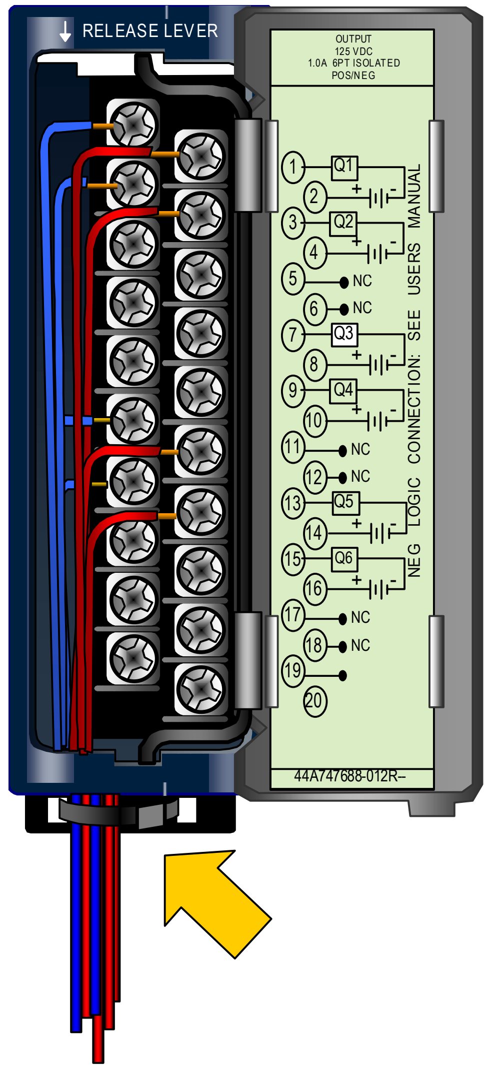


I/O Module Connections

For most RX3i I/O modules, connections are made to the module's removable terminal board. Specific wiring information for each module is printed on the door insert and also shown in the module description in this manual.

This section describes the 20-pin removable terminal block, which is used by most RX3i I/O modules. Higher-density modules use other connection methods.

- See chapter 14 for information about 36-pin removable terminal blocks used for most higher-density modules.
- See appendix B for information about connections to I/O modules that have two 20-pin connectors on the front of the module.



Screw terminals on a 20-pin terminal block accept from two AWG #22 (0.36 mm^2) to two AWG #16 (1.3 mm^2), or one AWG #14 (2.1 mm^2) copper 90°C (194°F) wire(s). Each terminal can accept solid or stranded wires, but the wires into any given terminal should be the same type (both solid or both stranded) to ensure a good connection. Wires are routed to and from the terminals out of the bottom of the terminal board cavity. The suggested torque for the I/O terminal board connection screws is from 9.6 in-lbs to 11.5 in-lbs (1.1 to1.3 Newton-meters).

After the wiring is completed, wires should be bundled and fastened at the bottom of the module as shown at right.

Installing or Removing a 20-Pin Terminal Block Assembly

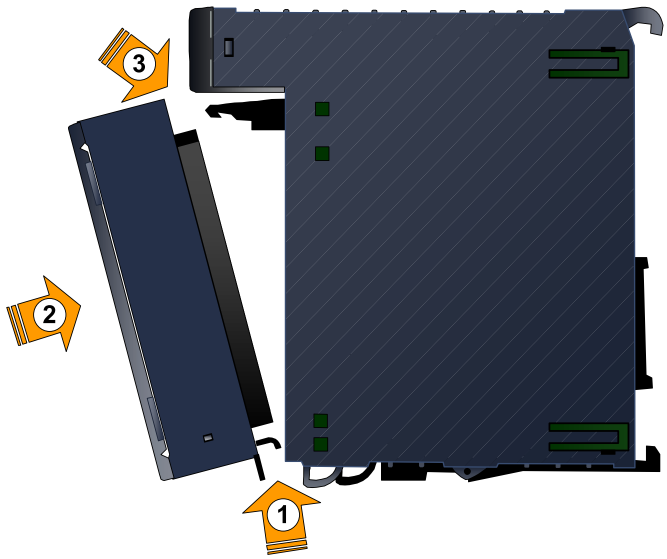
(See chapter 14 for instructions for installing or removing a 36-pin terminal assembly). Compare the module catalog number on the label on the terminal assembly door and the label on the side of the to be sure they match. If a wired terminal block is installed on the wrong module type, the module may be damaged when the system is powered up.

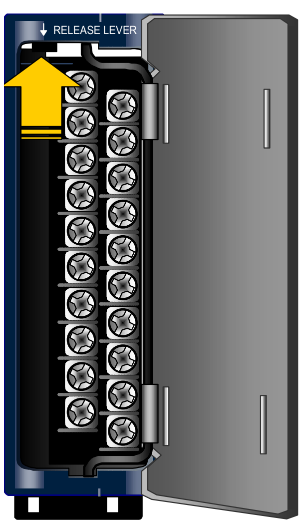
Warning

Field power must be turned off when installing or removing a Terminal Block assembly.

Installing a Terminal Block

1. Insert the pivot hook on the bottom of the terminal block assembly into the slot on the bottom of the module.
2. Pivot the terminal block assembly upward to engage the connector.
3. Press the terminal block assembly toward the module until the release lever latch snaps into place. Check to be sure the terminal block is firmly seated.





Removing a Terminal Block

1. Open the terminal block door.
2. Push up the release lever to unlock the terminal block.
3. Pull the terminal block away from the module until the contacts have separated and the bottom pivot hook has disengaged.

Installing or Removing a Terminal Block Cover

The terminal block assembly cover can be removed for easier access to the terminals.

Warning

Potentially dangerous voltages from user devices may be present on a module's screw terminals even though power to the backplane is turned off. Always be careful handling the module's removable terminal block assembly and any wires connected to it.

Removing a Terminal Block from its Cover

To remove a Terminal Block from its cover:

1. Grasp the sides of the Terminal Block cover.
2. Pull down on the bottom of the Terminal Block as shown at left.

Inserting a Terminal Block in its Cover

To re-insert a Terminal Block in its cover:

1. Align the top of the Terminal Block with the bottom of the cover, making sure that the notches in the Terminal Block match up with the grooves in the cover.
2. Slide the Terminal Block upward until it clicks into place.

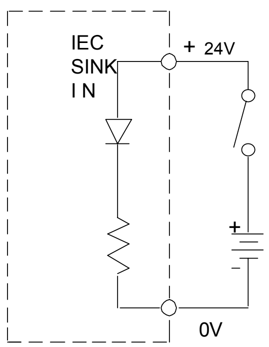
Positive and Negative Logic Connections to Discrete Modules

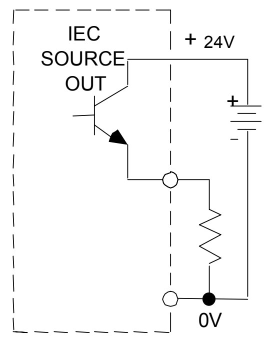
The IEC definitions for positive logic and negative logic for PACSystems RX3i modules are described below.

Positive Logic

Positive logic input modules sink current from the input device to the user common or negative power bus (left). The input device is connected between the positive power bus and the input terminal.

Positive logic output modules (right) source current to the loads from the user common or positive power bus. The load is connected between the negative power bus and the module output.

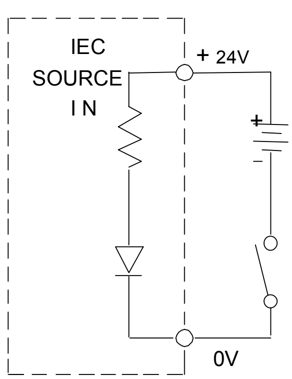


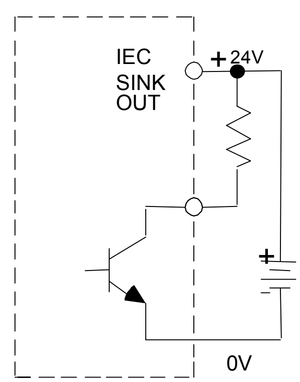


Negative Logic

Negative logic input modules (left) source current through the input device to the user common or positive power bus. The input device is connected between the negative power bus and the input terminal.

Negative logic output modules (right) sink current from the loads to the user common or negative power bus. The load is connected between the positive power bus and the output terminal.





Wiring for Analog Modules

Twisted, shielded instrumentation cable is strongly recommended for analog module input or output signal connections. Proper grounding of the shield is also important. For maximum electrical noise suppression, the cable shield should only be grounded at one end of the cable.

It is generally best to ground the cable shield as close to the source of the noise as possible. For Analog Input modules, ground the end that is in the noisiest environment (usually the field device end). Cut the shield off at the module end of cable and insulate with shrink tubing. For Analog Output modules, ground at the module end. Cut the shield off at device end of cable and insulate with shrink tubing.

It is best to keep the length of stripped cable leads as short as possible to minimize the length of unshielded conductors exposed to the noisy environment.

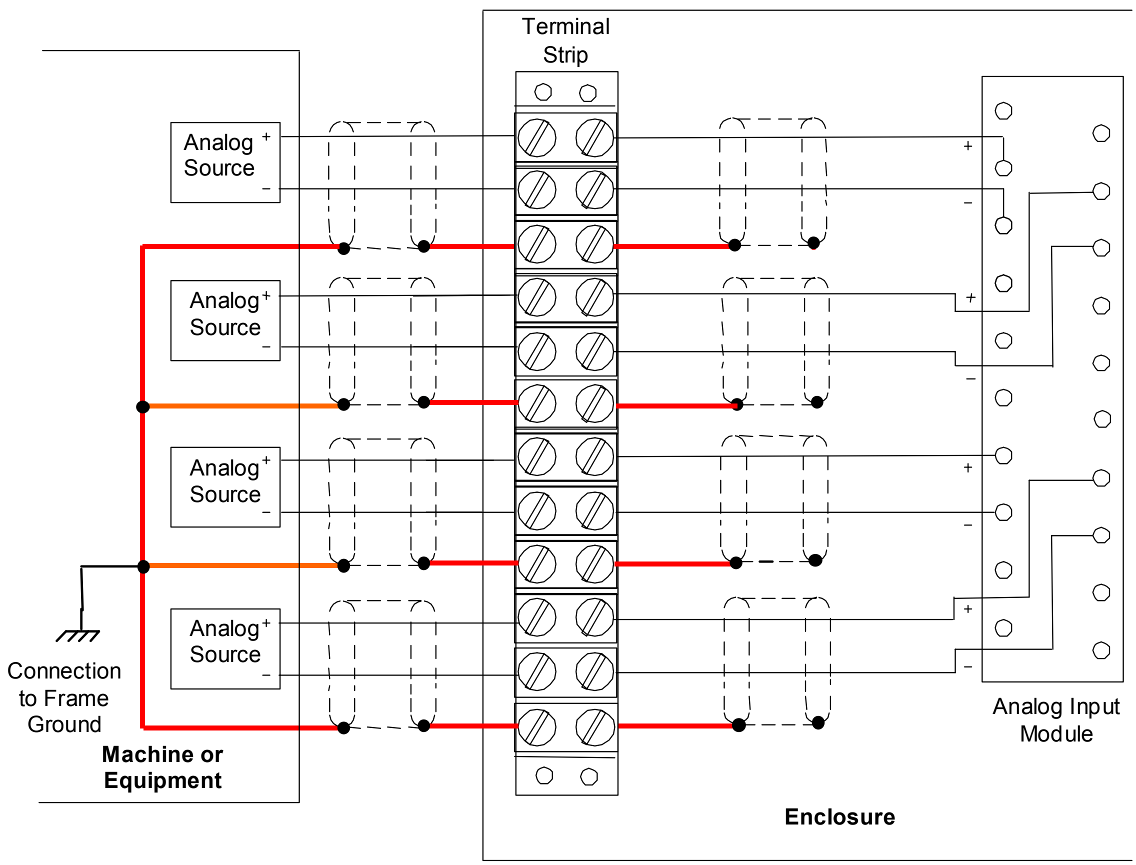
Connections can be made directly to the module terminals, or via an intermediate terminal block. The diagrams in this section show wiring for various types of analog input and analog output installations.

Shielding for Analog Input Modules

Generally, the shield for analog input cables should be grounded at the analog source. However, ground connections for each channel, labeled COM and GND, can be used to connect shields at the analog input module if appropriate. An analog input module's COM terminals connect to the analog circuit common in the module. The GND terminals connect to the backplane (frame ground). Shields may be connected to either COM or GND. This section shows four shield grounding examples for analog input modules.

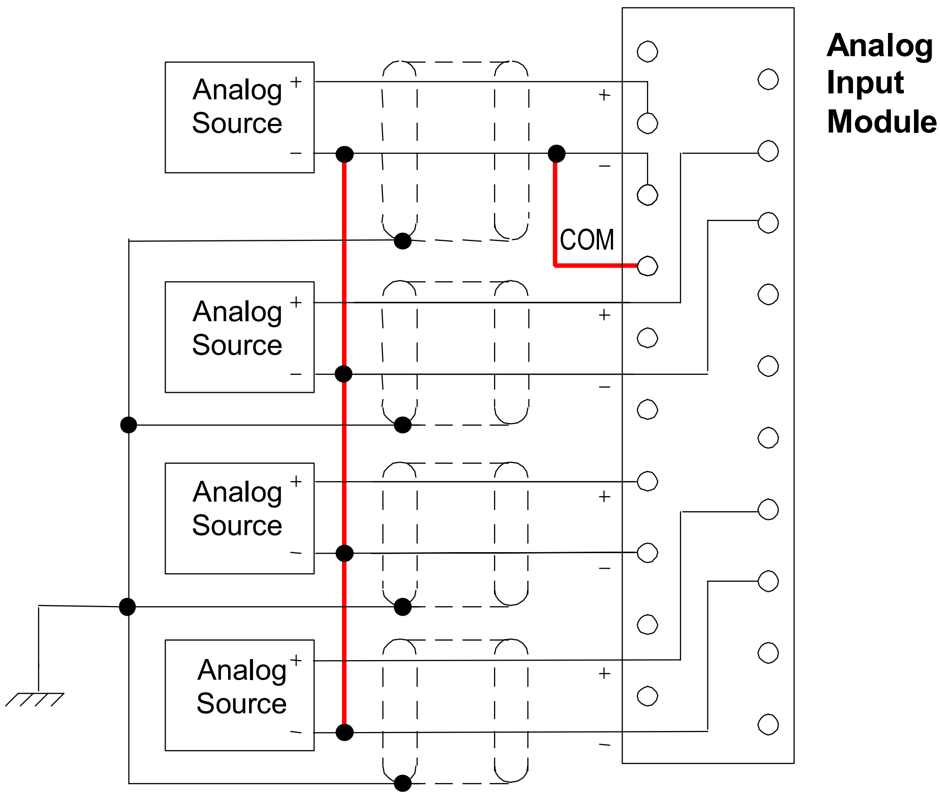
Analog Input Shield Grounding with a Terminal Strip

For an unbalanced source, the ground shield should be connected to the source common or ground at the source end. If all source inputs to the module come from the same location and are referenced to the same common, all shield grounds should be connected to the same ground point. If there is an additional terminal strip between the analog input module and the field devices (analog sources), use the method shown below to continue each cable shield using a terminal on the terminal strip. Each cable is only grounded at one end - the end closer to the field devices (analog sources). Shield connections are shown in red (bold).



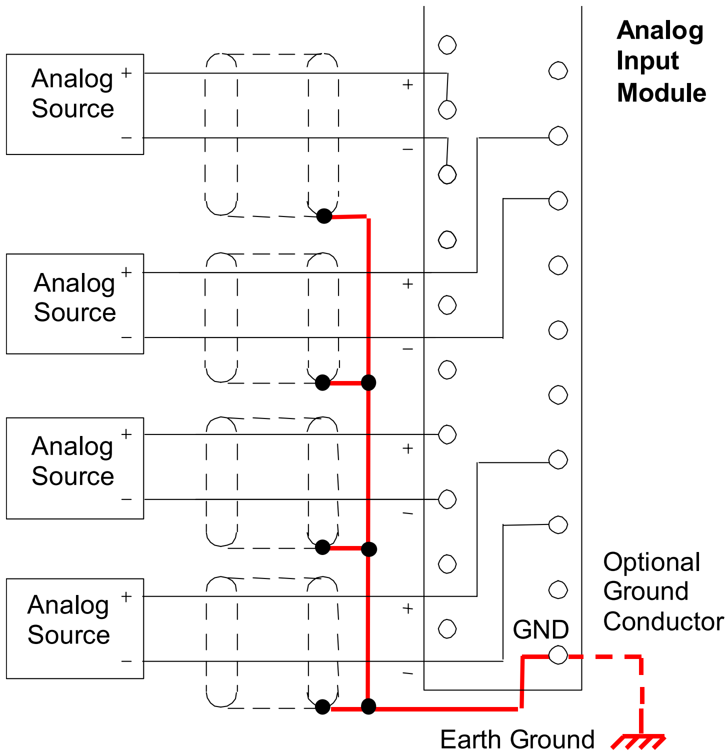
Analog Input Shield Grounding to Common Connections

In some applications, noise rejection can be improved by connecting the source common points together at the source end, then connecting a common line to the module at only one module COM terminal. That will eliminate multiple grounding or ground loops that could cause false input data. The common connections here are shown in red (bold).



Analog Input Shields Connected to Module Terminal Board

It is usually preferable to ground cable shields at the source end. If that is difficult, or if electrical noise is not a concern, it may be acceptable to ground cable shields at the analog input module end. They can be connected to one of the module's GND terminals (which is connected to frame ground through an internal path) as shown left below. If necessary to improve noise immunity, a conductor can be used to connect a ground terminal on the module to earth ground as shown below. This will bypass noise around the module.

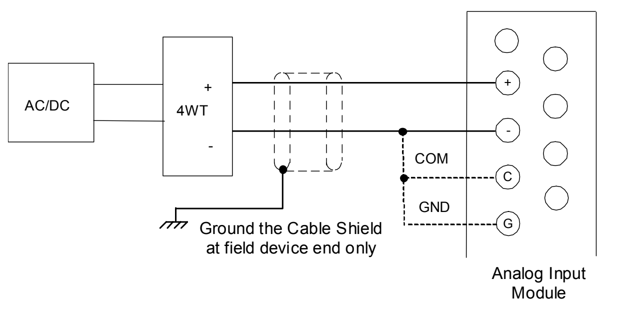


Wiring for Current Transducers

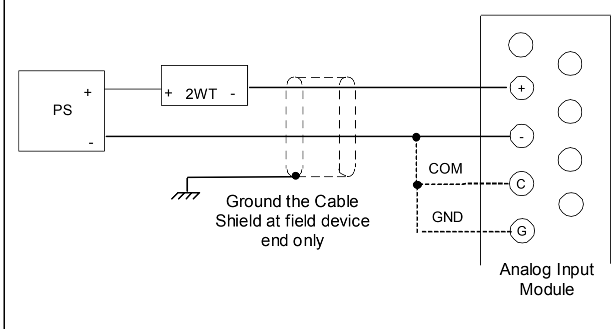
For all of the examples shown below, connect the (-) conductor to the Analog Input module COM terminal, if the source is floating, to limit common-mode voltages. Common mode voltage is limited to 11 volts.

If noise causes inaccurate readings, the (-) conductor can also be connected to the Analog Input module GND terminal.

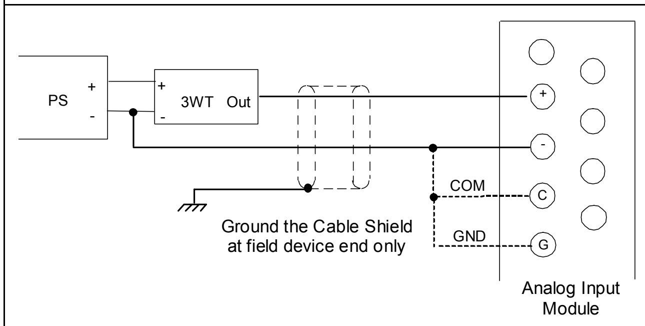
4-Wire Transducer, Externally Powered via AC or DC Supply



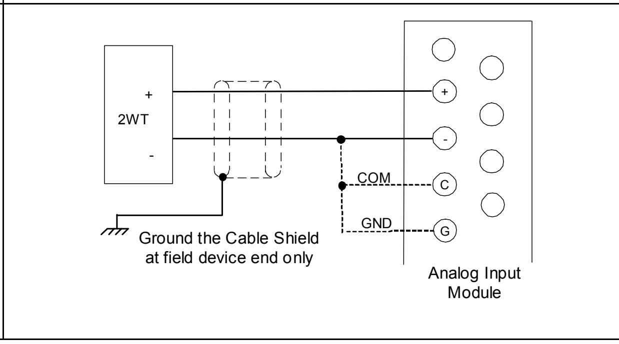
2-Wire Transducer, Externally Powered via DC Supply



3-Wire Transducer, Externally Powered via DC Supply



2-Wire Transducer, Self Powered

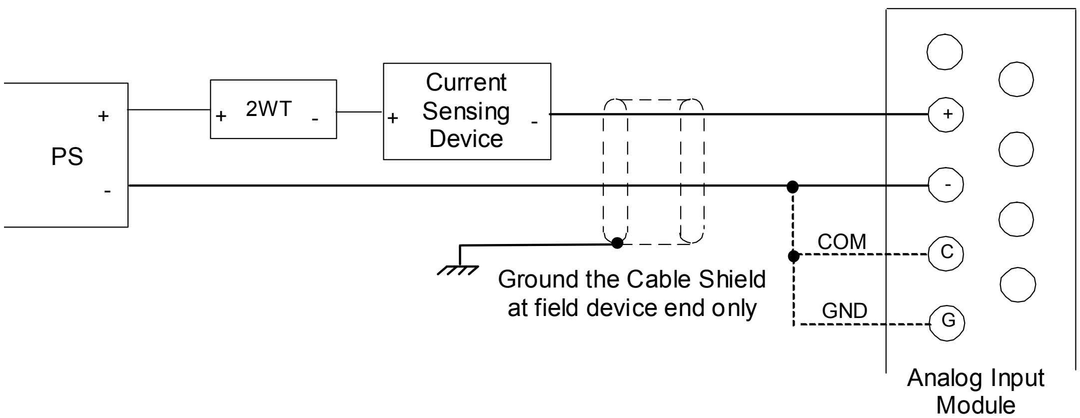


2-Wire Transducer Connected to Two Measuring Devices

Connect the (-) conductor to the Analog Input module COM terminal, if the source is floating, to limit common-mode voltages. Common mode voltage is limited to 11 volts.

If noise causes inaccurate readings, the (-) conductor can also be connected to the Analog Input module GND terminal.

The analog module must be the last device on the circuit. When grounding the (-) return side of the Analog Input Module, the other current-sensing device must be floating and able to withstand a common mode voltage of at least 20 volts, including the noise level.



Verifying Analog Input Current

RX3i Analog Current Input Modules have an internal 250 ohm resistor across the input terminals. You can measure the voltage across the input terminals using a volt meter, then use Ohm's Law to determine the input current:

Input Current (in Amps) = Volts / 250

For example, if you measured 3 volts across the input terminals:

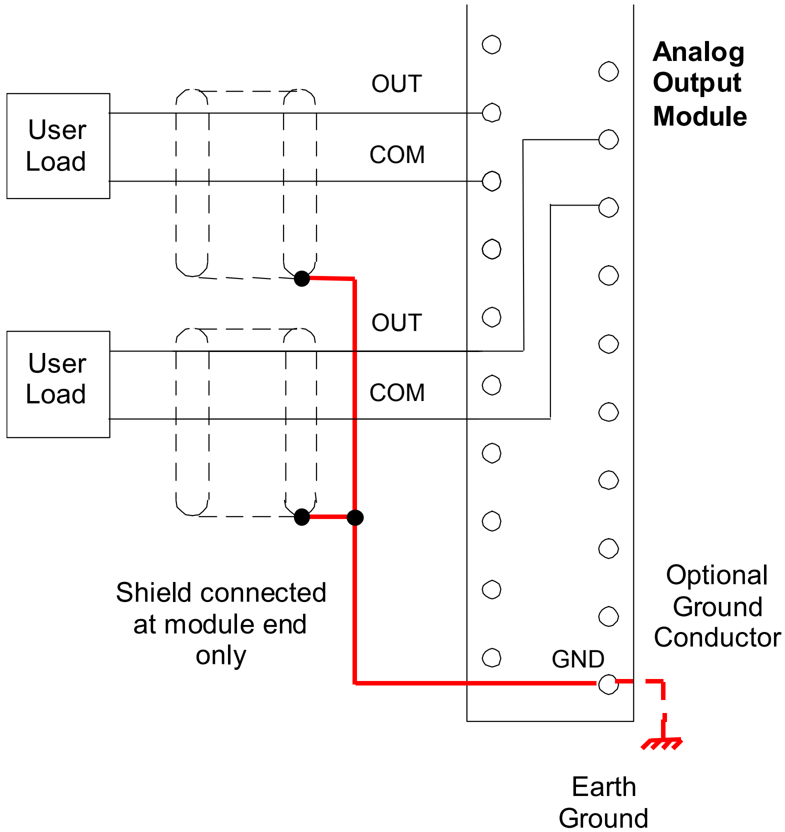
Input Current (in Amps) = Volts / 250

Input Current (in Amps) = 3/250

Input Current (in Amps) = .012 (which equals 12 mA)

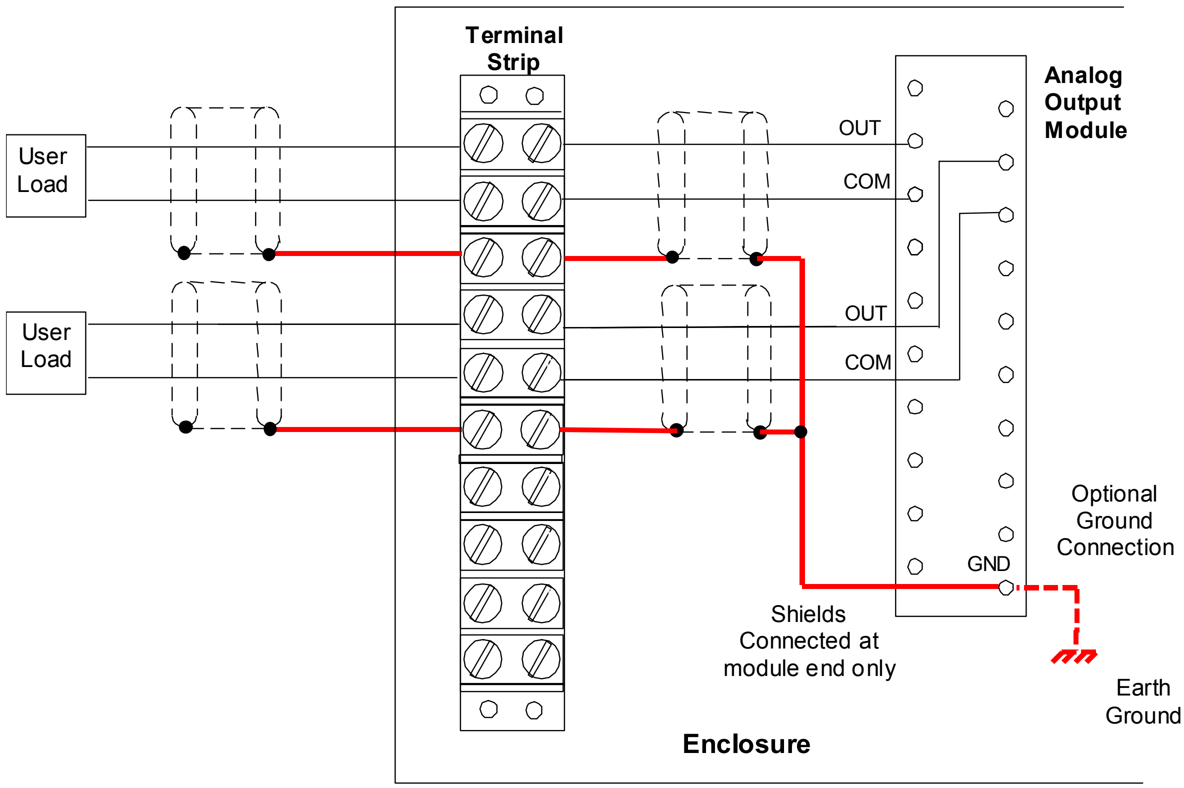
Shield Connections for Analog Output Modules

For analog output modules, the shield is normally grounded at only the source end (the module). The GND connection provides access to the backplane (frame ground) resulting in superior rejection of noise caused by any shield drain currents. In extreme-noise environments, you can connect an optional ground braid from the GND terminal to an external earth ground to bypass noise around the module.



Analog Output Shield Grounding with a Terminal Strip

If there is a terminal strip between the analog output module and the field devices (user loads), use the method in the following figure for grounding the cable shields. Each cable is only grounded at one end - the end closer to the Analog Output Module. An optional external ground connection to the output module's GND terminal is shown for installations that require extra noise suppression.



Module Fuse List

Warning

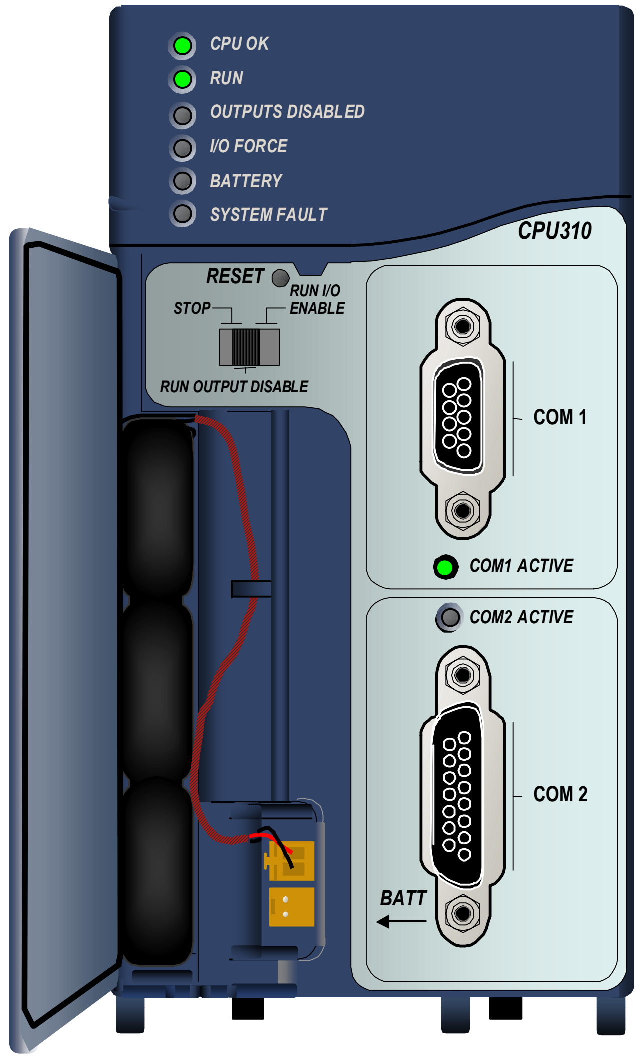
Replace fuse only with the correct size and type. Using an incorrect fuse can result in harm to personnel, damage to equipment, or both.

Module Catalog Number	*Module Type*	*Current Rating*	*Quantity on Module*	*GE Fanuc Fuse Part Number*	*Other Sources and Part Numbers*
IC694MDL310	120 VAC, 0.5A	3A	2	44A724627-111 (1)	Bussman – GMC-3 Littlefuse – 239003
IC694MDL330	120/240 VAC, 1A	5A	2	44A724627-114 (1)	Bussman – GDC-5 Bussman S506-5
IC694MDL340	120 VAC, 0.5A	3A	2	44A724627-111 (1)	Bussman – GMC-3 Littlefuse – 239003
IC694MDL390	120/240 VAC, 2A	3A	5	44A724627-111 (1)	Bussman – GMC-3 Littlefuse – 239003
IC694PWR321 and IC694PWR330	120/240 VAC or 125 VDC Input, 30 Watt Power Supply	2A	1	44A724627-109 (2)	Bussman – 215-002 (GDC-2 or GMC-2) Littlefuse – 239-002
IC694PWR331	24 VDC Input, 30 Watt Power Supply	5A	1	44A724627-114 (2)	Bussman – MDL-5 Littlefuse – 313005

(1) Mounted in clip. Accessible by removing circuit board from module housing.
(2) Line fuse. Mounted in clip – accessible by removing module front.

CPU

1. Make sure that rack power is off.
2. Install the CPU module in the appropriate slot. The CPU requires two slots and can use any slots except the highest numbered (rightmost) slot.
3. Turn on power. The module should power up. When the CPU has successfully completed initialization, the OK LED stays on and the RUN and EN LEDs are off. The CPU is now ready to be programmed.
4. Connect the battery to either of the battery connectors on the module. (You can connect the battery at any step in the installation process but it will begin to drain immediately unless power is applied. To maximize battery life, install it after power has been turned on).
5. If appropriate, communications cables can be secured to the tie-downs on the bottom of the module.

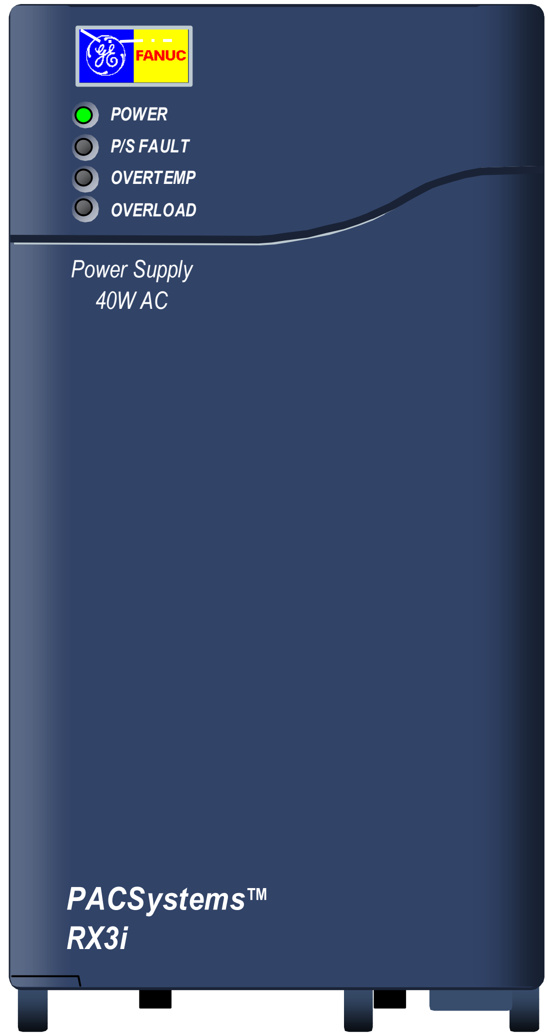


After the program has been verified, the mode switch can be moved to the appropriate operation mode position: RUN I/O ENABLED, RUN OUTPUT DISABLE, or STOP. The LEDs indicate the position of the mode switch and status of serial port activity.

Caution

This module may NOT be hot-inserted in the backplane; power must be removed before installing or removing the CPU.

Power Supplies



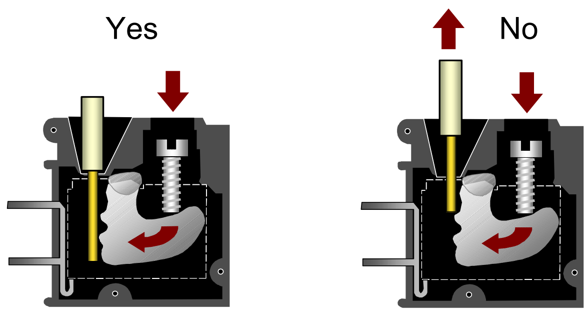
1. Install the Power Supply module in the appropriate slot(s).
2. Universal Power Supplies (IC695) can be installed in any slots except the highest numbered (rightmost) slot in a Universal Backplane. Expansion Power Supplies (IC694) must be installed in the Power Supply (leftmost) slot in an Expansion Backplane, See chapter 3, Backplanes, for more information about module locations.
3. Connect wiring to the Power Supply as described below.
4. Use the three wiring tie-downs on the bottom of the module to secure the power and ground wires after installation.

Warning

For all Power Supplies, if the same input power source is used to provide power to two or more power supplies in the system, connection polarity must be identical at each power supply. A resulting difference in potential can injure personnel or cause damage to equipment. Also, each backplane must be connected to a common system ground.

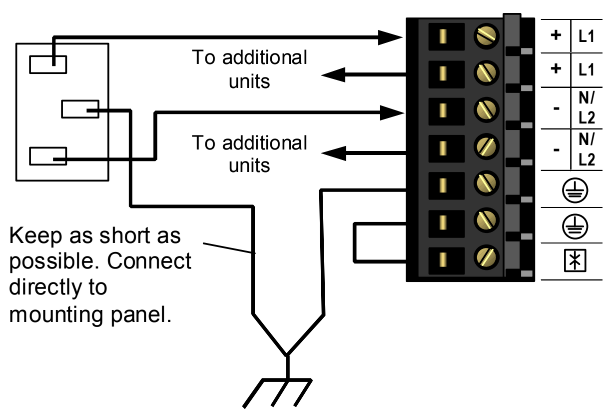
Power Supply Field Wiring

- For IC695 Power Supplies, each terminal accepts one AWG #14 to AWG #22 wire. The diagram below is a cross-section of one of the terminals on an IC695 Power Supply. The end of each wire should be stripped at least 3/8-inch (9mm). The terminal can accept a wire that is stripped up to 11 mm (.433 in) while providing full seating of the insulator. The wire must be fully-inserted into the terminal block as shown at left, so that the insulation meets the insulation stop position inside the terminal. Tightening the terminal screw pivots the clamp firmly against the stripped end of the wire, holding it in place. If the wire is not fully inserted, as shown on the right, tightening the clamp may push the wire upward, so that it is not connected.

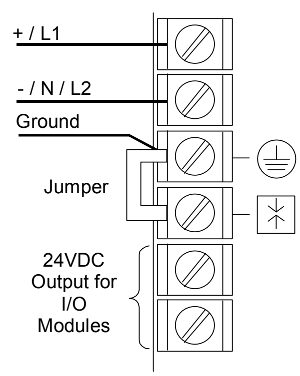


- For IC694 Power Supplies, each terminal accepts one AWG #14 (2.1mm^2) or two AWG #16 (1.3mm^2) copper 75°C (167°F) wires. The suggested torque for the Power Supply terminals is 12 in-lbs (1.36 Newton-meters). Each terminal can accept solid or stranded wires. Both the wires in any terminal should be the same type.

IC695 Power Supply Terminals



IC694 Power Supply Terminals



For Expansion (IC694) Power Supplies only, the bottom terminals provide access to the Expansion Backplane's Isolated +24V DC output, which can be used to power input circuits for certain IC694 modules. See the table of module load requirements in chapter 4 for information.

Caution

If the Isolated 24 VDC supply is overloaded or shorted, the PLC will stop operation.

AC Power Source Connections

Connect the hot and neutral wires or lines L1 and L2 to the appropriate Power Supply terminals.

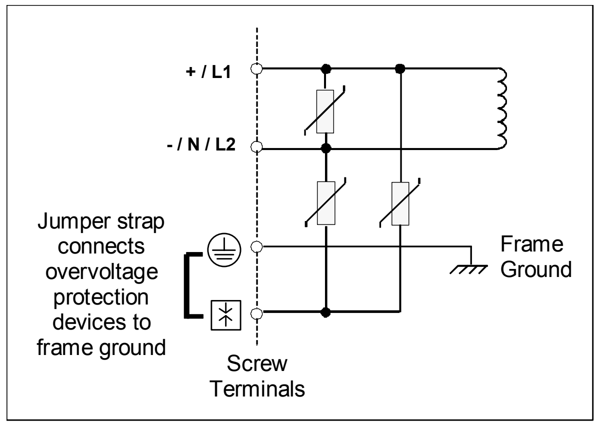
DC Power Source Connections

All RX3i Power Supplies have DC input capabilities. Connect the + and - wires from the DC source to the appropriate terminals. These connections are polarity-sensitive DC-only supplies.

Ground Connection

Connect the safety ground wire to the terminal marked with a ground symbol.

External Overvoltage Protection



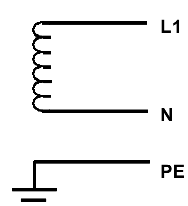
The Ground and MOV terminals on a Power Supply module are normally connected to frame ground with a user-installed jumper as shown at right. If overvoltage protection is not required or is supplied upstream, no jumper is needed.

In systems with a floating neutral input (the neutral line is not referenced to Protective Earth Ground), this jumper must NOT be installed. In addition, in a floating neutral system, voltage surge protection devices such as MOVs **must** be installed from L1 to earth ground, and from L2 (Neutral) to earth ground.

AC Power Supply Connections for Floating Neutral (IT) Systems

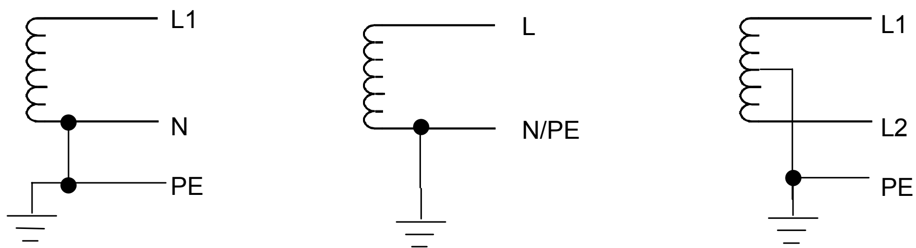
If an AC input power supply is installed in a system where the Neutral line is not referenced to Protective Earth Ground, special installation instructions must be followed to prevent damage to the power supply.

A *Floating Neutral System* is a system of power distribution wiring where Neutral and Protective Earth Ground are not tied together by a negligible impedance. In Europe this is referred to as an IT system (see IEC950). In a *Floating Neutral System*, voltages measured from input terminals to protective earth ground may exceed the 264 Volts AC maximum input voltage power supply specification.



Non-Floating Neutral System

Systems where one leg of the power distribution wiring is tied to Protective Earth or a tap between two legs of the power distribution wiring is tied to Protective Earth are not *Floating Neutral Systems*. Non-floating neutral systems **do not** require special installation procedures.



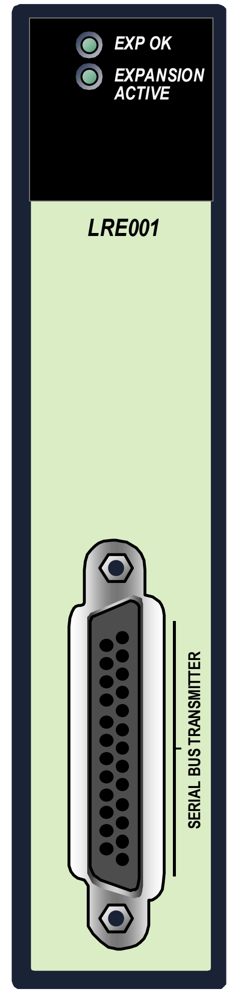
Instructions for Floating Neutral Systems

1. The input power terminals should be wired as shown previously.
2. No jumper may be installed jumper between terminals 3 and 4 of the Power Supply module.
3. Voltage surge protection devices such as MOVs must be installed:
   - From L1 to earth ground
   - From L2 (Neutral) to earth ground

The voltage surge devices must be rated such that the system is protected from power line transients that exceed *Line voltage + 100V +(N-PE)*$_{MAX.}$ The expression *N-PE* refers to the voltage potential between neutral and Protective Earth (PE) ground.

For example, in a 240 Volt AC system with neutral floating 50V above earth ground, the transient protection should be rated at: 240V + 100V + 50V= 390V

Serial Bus Transmitter Module



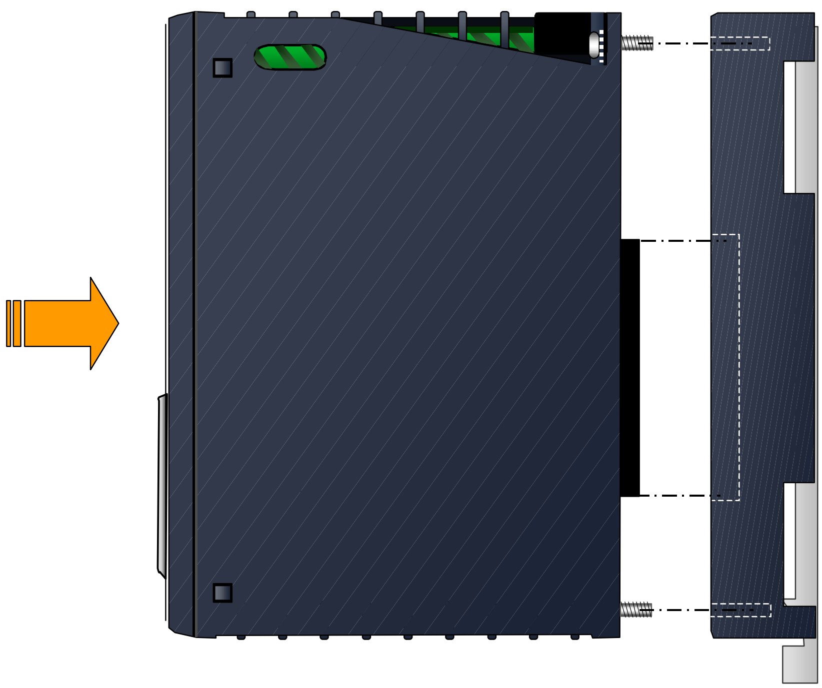
The RX3i Serial Bus Transmitter Module, IC695LRE001, provides communications between a PACSystems RX3i Universal Backplane (IC695-model number), and serial expansion and remote backplanes (IC694- or IC693-model numbers). It must reside in the expansion connector on the right end of a Universal Backplane.

Module Installation

This module may NOT be hot-inserted in the backplane; power must be removed before installing or removing the Bus Transmitter Module.

Insert the Serial Bus Transmitter Module straight into its slot as shown below. This module does not have the same pivoting and latching mechanisms as other RX3i modules.

Tighten the two captive screws in the corners of the module. Recommended torque is 4.4 in/lb maximum.*



Expansion Cable Installation

Subsequent backplanes in the system are linked by expansion cables as described in chapter 5. The expansion cable may not be attached or removed if the expansion rack has power applied.

Chapter 3 Backplanes

This section describes the following RX3i backplanes for PACSystems:

- 16 Slot RX3i Universal Backplane, IC695CHS016
- 12 Slot RX3i Universal Backplane, IC695CHS012
- 5 Slot RX3i Serial Expansion Backplane, IC694CHS398
- 10 Slot RX3i Serial Expansion Backplane, IC694CHS392

Backplane Types

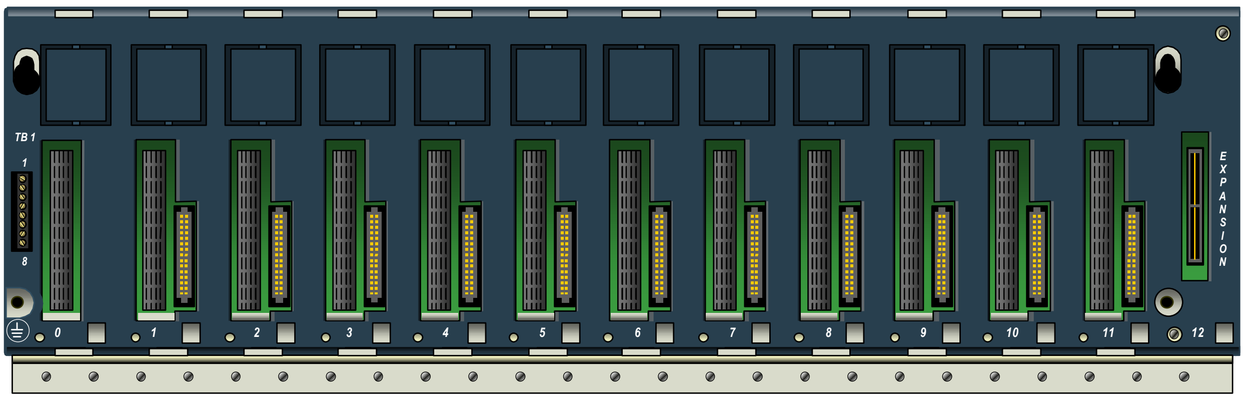
The following types of backplanes can be included in an RX3i system:

Backplane Type	***Catalog Number***
16 Slot RX3i Universal Backplane	IC695CHS016
12 Slot RX3i Universal Backplane	IC695CHS012
5 Slot RX3i Serial Expansion Backplane	IC694CHS398
10 Slot RX3i Serial Expansion Backplane	IC694CHS392
5 Slot Series 90-30 Expansion Backplane	IC693CHS398
10 Slot Series 90-30 Expansion Backplane	IC693CHS392
5 Slot Series 90-30 Remote Backplane	IC693CHS399
10 Slots Series 90-30 Remote Backplane	IC693CHS393

For information about Series 90-30 Expansion and Remote Backplanes, see GFK-0898, the *Series 90-30 PLC Installation Manual*.

RX3i Universal Backplanes: IC695CHS012, IC695CHS016

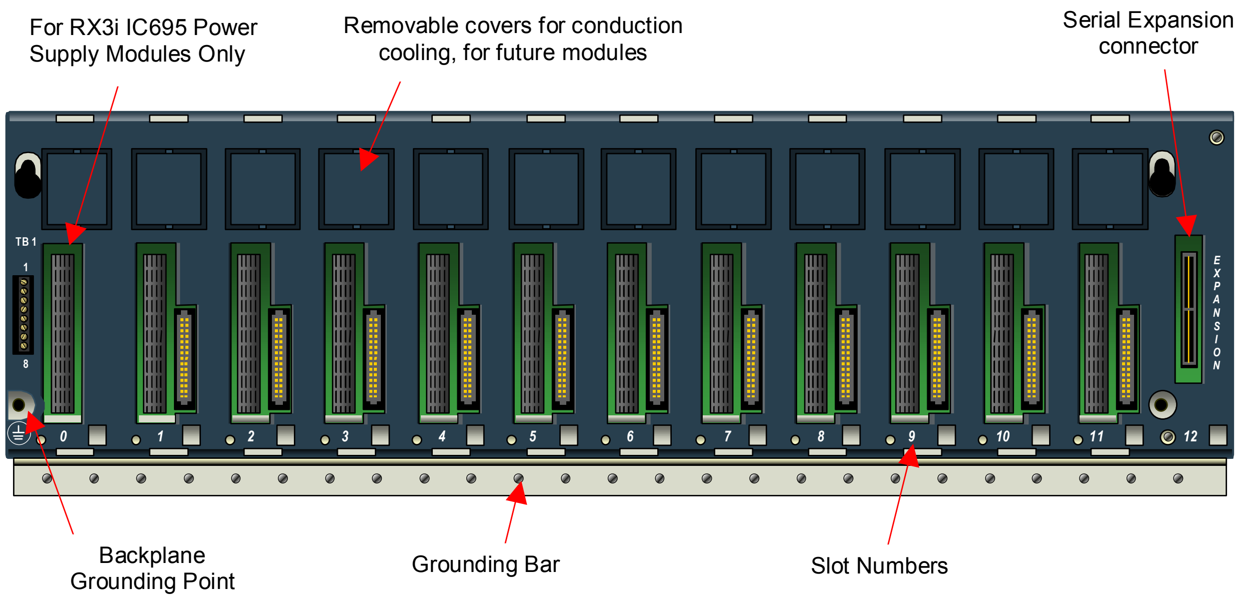
Two Universal Backplanes are available for RX3i PACSystems: the 16-slot Universal Backplane (IC695CHS016), and the 12-slot Universal Backplane (IC695CHS012), shown below.



The RX3i Universal Backplane supports both PCI (IC695) and serial (IC694) I/O and option modules with its dual-bus backplane. The RX3i Universal Backplane also supports 90-30 IO and option modules. See Chapter 1 for lists of supported modules.

RX3i modules (IC695 catalog numbers) communicate over the backplane's PCI bus. RX3i modules (IC694 catalog numbers) and Series 90-30 modules (IC693) communicate over the backplane's serial bus.

Universal Backplane Features



Features of the Universal Backplane include:

- Terminal Strip on the left end for future fan connection and Isolated +24V input
- Backplane grounding point as described in chapter 2
- An integral grounding bar for connecting module/shield grounds as described in chapter 2
- Removable covers that provide access for module conduction cooling (for future use).
- Serial Expansion connector for connection to Serial Expansion and Remote Backplanes
- Slot numbers are printed on the backplane and are used for reference for configuration in Machine Edition. Slots and connectors are described on the following pages. Most modules occupy one slot. Some, such as CPU modules and AC Power Supplies, are twice as wide, and occupy two slots.

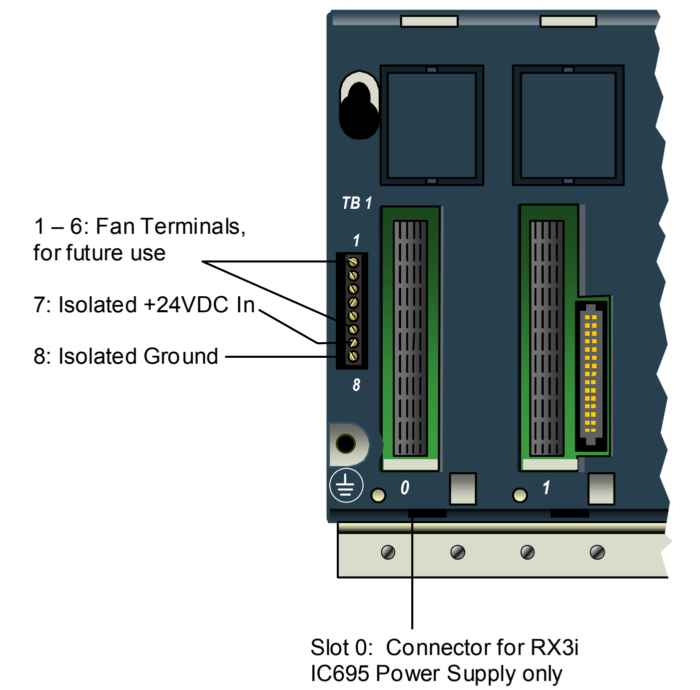
Universal Backplane TB1 Input Terminals

Terminals 1 through 6 on the left end of the Universal Backplane are reserved for external fan control (available in future systems).

The RX3i IC695 Power Supplies do not provide Isolated +24V output power over the backplane. Terminals 7 and 8 can be used to connect an optional external source of Isolated +24VDC, which is required for some IC693 and IC694 modules as listed in the table of Module Load Requirements in chapter 4.

These terminals accept individual wires from 14 to 22 AWG.

If modules that require Isolated +24VDC are installed in an Expansion Backplane instead, an external Isolated +24V power supply is not required.



Slot 0

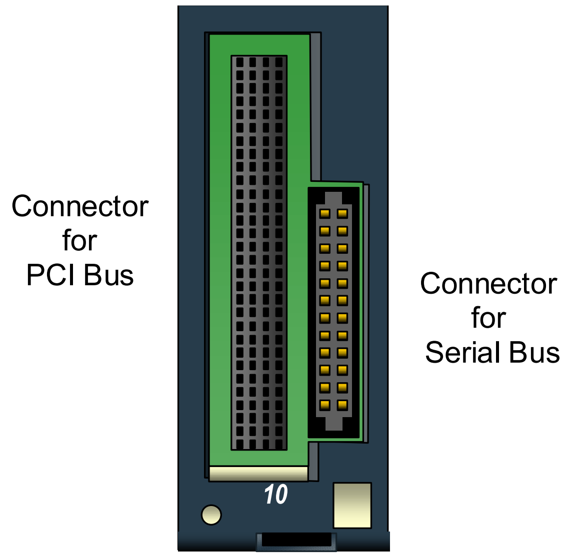
The leftmost slot in a Universal Backplane is slot 0. Only the backplane connector of IC695 Power Supplies can be installed in slot 0 (note: IC695 Power Supplies can be installed any slot). However two-slot wide modules that have right-justified connectors, like the CPU310 for example, can be plugged into slot 1and also cover slot 0.

The CPU is referenced for configuration and application logic by the leftmost slot occupied by the entire module, not by the slot the physical connector is located in. For example, if the CPU has its physical connector inserted in slot 3, the module occupies slots 2 and 3 and the CPU is referenced as being located in slot 2. The CPU may be located in slot 0 with its connector in slot 1.

Slot 1 to Slot 11 or 15

Slots 1 through 11 or 15 have two connectors as shown at right, a connector for the RX3i PCI bus and connector for the RX3i serial bus. Each of these slots can accept any type of compatible module: IC695 Power Supply, IC695 CPU, or IC695, IC694 and IC693 I/O or option modules.

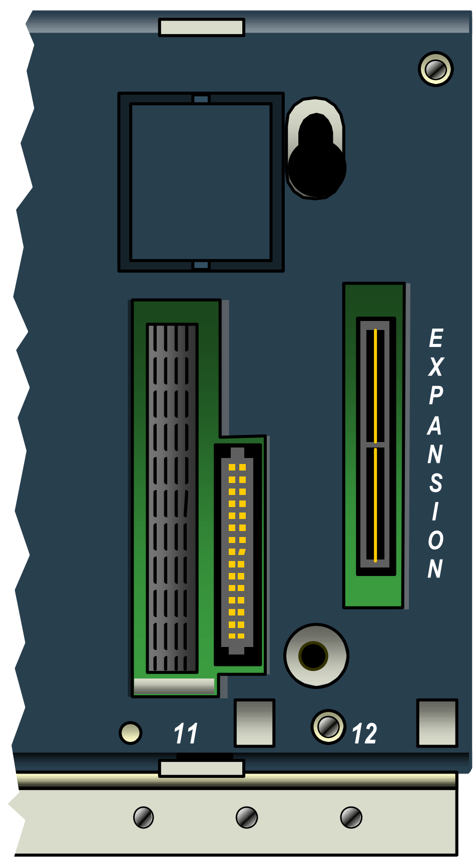
Provided the Hot Installation procedure described in chapter 2 is carefully followed, I/O and option modules in a Universal Backplane may be removed and replaced without powering-down.



Expansion Slot (Slot 12 or 16)

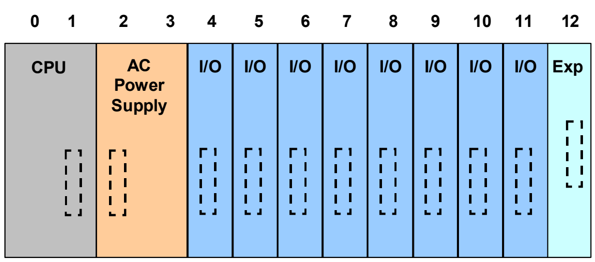
The rightmost slot in a Universal Backplane has a different connector than the other slots. It can only be used for an RX3i Serial Expansion Module (IC695LRE001).

An RX3i two-slot module cannot occupy this expansion slot.

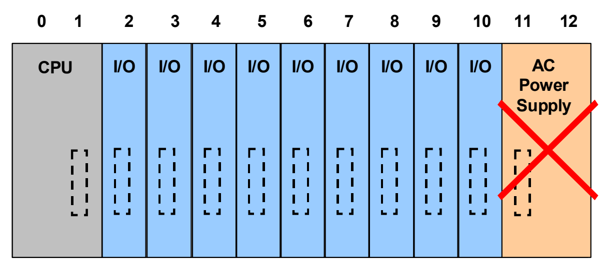


Module Locations in a Universal Backplane

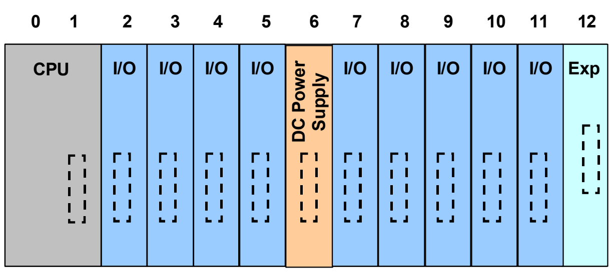
- IC695 Power Supply modules may be installed in any slot. DC Power Supplies IC695PSDx40 occupy 1 slot. AC Power Supplies IC695PSAx40 occupy 2 slots. RX3i (IC694) and Series 90-30 (IC693) Power Supplies cannot be installed in Universal Backplanes.
- An RX3i CPU module can be installed anywhere in the backplane except the Expansion slot. CPU modules occupy 2 slots.
- I/O and option modules can be installed in any available slot except slot 0, which can only accept IC695 Power Supplies, and the Expansion slot. Each I/O slot has two connectors, so either an RX3i PCI-based module or a serial module can be installed in any I/O slot.
- The rightmost slot is the expansion slot. It can only be used for optional serial expansion module IC695LRE001. See chapter 5 for information about the LRE001 Serial Expansion Module and expansion cables.



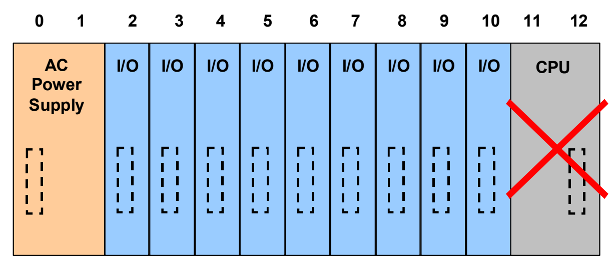
Configured as CPU in slot 0, Power Supply in slot 2



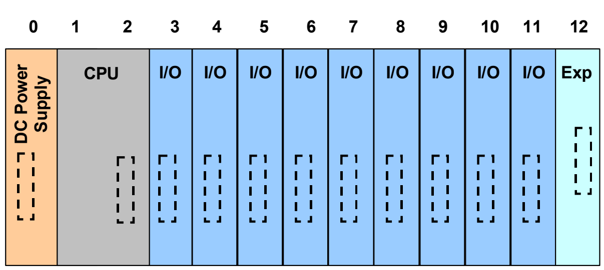
Invalid: AC Power Supply cannot be in Slot 11.



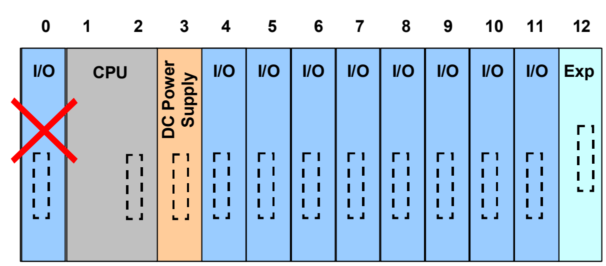
Configured as CPU in slot 0, Power Supply in slot 6



Invalid: CPU cannot be configured in slot 11



Configured as Power Supply in slot 0, CPU in slot 1



Invalid: Only a Power Supply can be installed in slot 0.

Locating the CPU in Slot 1

Installing the CPU in slot 1 means that only a singlewide power supply may be used in slot 0. Either DC power supply can be used (IC695PSD040 or IC695PSD140). If the application must maintain a slot 1 CPU and uses an AC power-supply, the RX3i AC power-supply must be located in a slot to the right of the RX3i CPU in slot 1.

Locating the CPU in a Slot Other than 1

Before deciding to place the CPU in a slot other than slot 1, it is important to consider possible issues that could arise, as explained below.

Communications: For Service Request #15 (Read Last-Logged Fault Table Entry) and Service Request #20 (Read Fault Tables), the location of CPU faults is not the standard 0.1 location, but the slot the CPU is located in. Logic that decodes fault table entries retrieved by these service requests may need updating.

COMMREQs directed to the CPU (e.g. those directed to the serial ports of the CPU) will need to be updated with the correct CPU slot reference.

Hardware Configuration: The slot location of the CPU must be updated in the hardware configuration to reflect the CPU's true location.

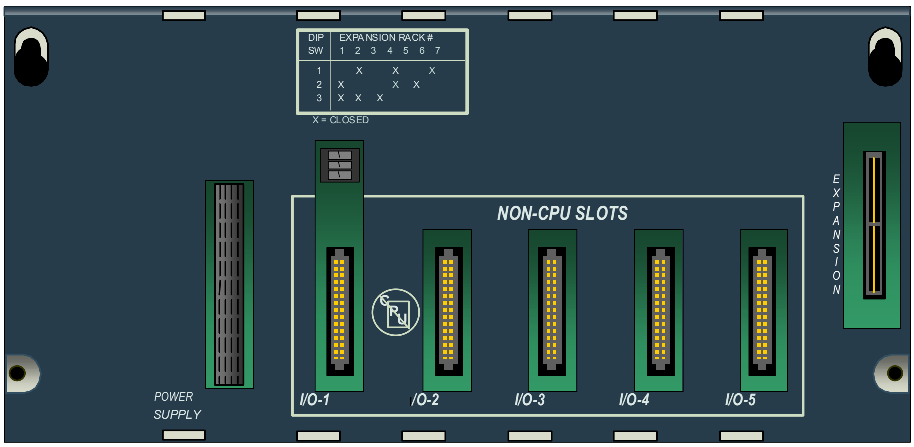
Fault Tables: Faults logged for the CPU in the fault table will reflect the CPU's actual slot.

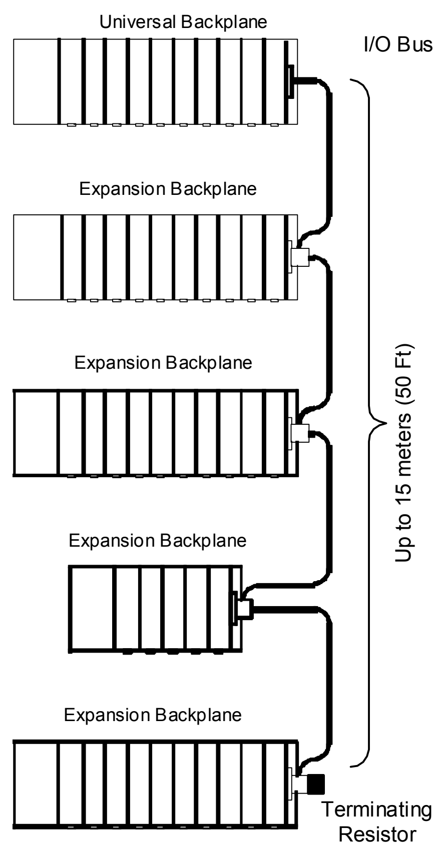
Remote Series 90 PLCs that use SRTP Channels COMMREQs expect the CPU to be in slot 1 or slot 2. To support communications with Series 90 SRTP clients such as Series 90 PLCs using SRTP Channels, the RX3i internally redirects incoming SRTP requests destined for {backplane 0, slot 1} to {backplane 0, slot 2}, provided that the CPU is located in backplane 0 slot 2 (and the remote client has not issued an SRTP Destination service on the connection to discover the backplane and slot of the CPU). This special redirection permits Series 90-30 applications that expect the power supply to be located leftmost and the CPU to be located to the right of the power supply to function. Attempts to establish channels with CPUs in slots other than 1 or 2 will fail if initiated from Series 90 PLCs.

All external communication devices that interact with the CPU should be checked for compatibility with CPU slot locations other than slot 1. Problems may arise with, but are not limited to, initial connection sequences and fault reporting.   Machine Edition View users should select "GE SRTP" as their communications driver – it can communicate with a CPU in any slot.

Serial Expansion Backplanes: IC694CHS392, IC694CHS398

The system can include any combination of up to seven RX3i Serial Expansion backplane and/or Series 90-30 Expansion/Remote Backplanes. RX3i Serial Expansion Backplanes are available with either 5 I/O slots (IC694CHS398, shown below) or 10 I/O slots (IC694CHS392).





- The leftmost module in an RX3i Serial Expansion Backplane must be a Serial Expansion Power Supply:
  - *IC694PWR321: Serial Expansion Power Supply, 120/240VAC, 125VDC*
  - *IC694PWR330: Serial Expansion Power Supply, 120/240VAC, 125VDC, High Capacity*
  - *IC694PWR331: Serial Expansion Power Supply, 24VDC, High Capacity*
- Module Hot Installation and Removal are NOT permitted on Expansion Backplanes.
- Each Expansion Backplane has a Rack Number Selection DIP switch that must be set before module installation. See chapter 2 for details.
- Each Expansion Backplane has a Bus Expansion connector at its right end for attaching an optional expansion cable. There can be no more than 50 feet (15 meters) of cable interconnecting Expansion backplanes with the Universal Backplane. If the system includes Series 90-30 Remote Backplanes, the additional requirements summarized in chapter 1 must also be observed.

Chapter 4 Power Supplies

This chapter describes Power Supplies for RX3i PACSystems:

Power Supply Type	***Catalog Number***
120/240 VAC, 125 VDC, 40 Watt Power Supply	IC695PSA040
120/240 VAC, 125 VDC, 40 Watt, Multi-Purpose Power Supply	IC695PSA140
24 VDC, 40 Watt Power Supply	IC695PSD040
24 VDC, 40 Watt Multipurpose Power Supply	IC695PSD140
120/240 VAC, 125 VDC, Serial Expansion Power Supply	IC694PWR321
120/240 VAC, 125 VDC, High Capacity Serial Expansion Power Supply	IC694PWR330
24 VDC, High Capacity Serial Expansion Power Supply	IC694PWR331

Power Supply Overview

This section provides a general description of the IC695 Power Supplies, which must be used in RX3i (IC695) Universal Backplanes, and IC694 Power Supplies, which must be used in RX3i Serial Expansion (IC694) Backplanes. Individual Power Supply specifications are listed in the sections that follow.

The IC695 Power Supplies provide up to 40 Watts each. The IC694 (Expansion) Power Supplies provide up to 30 Watts each. However, IC694PWR321 is limited to 15 Watts on the +5 VDC output.

The total of all outputs combined cannot exceed the stated load capacity in Watts. Machine Edition will automatically calculate the power consumption of modules as they are added to the system configuration. Power requirements of system modules are shown in this section, for reference when planning the system.

The maximum load for each type of Power Supply is shown below.

Catalog Number	***Can be Located In***	***Nominal Input***	***Load Capacity****	***Load Sharing, Redundancy***	***Maximum +3.3 VDC***	***Maximum +5 VDC***	***Maximum +24 VDC Isolated***	***Maximum +24 VDC Relay***
IC695PSA040	Universal Backplane	120/240 VAC or 125 VDC	40 Watts	No	30 Watts	30 Watts	--	40 Watts
IC695PSA140	Universal Backplane	120/240 VAC or 125 VDC	40 Watts	Yes	30 Watts	30 Watts	--	40 Watts
IC695PSD040	Universal Backplane	24 VDC	40 Watts	No	30 Watts	30 Watts	--	40 Watts
IC695PSD140	Universal Backplane	24 VDC	40 Watts	Yes	30 Watts	30 Watts	--	40 Watts
IC694PWR321	Serial Expansion Backplane	100/240 VAC or 125 VDC	30 Watts	No	--	15 Watts	20 Watts	15 Watts
IC694PRW330	Serial Expansion Backplane	100/240 VAC or 125 VDC	30 Watts	No	--	30 Watts	20 Watts	15 Watts
IC694PRW331	Serial Expansion Backplane	24 VDC	30 Watts	No	--	30 Watts	20 Watts	15 Watts

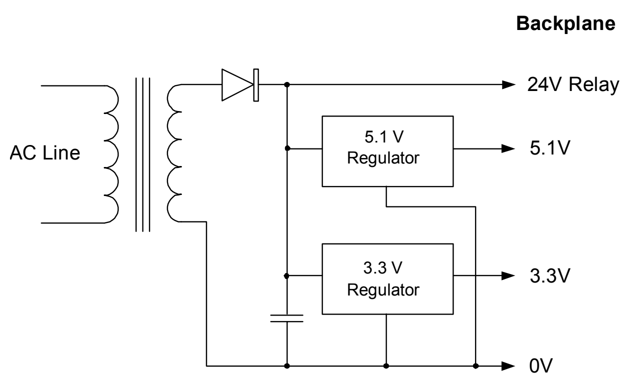
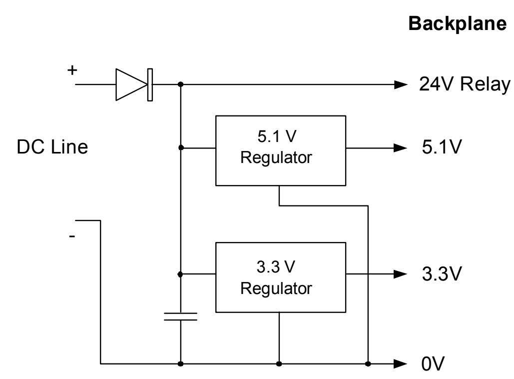
A power supply must be able to provide the total of the internal and external loads that may be placed upon it by all the hardware components in the backplane as well as the loads that may be connected to the Isolated +24 VDC supply on an expansion backplane.

24 VDC Isolated Power

The IC695 Power Supplies do not have Isolated +24 VDC output terminals. The RX3i Universal Backplane provides external input terminals (TB1) for connecting an optional Isolated +24 VDC external supply. Modules that draw +24 VDC from the backplane are listed in the table of Module Load Requirements that follows. (See Chapter 3 for more details on how to wire to TB1).

RX3i IC695 Power Supply Outputs

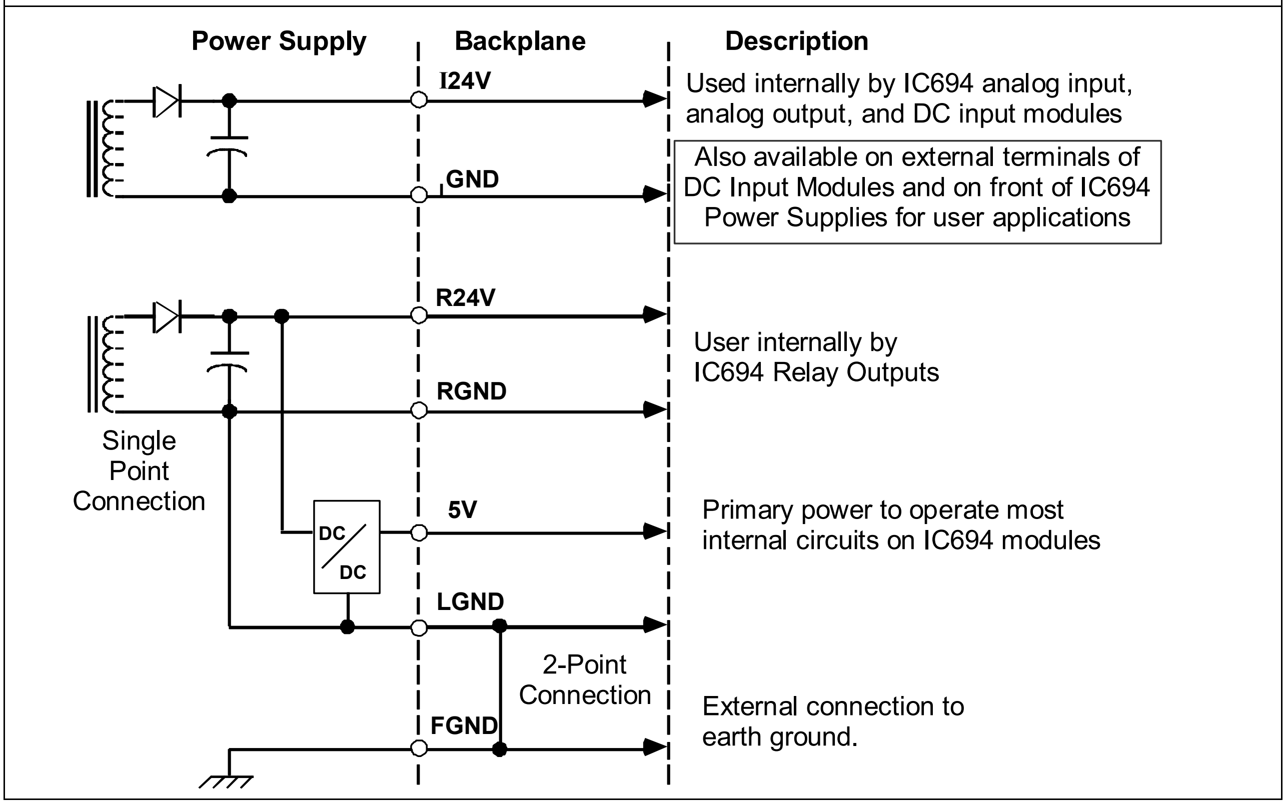
The IC695 power supplies have +5.1 VDC, +24 VDC Relay, and 3.3 VDC outputs that are connected internally on the backplane. The voltage and power required by modules installed on the backplane is supplied through the backplane connectors.

<table>
<tr><th>Outputs of Power Supply IC695PSA040</th><th>Outputs of Power Supply IC695PSD040 and 140</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Expansion Power Supply Outputs

The IC694 power supplies have +5 VDC, Relay +24 VDC and Isolated +24 VDC outputs that are connected internally on the backplane. The voltage and power required by modules installed on the backplane is supplied through the backplane connectors.

Outputs of Power Supplies IC694PWR321, IC694PWR330, and IC694PWR331



Module Load Requirements

The table below summarizes the maximum load requirements in milliamps and Watts for RX3i modules. For I/O modules, the actual load may depend on the number of points on at the same time.

Catalog Number	***Module***	***+3.3 VDC***		***+5 VDC***		***+24 VDC Relay***		***+24 VDC Isolated***	
		mA	***Watts***	***mA***	***Watts***	***mA***	***Watts***	***mA***	***Watts***
IC695CHS012	Universal Backplane, 12-Slot	600	1.98	240	1.20	--	--	--	--
IC695CHS016	Universal Backplane, 16-Slot	600	1.98	240	1.20	--	--	--	--
IC695CPU310	300MHz CPU 10 Meg memory	1250	4.125	1000	5.00	--	--	--	--
IC695ETM001	Ethernet Module	840	2.772	614	3.07	--	--	--	--
IC695LRE001	Expansion Module	--	--	132	1.60	--	--	--	--
IC694ACC300	Input Simulator	--	--	120	0.60	--	--	--	--
IC694ACC307	Expansion Bus Termination Plug	--	--	72	0.36	--	--	--	--
IC694ALG220	Analog Input, Voltage, 4 Ch.	--	--	27	0.135	--	--	98	2.352
IC694ALG221	Analog Input, Current, 4 Ch	--	--	25	0.125	--	--	100	2.4
IC694ALG222	Analog Input, 8/16 Ch Voltage	--	--	112	0.56	--	--	41	0.984
IC694ALG223	Analog Input, 8/16 Ch, Current	--	--	120	0.60	--	--	--	--
IC694ALG390	Analog Output 2 Ch Voltage	--	--	32	0.16	--	--	120	2.88
IC694ALG391	Analog Output 2 Ch Current	--	--	30	0.15	--	--	215	5.16
IC694ALG392	Analog Output 8 Ch Current/Voltage	--	--	110	0.55	--	--		
IC694ALG442	Analog Current/Voltage 4 Ch In / 2 Ch Out	--	--	95	0.475	--	--	129	3.096
IC695ALG600	Universal Analog Input Module	350	1.155	400	2.00	--	--	--	--
IC695ALG608	Analog Input 8/4 Ch. Voltage/Current	330	1.089	600	3.00	--	--	--	--
IC695ALG616	Analog Input 16/8 Ch. Voltage/Current	450	1.485	600	3.00	--	--	--	--
IC695ALG626	Analog Input 4 Ch. Voltage/Current with HART Communications	625	2.063	600	3.00	--	--	--	--
IC695ALG628	Analog Input 8 Ch. Voltage/Current with HART Communications	625	2.063	450	2.25	--	--	--	--
IC695ALG704	Analog Output, 4 Ch. Voltage/Current	375	1.238	--	--	--	--	--	--
IC695ALG708	Analog Output, 8 Ch. Voltage/Current	375	1.238	--	--	--	--	--	--
IC695ALG728	Analog Output, 8 Ch Voltage/Current with HART Communications enabled	380	1.255						
IC694APU300	High-Speed Counter	--	--	250	1.25	--	--	--	--
IC694APU305	Special I/O Processor (module only, +10mA per output on	--	--	360	1.80	--	--	--	--
IC694BEM320	I/O Link Interface Module with Optical Adapter	--	--	205 405	1.025 2.025	--	--	--	--
IC694BEM321	IO Link Master Module With Optical Adapter	--	--	415 615	2.075 3.075	--	--	--	--
IC694CHS392	Expansion/Remote Backplane, 10 Slot	--	--	150	0.75	--	--	--	--
IC694CHS398	Expansion/Remote Backplane, 5 Slot	--	--	170	0.85	--	--	--	--
IC694DSM314	Motion Controller	--	--	1300	6.50	--	--	--	--
IC694DSM324	Motion Controller (+ external encoder, if used)	--	--	860 +500	4.30 +2.50	--	--	--	--
IC694MDL230	120VAC Isolated, 8 Pt Input	--	--	60	0.30	--	--	--	--
IC694MDL231	240VAC Isolated 8 Pt Input	--	--	60	0.30	--	--	--	--

Catalog Number	Module	+3.3 VDC		+5 VDC		+24 VDC Relay		+24 VDC Isolated	
		mA	Watts	mA	Watts	mA	Watts	mA	Watts
IC694MDL240	120VAC 16 Pt Input	--	--	90	0.45	--	--	--	--
IC694MDL241	24VAC/DC Pos/Neg Logic 16 Pts	--	--	80	0.40	--	--	125	3.00
IC694MDL250	120VAC 16 Pt Isolated Input (all inputs on)			220	1.10				
IC694MDL260	120VAC 32 Pt Isolated Input (all inputs on)			220	1.10				
IC694MDL310	120VAC 0.5A 12 Pt Output (all outputs on)	--	--	210	1.05	--	--	--	--
IC694MDL330	120/240VAC 0.5A 16 Pt Output (all outputs on)	--	--	160	0.80	--	--	--	--
IC694MDL340	120VAC 0.5A 16 Pt Output (all outputs on)	--	--	315	1.575	--	--	--	--
IC694MDL350	124/240 VAC Isolated 16 Point Output (all outputs on)			315	1.575				
IC694MDL390	124/240VAC Isolated 2A 5Pt Out. (all outputs on)	--	--	110	0.55	--	--	--	--
IC694MDL632	125VDC Pos/Neg Logic 8 Pt Input	--	--	40	0.20	--	--	--	--
IC694MDL634	24VDC Pos/Neg Logic 8 Pt Input	--	--	45	0.225	--	--	62	1.488
IC694MDL645	24VDC Pos/Neg Logic 16 Pt Input	--	--	80	0.40	--	--	125	3.00
IC694MDL646	24VDC Pos/Neg Logic FAST 16 Pt	--	--	80	0.40	--	--	125	3.00
IC694MDL654	5/12VDC (TTL) Pos/Neg 32 Pts 195 = (29mA + 0.5mA/point ON + 4.7mA/LED ON) 440mA (maximum) from +5V bus on backplane (if module isolated +5V supply used to power inputs and all 32 inputs ON)	--	--	195/440	0.975 / 2.20	--	--	--	--
IC694MDL655	24VDC Pos/Neg 32 Pt Input (29mA +0.5mA/point ON +4.7mA/LED ON)	--	--	195	0.975	--	--	224 (typ)	5.376
IC694MDL660	24VDC Input 32 Pts Pos/Neg	--	--	300	1.50	--	--	--	--
IC694MDL732	12/24VDC Pos Logic 0.5A 8 Pt Out	--	--	50	0.25	--	--	--	--
IC694MDL734	125VDC Pos/Neg Logic 6 Pt Out. (all outputs on)	--	--	90	0.45	--	--	--	--
IC694MDL740	12/24 VDC Pos Logic 0.5A 16 Pt Out (all outputs on)	--	--	110	0.55	--	--	--	--
IC694MDL741	12/24VDC Neg Logic 0.5A 16 Pt Out.(all outputs on)	--	--	110	0.55	--	--	--	--
IC694MDL742	12/24VDC Pos Logic ESCP 1A 16 Pt Out.(all outputs on)	--	--	130	0.65	--	--	--	--
IC694MDL752	5/24VDC (TTL) Neg Logic 0.5A 32 Pt Output (13mA + 3 mA/point ON + 4.7 mA/LED)	--	--	260	1.30	--	--	--	--
IC694MDL753	12/24VDC Pos Logic 0.5A 32 Pt Output (13mA + 3mA/point ON + 4.7mA/LED)	--	--	260	1.3	--	--	--	--
IC694MDL754	24VDC High-density Output 32 Pt	--	--	300	1.50	--	--	--	--
IC694MDL930	Relay NO 4A Isolated 8 Pt Output (all outputs on)	--	--	6	0.03	70	1.68	--	--
IC694MDL931	Relay NC and Form C 8 A Isolated 8 Pt Output (all outputs on)	--	--	6	0.03	110	2.64	--	--
IC694MDL940	Relay NO 2A 16 Pt Output (all outputs on)	--	--	7	0.035	135	3.24	--	--

Power Supply Loading Example

To determine the total load placed on a Power Supply, add the current requirements of each module and the backplane.

For example:

Catalog Number	Module	+3.3 VDC	+5.1 VDC	+24 VDC Relay	+24 VDC Isolated*
IC695CPU310	300MHz CPU 10 Meg memory	1250	1000	--	--
IC695CHS012	Universal Backplane, 12-Slot	600	240	-	-
IC695ETM001	Ethernet Module	840	614	--	--
IC695LRE001	Expansion Module	--	132	-	-
IC694ALG220	Analog Input, Voltage, 4 Ch.		27	-	98*
IC694ALG390	Analog Output 2 Ch Voltage		32	-	120*
IC694ALG442	Analog Current/Voltage 4 Ch In / 2 Ch Out	--	95		
IC694APU300	High-Speed Counter	-	250	-	-
IC694MDL340	120VAC 0.5A 16 Pt Output	-	315	-	-
IC694MDL230	120VAC Isolated, 8 Pt Input	--	60		
IC694MDL240	120VAC 16 Pt Input	--	90		
IC694MDL930	Relay NO 4A Isolated 8 Pt Output (all outputs on)	--	6	70	
IC694MDL931	Relay NC and Form C 8 A Isolated 8 Pt Output (all outputs on)	--	6	110	
	Total Amps	2.690	2.867	0.180	
	Converted to Watts	(x3.3V)	(x5.1V)	(x24V)	
	Power Consumption from Power Supply	=8.877W	=14.622W	=4.32W	
Total Power Consumption from Power Supply		8.877 + 14.622 + 4.32 = 27.817			

At ambient temperatures up to 32°C, Power Supply IC695PSA040 provides the following power outputs:

- 40 Watts maximum total
- 5.1VCD = 30 Watts maximum
- 3.3VDC = 30 Watts maximum

In this example, all of the module power requirements are met by Power Supply PSA040. Because the Universal Backplane and IC695 power supply do not provide +24 VDC Isolated power, an external +24 VDC supply will be required for analog modules ALG220, ALG221 and ALG222.

Load Sharing / Redundancy

To meet the power needs of the application, as many as four Multipurpose Power Supplies can be installed in a Universal Backplane. These Power Supplies can be combined to provide:

- Load Sharing
- Power Supply Module Redundancy
- Power Source Redundancy

No other types of RX3i power supply can be included in these applications.

Load Sharing

Multi-Purpose Power Supplies can be combined into load sharing applications, The following rules must be observed:

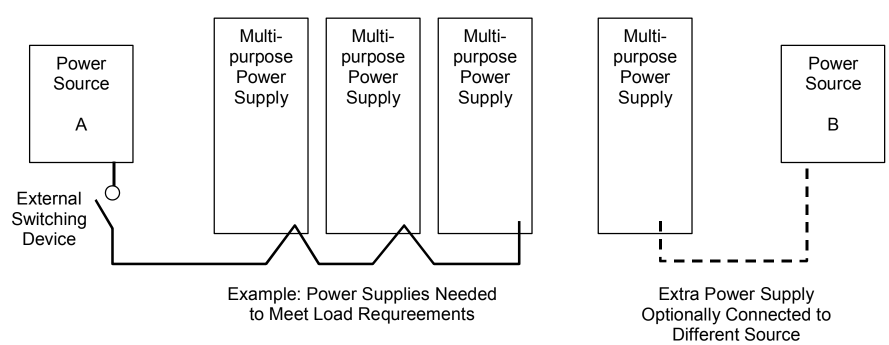
If multiple power supplies are required to meet the system load requirements, Multipurpose Power Supplies must be wired to the same power source in such a way that they all can be powered up or powered down simultaneously. The On/Off front panel switch on each of the power supplies must be left in the On position.

Caution

In a load-sharing application, it is important to ensure that the load-sharing power supply modules' On/Off switches cannot be inadvertently used. The minimum number of power supplies needed to meet the system power requirements MUST have their switches always kept in the On position. Also, the load-sharing power supplies must be connected to the system power source through the same external switch. The system must be powered up and powered down only from the external switch. If individual power supplies are powered up or powered down using their On/Off switches *or separate external switches*, resulting in insufficient power capacity, equipment damage may result. It may be necessary to re-load the PLC operating system to resume operation.

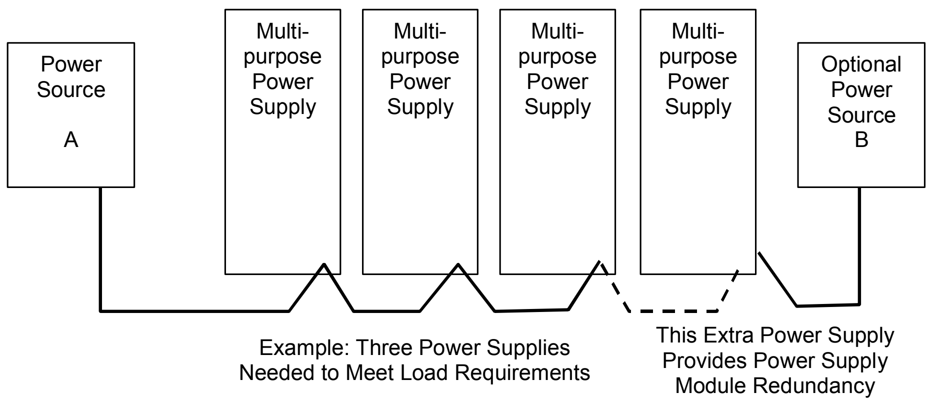
Connections for Load Sharing

In load-sharing installations, additional Multipurpose Power Supplies above the minimum required for the system load may be wired to the same power source, or a different source.



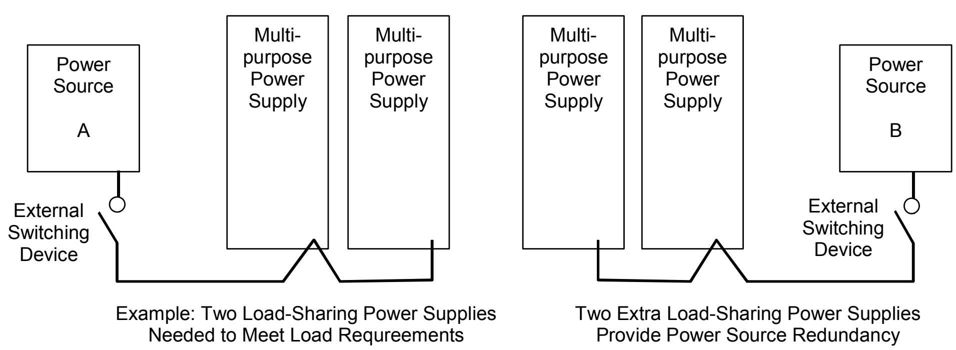
Connections for Power Supply Module Redundancy

Power Supply module redundancy can be provided by using one additional Multipurpose Power Supply above the minimum required for the system power load. In this type of installation, all Multipurpose Power Supplies contribute a share of the backplane power and run at a correspondingly reduced load. This results in longer life for the individual power supplies. In addition, should one power supply module fail, system operation is not interrupted. The front panel switch can be used to remove a redundant unit. Note that this type of system does not provide protection against loss of the input power source. If more than one power supply is switched off, the remaining power supplies may become overloaded and shut down. An External switching device must be used to remove power from more than one power supply at a time in the Power Supply Redundancy mode.



Power Source Redundancy

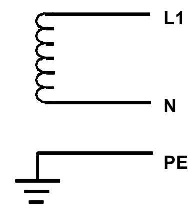
If the overall power needs of the system can be met using either one or two Multipurpose Power Supplies, then power source redundancy can be provided. This requires using twice the minimum number of Multipurpose Power Supplies required to meet the system load requirements. In this type of system, half of the Multipurpose Power Supplies must be connected to one power source and the other half must be connected to a separate source. This arrangement provides all the advantage of a Basic Redundancy system, as described above, plus power source redundancy. The front panel switch may be used to remove an individual power supply as long as the minimum number of units remain powered up.



AC Power Supply Connections for Floating Neutral (IT) Systems

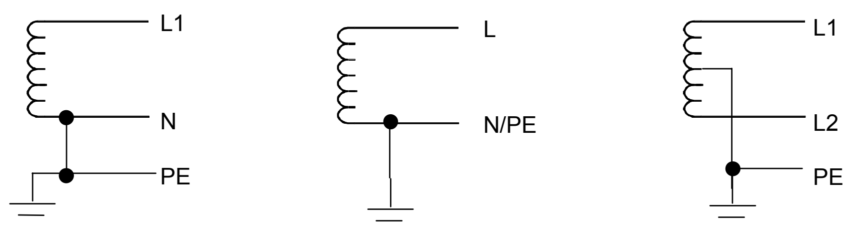
If an AC input power supply is installed in a system where the Neutral line is not referenced to Protective Earth Ground, special installation instructions must be followed to prevent damage to the power supply.

A *Floating Neutral System* is a system of power distribution wiring where Neutral and Protective Earth Ground are not tied together by negligible impedance. In Europe this is referred to as an IT system (see IEC950). In a *Floating Neutral System*, voltages measured from input terminals to protective earth ground may exceed the 264 Volts AC maximum input voltage power supply specification.



Non-Floating Neutral System

Systems where one leg of the power distribution wiring is tied to Protective Earth or a tap between two legs of the power distribution wiring is tied to Protective Earth are not *Floating Neutral Systems*. Non-floating neutral systems **do not** require special installation procedures.



Instructions for Floating Neutral Systems

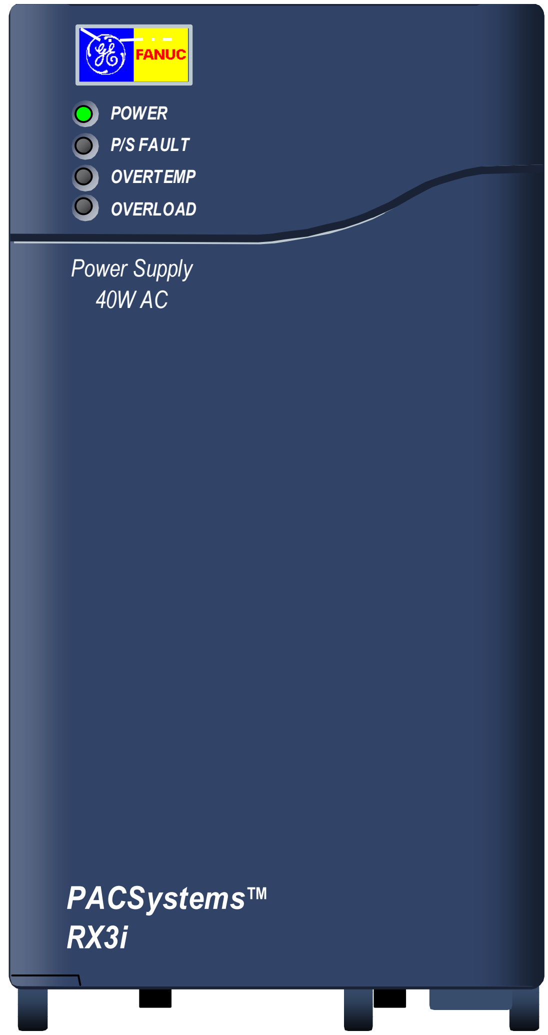
1. The input power terminals should be wired according to the instructions in this chapter.
2. For IC695 Power Supplies, no jumper may be installed between terminal 5 or 6 and terminal 7. For IC694 or IC693 Power Supplies. no jumper may be installed jumper between terminals 3 and 4 of the Power Supply module.
3. Voltage surge protection devices such as MOVs must be installed:
   - From L1 to earth ground
   - From L2 (Neutral) to earth ground

The voltage surge devices must be rated such that the system is protected from power line transients that exceed *Line voltage + 100V +(N-PE)$_{MAX.}$* The expression *N-PE* refers to the voltage potential between neutral and Protective Earth (PE) ground.

For example, in a 240 Volt AC system with neutral floating 50V above earth ground, the transient protection should be rated at: 240V + 100V + 50V = 390V

Power Supply, 120/240 VAC or 125 VDC, 40 Watt: IC695PSA040

Power Supply IC695PSA040 is a 40-Watt supply that operates from an input voltage source in the range of 85 to 264 VAC or 100 VDC to 300 VDC.



This power supply provides three outputs:

- +5.1 VDC output,
- +24 VDC relay output that can be used to power circuits on Output Relay modules.
- +3.3 VDC. This output is used internally by RX3i modules with IC695 catalog numbers.

Caution

Only one IC695PSA040 can be used in a PACSystems RX3i (IC695 catalog number) Universal Backplane. This Power Supply cannot be used with other RX3i power supplies in redundant or increased capacity modes. Power Supply version IC695PSA040C and before may cause equipment damage if inadvertently installed in the same backplane as another RX3i power supply.

If the number of modules required exceeds the capacity of the Power Supply, the additional modules must be installed in Expansion or Remote backplanes.

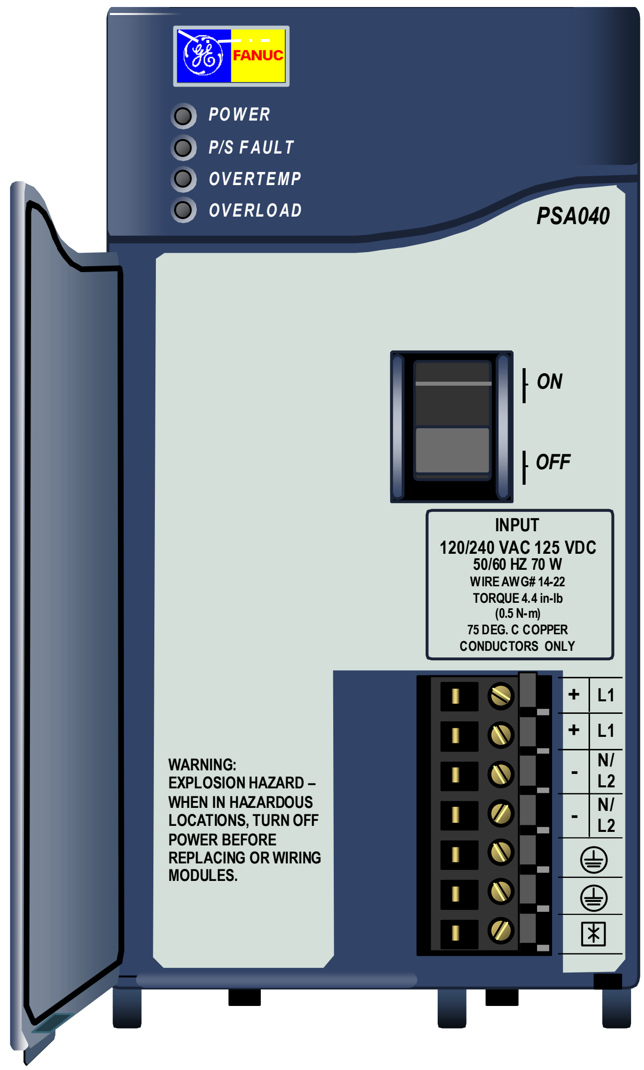
The Power Supply indicates when an internal fault occurs so the CPU can detect loss of power or log the appropriate fault code.

LEDs

Four LEDs on the Power Supply indicate:

- Power (Green/Amber). When this LED is green, it indicates power is being supplied to the backplane. When this LED is amber, power is applied to the Power Supply but the Power Supply switch is off.
- P/S Fault (Red). When this LED is lit, it indicates the Power Supply has failed and is no longer supplying sufficient voltage to the backplane.
- Over Temperature (Amber). When this LED is lit, it indicates the Power Supply is near or exceeding its maximum operating temperature.
- Overload (Amber). When this LED is lit, it indicates the Power Supply is near or exceeding its maximum output capability on at least one of its outputs.

The CPU Fault Table shows a fault if any Overtemperature, Overload, or P/S Fault occurs.



On/Off Switch

The ON/OFF switch is located behind the door on the front of the module. The switch controls the operation of the outputs of the supply. It does NOT interrupt line power. Projecting tabs next to the switch help prevent accidentally turning it on or off.

Wiring Terminals

Terminals for power, ground, and MOV disconnect accept individual 14 to 22 AWG wires.

Specifications: IC695PSA040

Nominal Rated Voltage **Input Voltage Range** **AC** **DC**	120/240 VAC or 125 VDC 85 to 264 VAC 100 to 300 VDC
Input Power (Maximum with Full Load) **Inrush Current**	70 Watts maximum 4 Amps, 250 milliseconds maximum *
Output Power	40 Watts maximum total 5.1 VDC = 30 Watts maximum 3.3 VDC = 30 Watts maximum The maximum total output power available depends on the ambient temperature, as shown.
Output Voltage	24 VDC: 19.2 VDC to 28.8 VDC 5.1 VDC: 5.0 VDC to 5.2 VDC (5.1 VDC nominal) 3.3 VDC: 3.1 VDC to 3.5 VDC (3.3 VDC nominal)
Output Current	24 VDC: 0 to 1.6 Amps 5.1 VDC: 0 to 6 Amps 3.3 VDC: 0 to 9 Amps
Isolation (input to backplane):	250 VAC continuous; 1500 VAC for 1 minute
Ripple (all outputs)	150 mV
Noise (all outputs)	150 mV
Ride-through time	20 ms. This is the length of time the Power Supply maintains valid outputs if the power source is interrupted
Wiring Terminals	Each terminal accepts one 14 AWG to 22 AWG wire.
Current per Terminal	6 Amps
Number of Daisy-Chained PSA040 Supplies	Up to 4

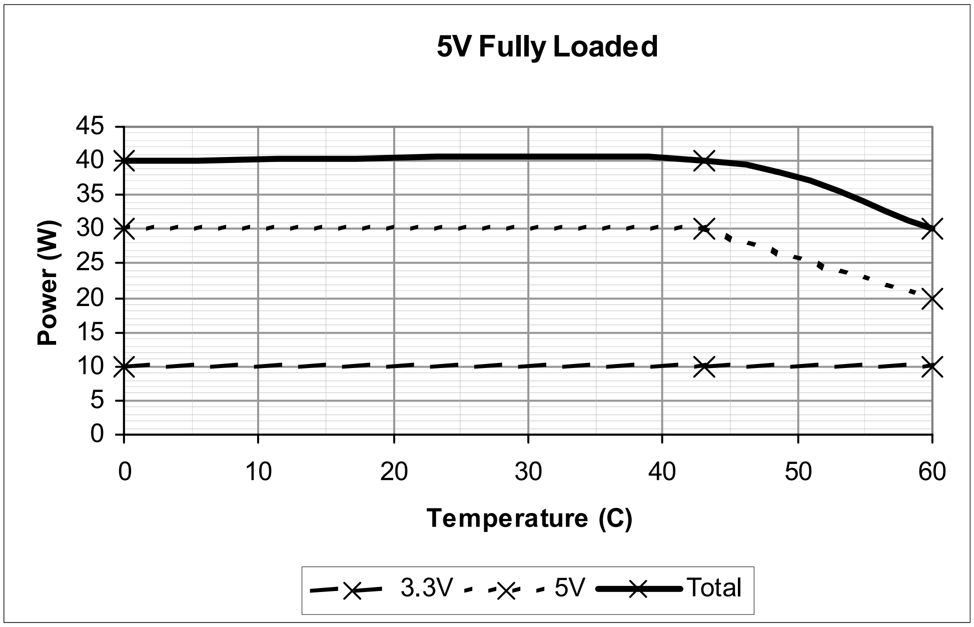
* The Inrush Current specification is given as a guide for sizing the external power source for the IC695PSA040. Peak inrush current may be higher for shorter durations.

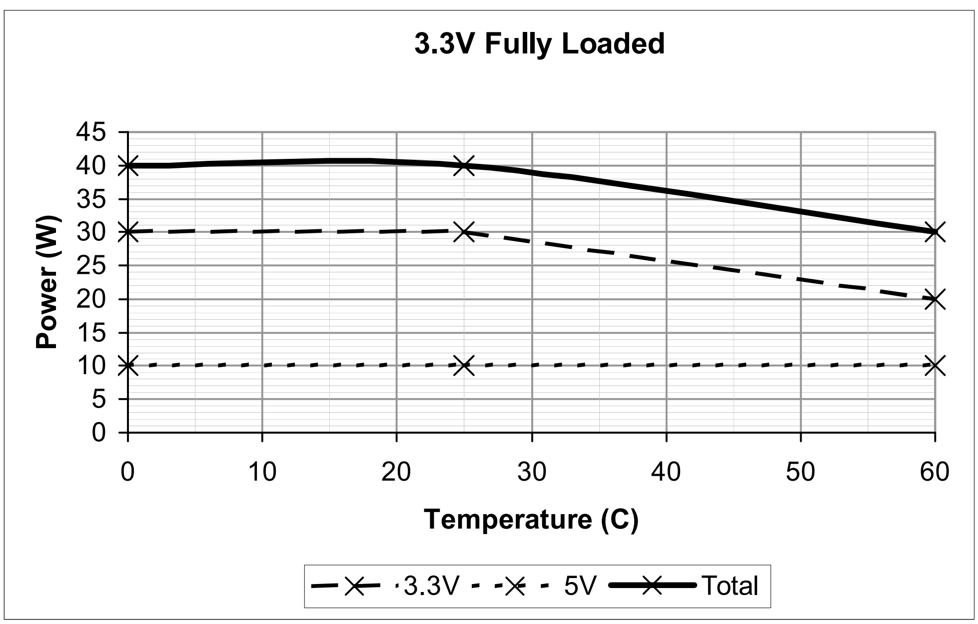
Warning

The power supply's door must be closed. During normal operation with an AC power source either 120 VAC or 240 VAC is present on the AC Power Supply. The door protects against accidental shock hazard that could cause severe or fatal injury to personnel.

Thermal Deratings

The maximum output power for Power Supply PSA040 depends on the ambient temperature, as shown below. Full output power is available up to at least 32°C (89.6°F).





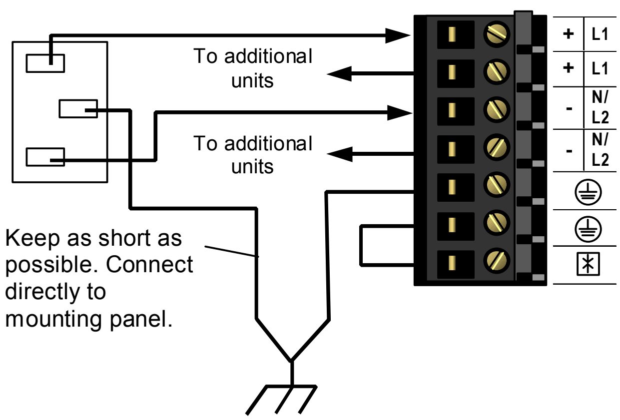
Overcurrent Protection

The 5.1 VDC output is electronically limited to 7 Amps. The 3.3 VDC output is limited to 10 Amps. If an overload (including short circuits) occurs, it is sensed internally and the Power Supply shuts down. The Power Supply continually tries to restart until the overload condition is removed. An internal, non-repairable, fuse in the input line is provided as a backup. The Power Supply usually shuts down before the fuse blows. The fuse also protects against internal supply faults The CPU Fault Table shows a fault if any Overtemperature, Overload, or P/S Fault occurs. There is no additional indication if the Power Supply fuse blows

Field Wiring: IC695PSA040

Power Source and Ground Connections

The wires from the power source and ground connect to the terminals on the Power Supply as shown at right. Each terminal accepts one AWG 14 to AWG 22 wire.



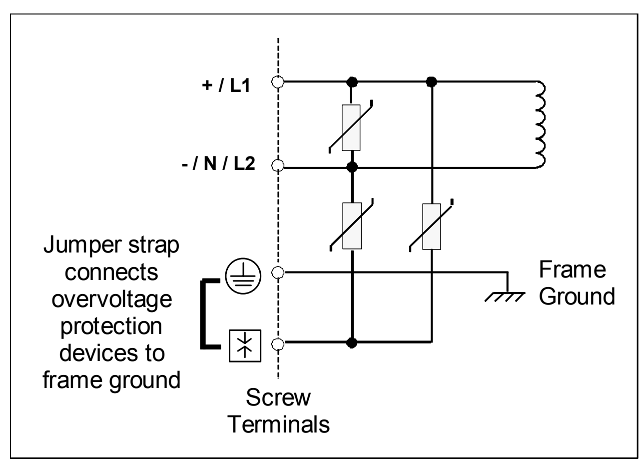
Warning

If the same external AC power source is used to provide power to two or more RX3i power supplies in the system, connection polarity must be identical at each power supply. A resulting difference in potential can injure personnel or cause damage to equipment. Also, each backplane must be connected to a common system ground.

Input Overvoltage Protection

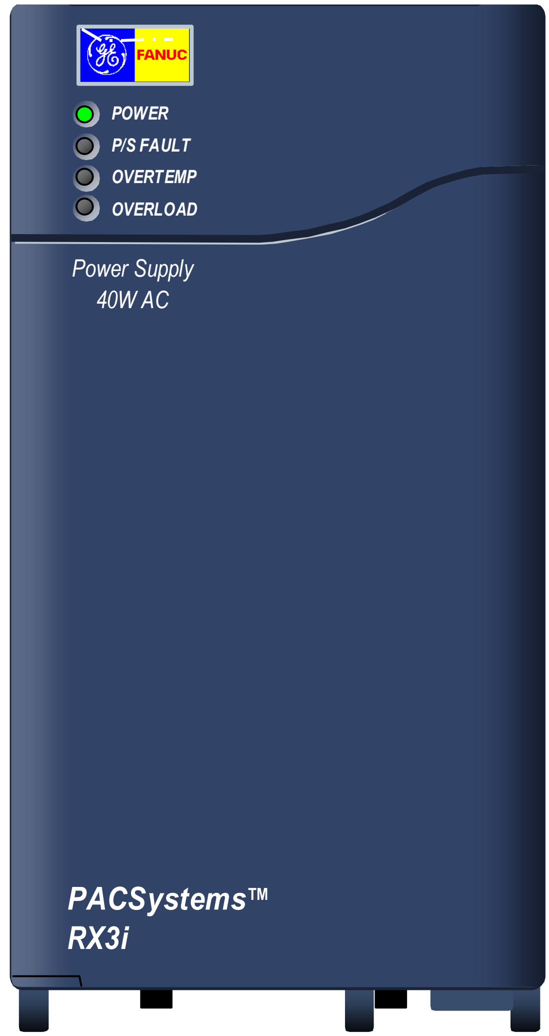
The bottom terminal is normally connected to frame ground with a user-installed jumper as shown lower right. If overvoltage protection is not required or is supplied upstream, no jumper is needed.

To Hi-pot test this supply, overvoltage protection must be disabled during the test by removing the jumper.   Re-enable overvoltage protection after testing by reinstalling the jumper.



In systems with a floating neutral input (the neutral line is not referenced to Protective Earth Ground), this jumper must NOT be installed. In addition, in a floating neutral system, voltage surge protection devices such as MOVs **must** be installed from L1 to earth ground, and from L2 (Neutral) to earth ground.

Multi-Purpose Power Supply, 120/240 VAC or 125 VDC, 40 Watt: IC695PSA140



Power Supply IC695PSA140 is a multi-purpose 40-Watt supply that operates from an input voltage source in the range of 85 to 264 VAC or 100 VDC to 300 VDC.

This power supply provides three outputs:

- +5.1 VDC output,
- +24 VDC relay output that can be used to power circuits on Output Relay modules.
- +3.3 VDC. This output is used internally by RX3i modules with IC695 catalog numbers.

This Power Supply is suitable for use in load-sharing and redundancy applications. Up to 4 Multi-purpose power supplies (PSA140 and/or PSD140) can be used in a PACSystems RX3i (IC695 catalog number) Universal Backplane. Use these Power Supplies if the number of modules required exceeds the capacity of one Power Supply. This Power Supply occupies two backplane slots.

The Power Supply indicates when an internal fault occurs so the CPU can detect loss of power or log the appropriate fault code.

Caution

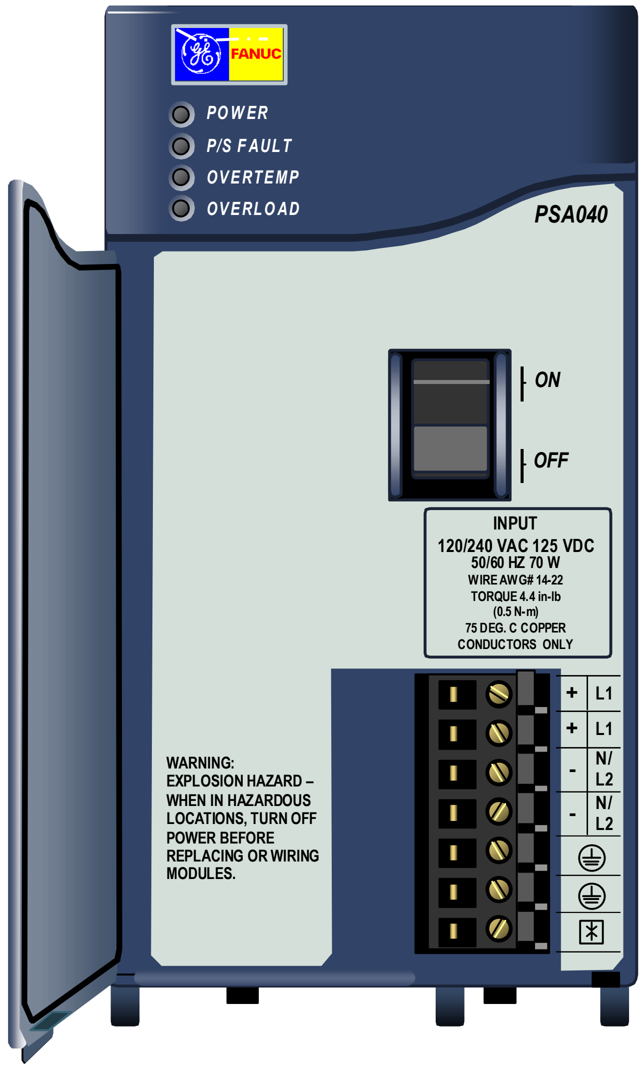
This Power Supply cannot be used with RX3i IC695PSD040 or IC695PSA040 Power Supplies in redundant or increased capacity modes. Damage to equipment may result.

LEDs

Four LEDs on the Power Supply indicate:

- Power (Green/Amber). When this LED is green, it indicates power is being supplied to the backplane. When this LED is amber, power is applied to the Power Supply but the Power Supply switch is off.
- P/S Fault (Red). When this LED is lit, it indicates the Power Supply has failed and is no longer supplying sufficient voltage to the backplane.
- Over Temperature (Amber). When this LED is lit, it indicates the Power Supply is near or exceeding its maximum operating temperature.
- Overload (Amber). When this LED is lit, it indicates the Power Supply is near or exceeding its maximum output capability on at least one of its outputs.

The CPU Fault Table shows a fault if any Overtemperature, Overload, or P/S Fault occurs.



On/Off Switch

The ON/OFF switch is located behind the door on the front of the module. The switch controls the operation of the outputs of the supply. It does NOT interrupt line power. Projecting tabs next to the switch help prevent accidentally turning it on or off.

Wiring Terminals

Terminals for power, ground, and MOV disconnect accept individual 14 to 22 AWG wires.

Specifications: IC695PSA140

Nominal Rated Voltage **Input Voltage Range** **AC** **DC**	120/240 VAC or 125 VDC 85 to 264 VAC 100 to 300 VDC
Input Power **(Maximum with Full Load)** **Inrush Current**	 70 Watts maximum 4 Amps, 250 milliseconds maximum *
Output Power	40 Watts maximum total 5.1 VDC = 30 Watts maximum 3.3 VDC = 30 Watts maximum The maximum total output power available depends on the ambient temperature, as shown.
Output Voltage	24 VDC: 19.2 VDC to 28.8 VDC 5.1 VDC: 5.0 VDC to 5.2 VDC (5.1 VDC nominal) 3.3 VDC: 3.1 VDC to 3.5 VDC (3.3 VDC nominal)
Output Current	24 VDC: 0 to 1.6 Amps 5.1 VDC: 0 to 6 Amps 3.3 VDC: 0 to 9 Amps
Isolation (input to backplane):	250 VAC continuous; 1500 VAC for 1 minute
Ripple (all outputs)	150 mV
Noise (all outputs)	150 mV
Ride-through time	20 ms. This is the length of time the Power Supply maintains valid outputs if the power source is interrupted
Wiring Terminals	Each terminal accepts one 14 AWG to 22 AWG wire.
Current per Terminal	6 Amps
Number of Daisy-Chained PSA140 Supplies	Up to 4
Number of PSA140 Power Supplies in Universal Backplane	Up to 4

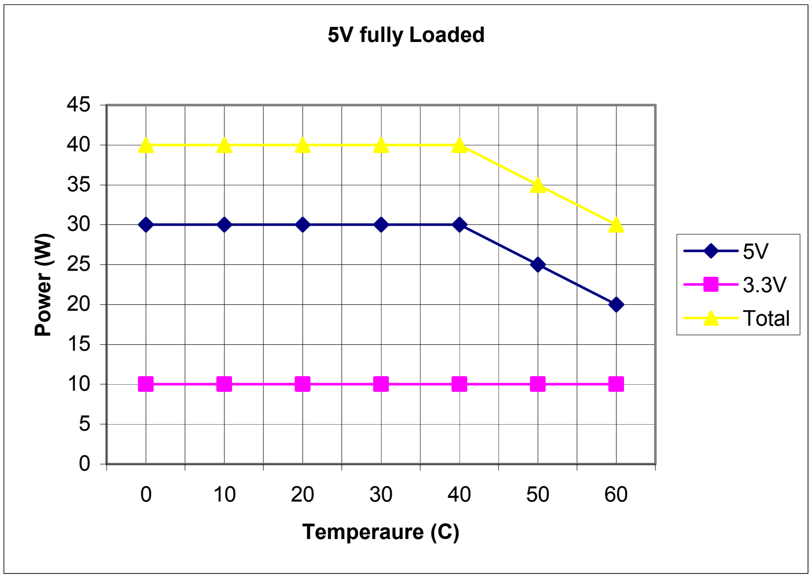
* The Inrush Current specification is given as a guide for sizing the external power source for the IC695PSA140. Peak inrush current may be higher for shorter durations.

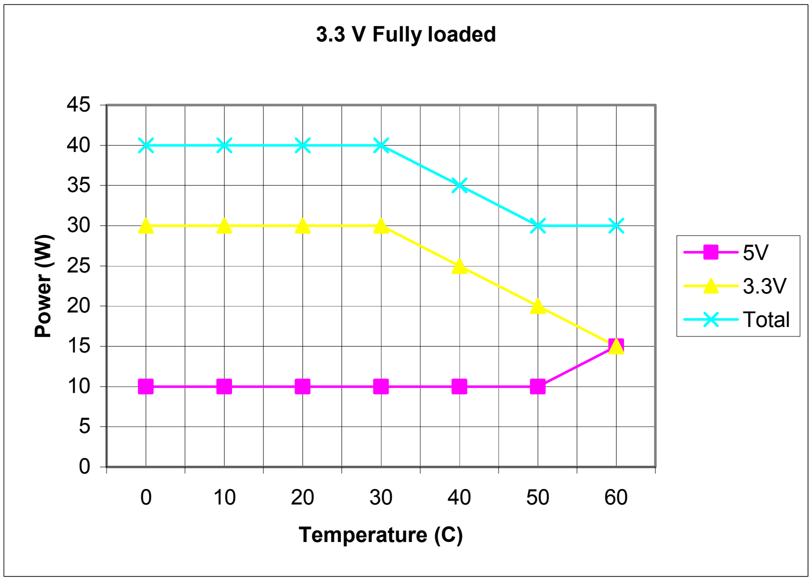
Warning

The power supply's door must be closed. During normal operation with an AC power source either 120 VAC or 240 VAC is present on the AC Power Supply. The door protects against accidental shock hazard that could cause severe or fatal injury to personnel.

Thermal Deratings: PSA140

The maximum output power for Power Supply PSA140 depends on the ambient temperature, as shown below.

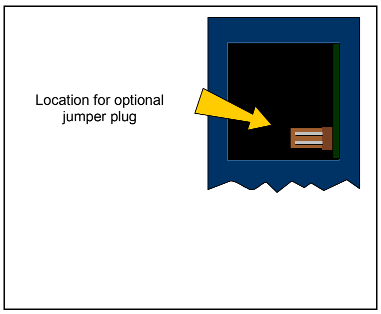




Overcurrent Protection

The 5.1 VDC output is electronically limited to 7 Amps. The 3.3 VDC output is limited to 10 Amps. If an overload (including short circuits) occurs, it is sensed internally and the Power Supply shuts down. Because it is designed for redundancy applications, this Power Supply latches "OFF" in fault conditions and will not automatically try to restart until the overload condition is removed. Input power must be cycled to clear a latched fault. However, if the Power Supply is used in a non-redundant application where automatic restarting is required, a jumper plug can be installed.

An internal fusable linke in the input line is provided as a backup. The Power Supply usually shuts down before the fusable linke blows. The fusable linke also protects against internal supply faults. The CPU Fault Table shows a fault if any Overtemperature, Overload, or P/S Fault occurs. There is no additional indication if the Power Supply fusable linke blows.

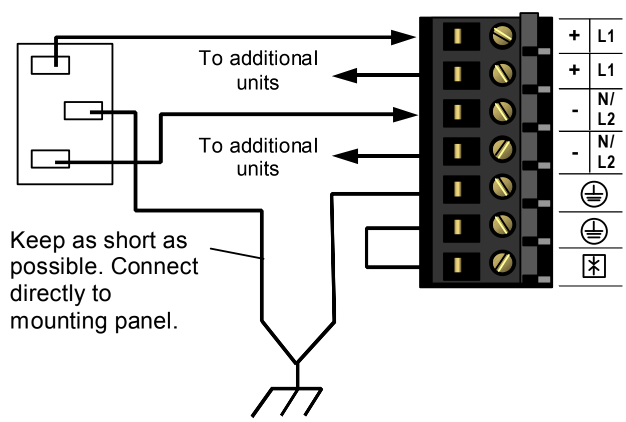


In a non-redundancy application, where automatic restarting is may be appropriate, a shunt can be installed on back of the module as shown at left. The shunt must have 0.100 inch spacing on center and accommodate 0.25 inch pins. Example parts are Radio Shack DIP Programming Shunt #276-1512 and DIGI-Key #59000-ND. The module must be removed from the backplane to install the shunt.

Field Wiring: IC695PSA140

Power Source and Ground Connections

The wires from the power source and ground connect to the terminals on the Power Supply as shown at right. Each terminal accepts one AWG 14 to AWG 22 wire.



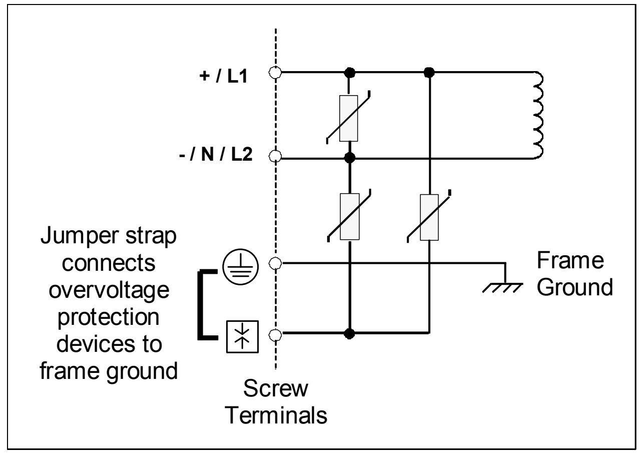
Warning

If the same external AC power source is used to provide power to two or more RX3i power supplies in the system, connection polarity must be identical at each power supply. A resulting difference in potential can injure personnel or cause damage to equipment. Also, each backplane must be connected to a common system ground.

Input Overvoltage Protection

The bottom terminal is normally connected to frame ground with a user-installed jumper as shown lower right. If overvoltage protection is not required or is supplied upstream, no jumper is needed.

To Hi-pot test this supply, overvoltage protection must be disabled during the test by removing the jumper. Re-enable overvoltage protection after testing by reinstalling the jumper.



In systems with a floating neutral input (the neutral line is not referenced to Protective Earth Ground), this jumper must NOT be installed. In addition, in a floating neutral system, voltage surge protection devices such as MOVs **must** be installed from L1 to earth ground, and from L2 (Neutral) to earth ground.

Power Supply, 24 VDC, 40 Watt: IC695PSD040

Power Supply IC695PSD040 is a 40-Watt supply that operates from an input voltage source in the range of 18 VDC to 30 VDC.

- +5.1 VDC output
- +24 VDC relay output that can be used to power circuits on Output Relay modules
- +3.3 VDC. This output is used internally by RX3i modules with IC695 catalog numbers

Caution

Only one IC695PSD040 can be installed in a PACSystems RX3i (IC695 catalog number) Universal Backplane. This Power supply cannot be used with other RX3i power supplies in redundant or increased capacity modes. Power Supply version IC695PSD040C or before may cause equipment damage if inadvertently installed in the same backplane as another RX3i power supply.

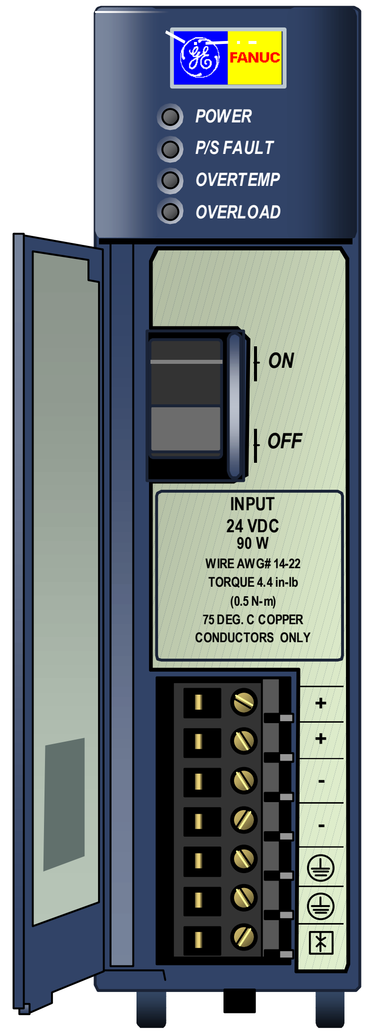
It occupies one slot. If the number of modules required exceeds the capacity of the Power Supply, the additional modules must be installed in Expansion or Remote backplanes.

The Power Supply indicates when an internal fault occurs so the CPU can detect loss of power or log the appropriate fault code.

LEDs

Four LEDs on the Power Supply indicate:

- Power (Green/Amber). When this LED is green, it indicates power is being supplied to the backplane. When this LED is amber, power is applied to the Power Supply but the Power Supply switch is off.
- P/S Fault (Red). When this LED is lit, it indicates the Power Supply has failed and is no longer supplying sufficient voltage to the backplane.
- Over Temperature (Amber). When this LED is lit, it indicates the Power Supply is near or exceeding its maximum operating temperature.
- Overload (Amber). When this LED is lit, it indicates the Power Supply is near or exceeding its maximum output capability on at least one of its outputs.



If the red P/S FAULT LED is lit, the Power Supply has failed and is no longer supplying sufficient voltage to the backplane .

The amber OVERTEMP and OVERLOAD LEDs light to warn of high temperature or high load conditions.

The CPU Fault Table shows a fault if any Overtemperature, Overload, or P/S Fault occurs.

On/Off Switch

The ON/OFF switch is located behind the door on the front of the module. The switch controls the operation of the outputs of the supply. It does NOT interrupt line power. A projecting tab next to the switch helps prevent accidentally turning it on or off.

Wiring Terminals

Terminals for +24V and –24V power, ground, and MOV disconnect accept individual 14 to 22AWG wires.

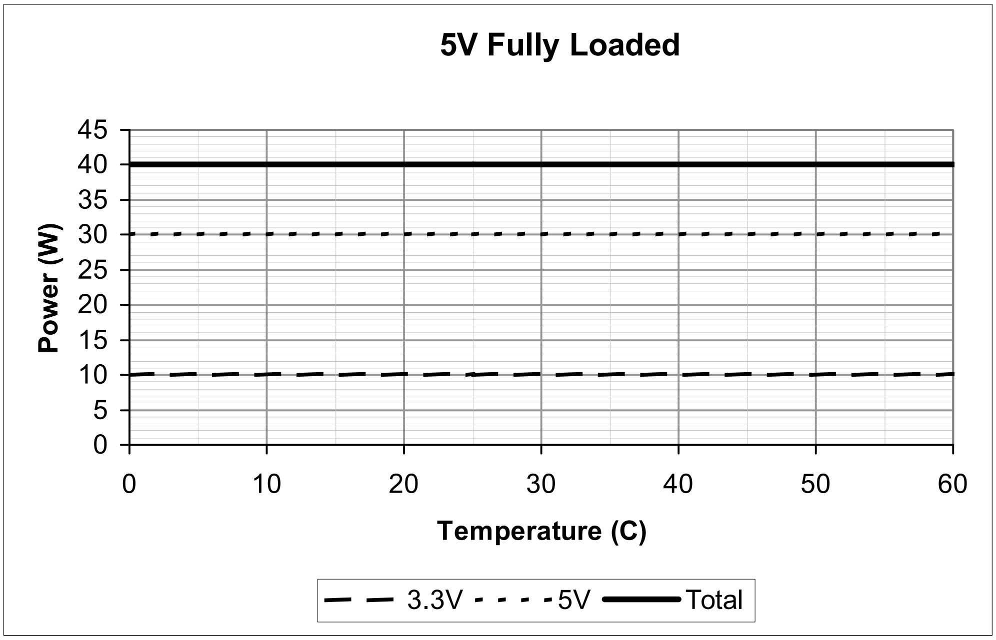
Specifications: IC695PSD040

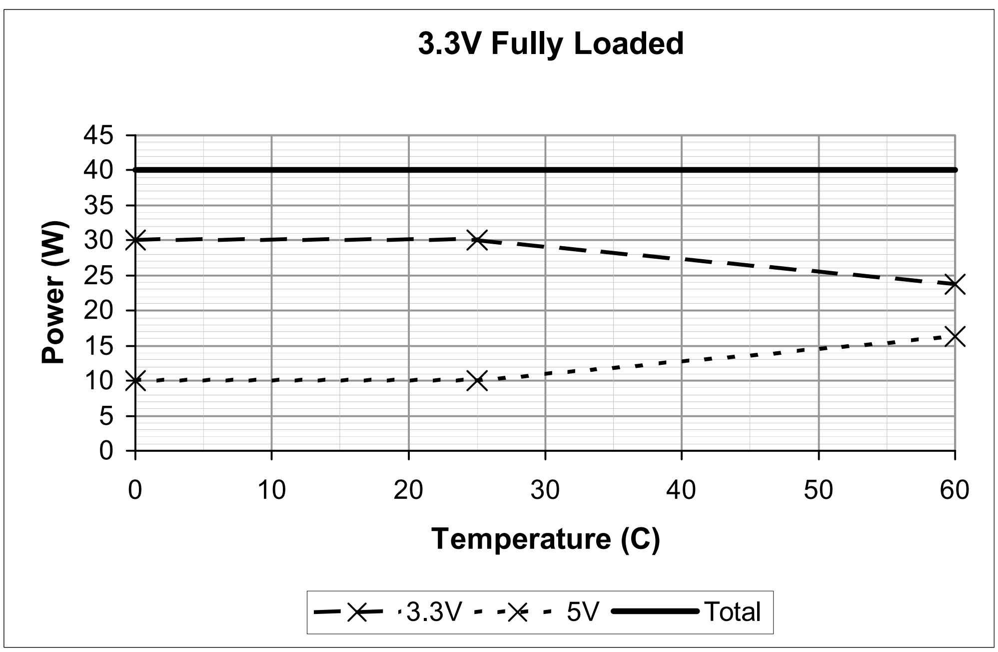
Nominal Rated Voltage **Input Voltage Range** **Start** **Run**	24 VDC 18 to 30 VDC 12 to 30 VDC
Input Power **Inrush Current**	60 Watts maximum at full load 4 Amps, 100 milliseconds maximum *
Output Power	40 Watts maximum total of both outputs. 5.1 VDC = 30 Watts maximum 3.3 VDC = 30 Watts maximum Maximum output power depends on ambient temperature, as shown.
Output Voltage	5.1 VDC: 5.0 VDC to 5.2 VDC (5.1 VDC nominal) 3.3 VDC: 3.1 VDC to 3.5 VDC (3.3 VDC nominal)
Output Current	5.1 VDC: 0 to 6 Amps 3.3 VDC: 0 to 9 Amps
Isolation	NONE
Ripple (all outputs)	50 mV
Noise (all outputs)	50 mV
Ride-through time	10 ms This is the length of time the Power Supply maintains valid outputs if the power source is interrupted. If this Power Supply is used with IC694 and IC693 modules that have relay outputs, note that dropouts longer than 10ms will cause dropouts on the modules.
Wiring Terminals	Each terminal accepts one 14 AWG to 18 AWG wire.
Terminal Current	6 Amps
Number of Daisy-Chained PSD040 Supplies	Up to 2

* The Inrush Current specification is given as a guide for sizing the external power source for the IC695PSD040. Peak inrush current may be higher for shorter durations.

Thermal Deratings: PSD040

The maximum output power for Power Supply PSD040 depends on the ambient temperature, as shown below. Full output power is available up to at least 40°C (89.6°F).



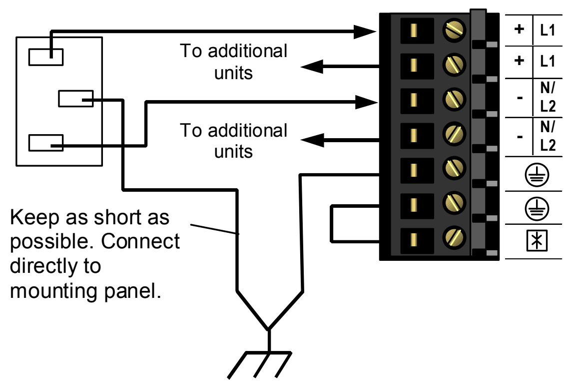


Overcurrent Protection

The 5.1 VDC output is electronically limited to 7 Amps. The 3.3 VDC output is limited to 10 Amps. If an overload (including short circuits) occurs, it is sensed internally and the Power Supply shuts down. The Power Supply continually tries to restart until the overload condition is removed. An internal fuse in the input line is provided as a backup. The Power Supply usually shuts down before the fuse blows. The fuse also protects against internal supply faults. The CPU Fault Table shows a fault if any Overtemperature, Overload, or P/S Fault occurs. There is no additional indication if the Power Supply fuse blows.

Field Wiring: IC695PSD040

Power Source and Ground Connections

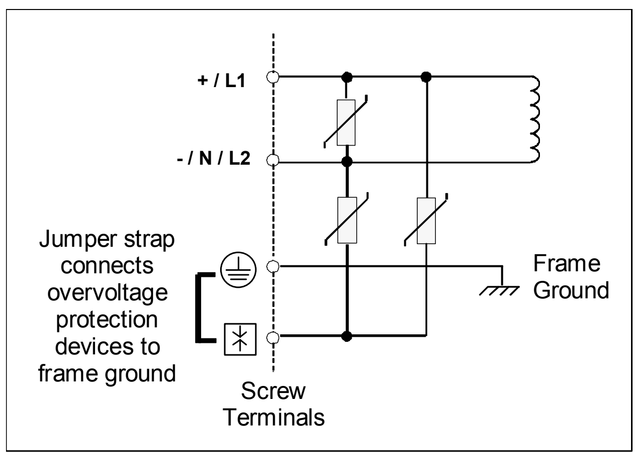


The wires from the power source and ground connect to the terminals on the Power Supply as shown at right. Each terminal accepts one AWG 14 to AWG 22 wire.

Warning

If the same external DC power source is used to provide power to two or more power supplies in the system, connection polarity must be identical at each RX3i power supply. A resulting difference in potential can injure personnel or cause damage to equipment. Also, each backplane must be connected to a common system ground.

Input Overvoltage Protection



The bottom terminal is normally connected to frame ground with a user-installed jumper as shown at lower right. If overvoltage protection is not required or is supplied upstream, no jumper is required.

To Hi-pot test this supply, overvoltage protection must be disabled during the test by removing the jumper. Re-enable overvoltage protection after testing by reinstalling the jumper.

Warning

This power supply is not isolated and is therefore not compatible with floating or positive grounded systems.

Multi-Purpose Power Supply, 24 VDC, 40 Watt: IC695PSD140

Power Supply IC695PSD140 is a multi-purpose 40-Watt supply that operates from an input voltage source in the range of 18 VDC to 30 VDC.

This power supply provides three outputs:

- +5.1 VDC output
- +24 VDC relay output that can be used to power circuits on Output Relay modules
- +3.3 VDC. This output is used internally by RX3i modules with IC695 catalog numbers

Multipurpose Power Supply IC695PSD140 is suitable for use in load-sharing and redundancy application. It must be installed in a PACSystems RX3i (IC695 catalog number) Universal Backplane. It can be used as the only power supply in the backplane, or combined with up to three additional Multipurpose Power Supplies.

Caution

This Power Supply cannot be used with RX3i IC695PSD040 or IC695PSA040 Power Supplies in redundant or increased capacity modes. Damage to equipment may result.

The Power Supply indicates when an internal fault occurs so the CPU can detect loss of power or log the appropriate fault code.

LEDs

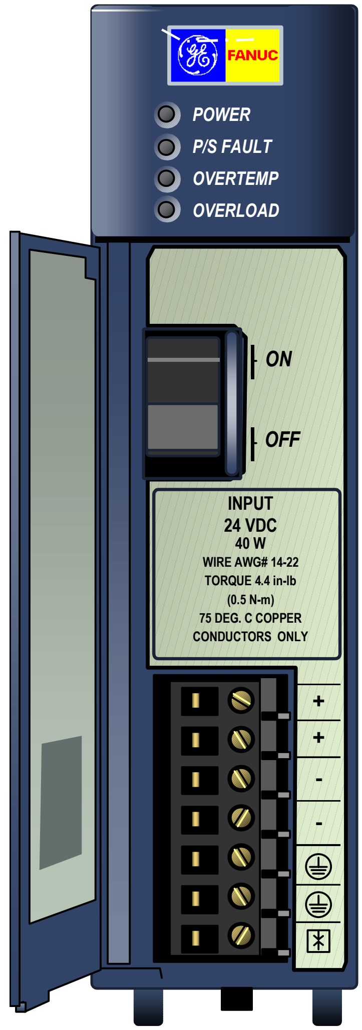
Four LEDs on the Power Supply indicate:

- Power (Green/Amber). When this LED is green, it indicates power is being supplied to the backplane. When this LED is amber, power is applied to the Power Supply but the Power Supply switch is off.
- P/S Fault (Red). When this LED is lit, it indicates the Power Supply has failed and is no longer supplying sufficient voltage to the backplane.
- Over Temperature (Amber). When this LED is lit, it indicates the Power Supply is near or exceeding its maximum operating temperature.
- Overload (Amber). When this LED is lit, it indicates the Power Supply is near or exceeding its maximum output capability on at least one of its outputs.

If the red P/S FAULT LED is lit, the Power Supply has failed and is no longer supplying sufficient voltage to the backplane .

The amber OVERTEMP and OVERLOAD LEDs light to warn of high temperature or high load conditions.

The CPU Fault Table shows a fault if any Overtemperature, Overload, or P/S Fault occurs.



Wiring Terminals

Terminals for +24V and –24V power, ground, and MOV disconnect accept individual 14 to 22 AWG wires.

On/Off Switch

The ON/OFF switch is located behind the door on the front of the module. The switch controls the operation of the outputs of the supply. It does NOT interrupt line power. A projecting tab next to the switch helps prevent accidentally turning it on or off.

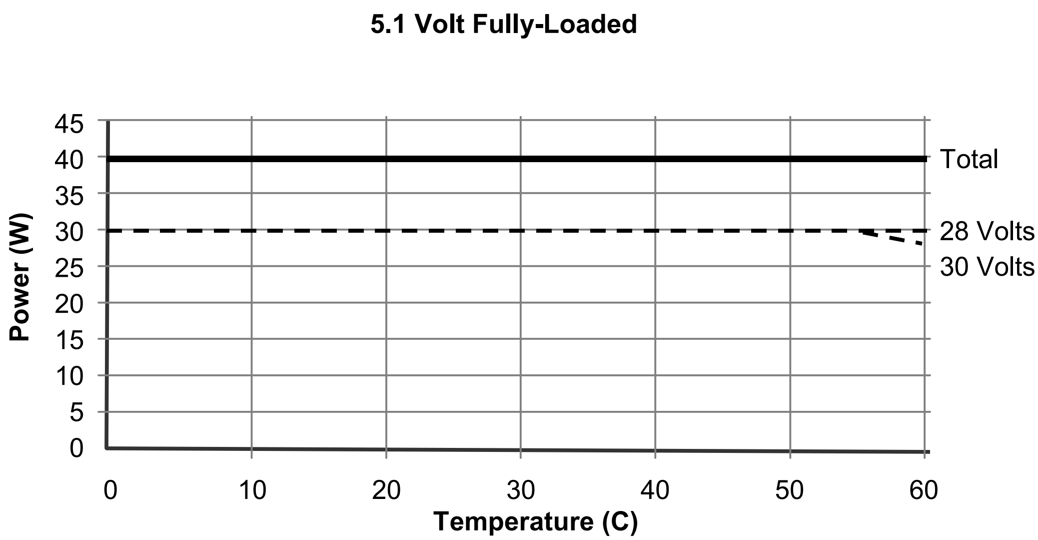
Specifications: IC695PSD140

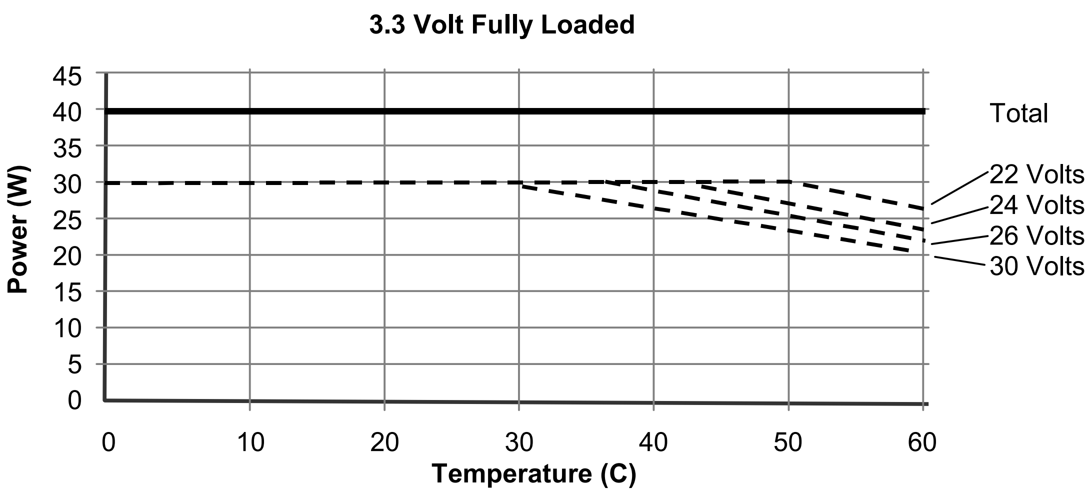
Nominal Rated Voltage **Input Voltage Range**	24 VDC 18 to 30 VDC
Input Power **Inrush Current**	60 Watts maximum at full load 4 Amps, 100 milliseconds maximum *
Output Power	40 Watts maximum total of both outputs. 5.1 VDC = 30 Watts maximum 3.3 VDC = 30 Watts maximum Maximum output power depends on ambient temperature, as shown.
Output Voltage	5.1 VDC: 5.0 VDC to 5.2 VDC (5.1 VDC nominal) 3.3 VDC: 3.1 VDC to 3.5 VDC (3.3 VDC nominal)
Output Current	5.1 VDC: 0 to 6 Amps 3.3 VDC: 0 to 9 Amps
Isolation	NONE
Ripple (all outputs)	50 mV
Noise (all outputs)	50 mV
Ride-through time	10 ms This is the length of time the Power Supply maintains valid outputs if the power source is interrupted. If this Power Supply is used with IC694 and IC693 modules that have relay outputs, special precautions should be taken because dropouts in the source voltage will be seen by the module and may cause relay dropouts.
Wiring Terminals	Each terminal accepts one 14 AWG to 24 AWG wire.
Terminal Current	6 Amps
Number of Daisy-Chained PSD140 Supplies	Up to 4
Number of PSD140 Supplies in Universal Backplane	Up to 4

* The Inrush Current specification is given as a guide for sizing the external power source for the IC695PSD140. Peak inrush current may be higher for shorter durations.

Thermal Deratings: PSD140

The maximum output power for Power Supply PSD140 depends on the ambient temperature, as shown below. Full output power is available up to at least 40°C (89.6°F).



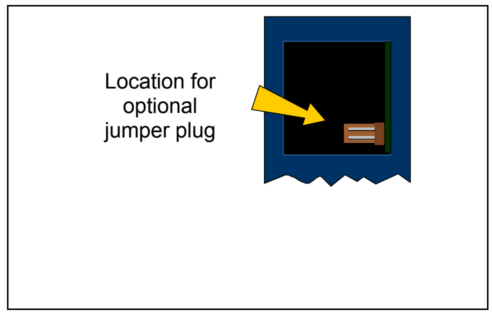


Overcurrent Protection

The 5.1 VDC output is electronically limited to 7 Amps. The 3.3 VDC output is limited to 10 Amps. If an overload (including short circuits) occurs, it is sensed internally and the Power Supply shuts down. Because it is designed for redundancy applications, this Power Supply latches “OFF” in fault conditions and will not automatically try to restart. Input power must be cycled to clear a latched fault.

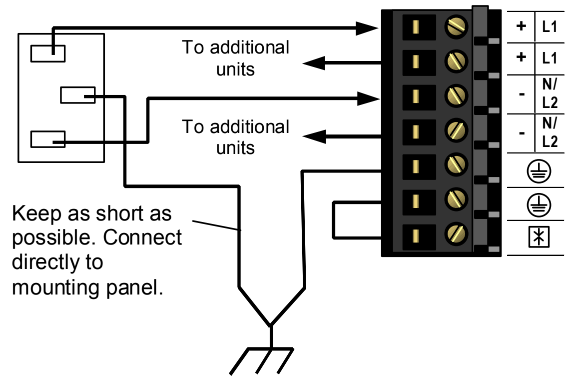
An internal fusable link in the input line is provided as a backup. The Power Supply usually shuts down before the fusable link blows. The fusable link also protects against internal supply faults. The CPU Fault Table shows a fault if any Overtemperature, Overload, or P/S Fault occurs. There is no additional indication if the Power Supply fusable link blows.

In a non-redundancy application, where automatic restarting may be appropriate, a shunt can be installed on back of the module as shown at left. The shunt must have 0.100 inch spacing on center and accommodate 0.25 inch pins. Example parts are Radio Shack DIP Programming Shunt #276-1512 and DIGI-Key #59000-ND. The module must be removed from the backplane to install the shunt.



Field Wiring: IC695PSD140

Power Source and Ground Connections

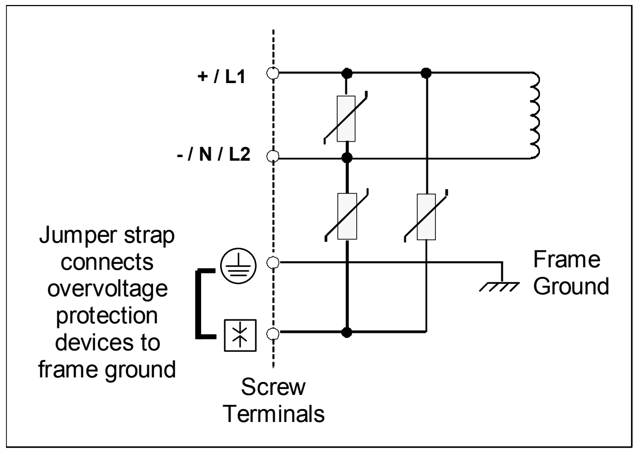


The wires from the power source and ground connect to the terminals on the Power Supply as shown at right. Each terminal accepts one AWG 14 to AWG 24 wire.

Warning

If the same external DC power source is used to provide power to two or more power supplies in the system, connection polarity must be identical at each RX3i power supply. A resulting difference in potential can injure personnel or cause damage to equipment. Also, each backplane must be connected to a common system ground.

Input Overvoltage Protection



The bottom terminal is normally connected to frame ground with a user-installed jumper as shown at lower right. If overvoltage protection is not required or is supplied upstream, no jumper is required.

To Hi-pot test this supply, overvoltage protection must be disabled during the test by removing the jumper. Re-enable overvoltage protection after testing by reinstalling the jumper.

Warning

This power supply is not isolated and is therefore not compatible with floating or positive grounded systems.

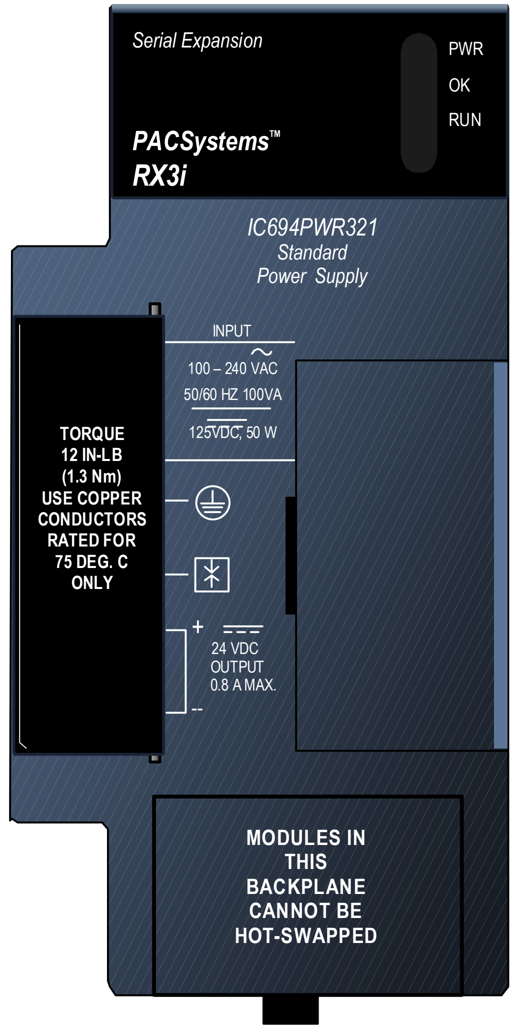
Power Supply, 120/240 VAC or 125 VDC: IC694PWR321

Power Supply IC694PWR321 is a 30-Watt supply that operates from an input voltage source in the range of 85 VAC to 264 VAC or 100 VDC to 300 VDC.

This power supply provides three outputs:

- +5 VDC output
- Relay +24 VDC output that can be used to power circuits on Output Relay modules
- Isolated +24 VDC. This power is used internally by some modules. It can also be used to power field devices connected to 24 VDC Input modules

Power Supply IC694PWR321 can be used in an Expansion backplane in an RX3i system. The battery backup and serial port functions are not available in Expansion Backplanes.



LEDs

The green PWR LED shows the operating state of the Power Supply. PWR is ON when the Power Supply has a correct source of power and is operating properly. It is OFF when a Power Supply fault occurs or power is not applied.

The green OK LED is steady ON if the PLC is operating properly. It is OFF if a problem is detected by the PLC.

The green RUN LED is ON when the PLC is in Run mode.

Specifications: IC694PWR321

Nominal Rated Voltage **Input Voltage Range** **AC** **DC**	120/240 VAC or 125 VDC 85 VDC to 264 VAC 100 VDC to 300 VDC
Input Power **(Maximum with Full Load)** **Inrush Current**	90 VA with VAC Input 50 W with VDC Input 4 Amperes peak, 250 milliseconds maximum
Output Power	5 VDC and 24 VDC Relay: 15 Watts maximum 24 VDC Relay: 15 Watts maximum 24 VDC Isolated: 20 Watts maximum *NOTE: 30 Watts maximum total (all three outputs)*
Output Voltage	5 VDC: 5.0 VDC to 5.2 VDC (5.1 VDC nominal) Relay 24 VDC: 24 VDC to 28 VDC Isolated 24 VDC: 21.5 VDC to 28 VDC
Isolation (input to backplane):	1500 VAC (for 1 minute)
Protective Limits **Overvoltage:** **Overcurrent:**	 5 VDC output: 6.4 VDC to 7 VDC 5 VDC output: 4 Amperes maximum
Ride-through Time:	20 milliseconds minimum This is the length of time the Power Supply maintains valid outputs if the power source is interrupted.
Fuse	2 Amps, GE Fanuc part number 44A724627-109 (2). See chapter 2 for more information.

Overcurrent Protection

The 5 VDC output is electronically limited to 3.5 Amps. If an overload (including short circuits) occurs, it is sensed internally and the Power Supply shuts down. The Power Supply continually tries to restart until the overload condition is removed. An internal fuse in the input line is provided as a backup. The Power Supply usually shuts down before the fuse blows. The fuse also protects against internal supply faults.

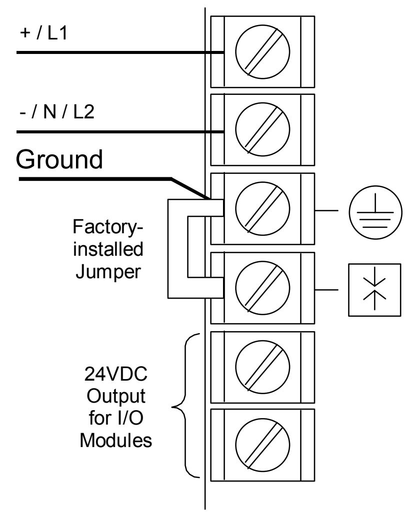
Warning

The power supply's door must be closed. During normal operation with an AC power source either 120 VAC or 240 VAC is present on the AC Power Supply. The door protects against accidental shock hazard that could cause severe or fatal injury to personnel.

Field Wiring: IC694PWR321

AC Power Source Connections

The Hot, Neutral, and Ground wires from the 120 VAC power source or L1, L2, and Ground wires from the 240 VAC power source connect to the top three terminals on the Power Supply.



DC Power Source Connections

Connect the + and - wires from the 125 VDC power source to the top two terminals. These connections are not polarity-sensitive on Power Supply PWR321.

Warning

If the same external DC power source is used to provide power to two or more power supplies in the system, connection polarity must be identical at each power supply. A resulting difference in potential can injure personnel or cause damage to equipment. Also, each backplane must be connected to a common system ground.

The bottom two terminals of the power supply terminal strip provide output connections to the Isolated +24 VDC. This output can be used to provide power for external circuits (within power limitations of the supply).

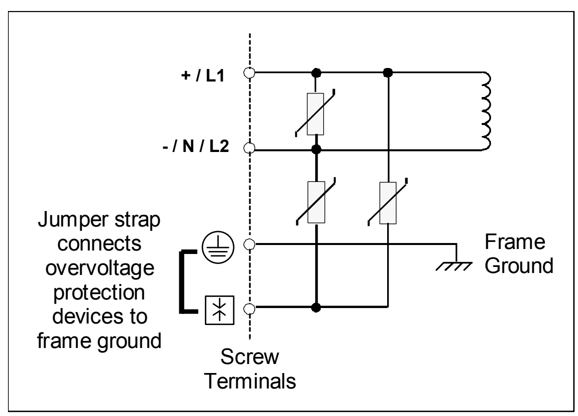
Caution

If the Isolated 24 VDC supply is overloaded or shorted, the PLC will stop operation.

Input Overvoltage Protection

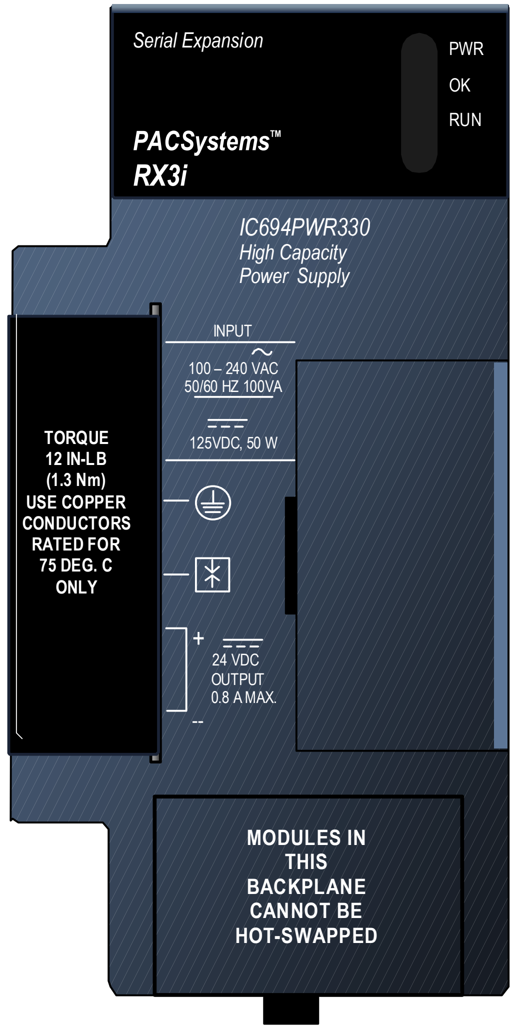
Terminal 4 is normally connected to frame ground (terminal 3) with a factory-installed jumper strap. If overvoltage protection is not required or is supplied upstream, this feature can be disabled by removing the jumper.

To Hi-pot test this supply, overvoltage protection must be disabled during the test by removing the terminal strip jumper. Re-enable overvoltage protection after testing by reinstalling the strap.



In systems with a floating neutral input (the neutral line is not referenced to Protective Earth Ground), this jumper must NOT be installed. In a floating neutral system, voltage surge protection devices such as MOVs **must** be installed from L1 to earth ground, and from L2 (Neutral) to earth ground

Power Supply, 120/240 VAC or 125 VDC High Capacity: IC694PWR330



High Capacity Power Supply IC694PWR330 is rated for 30 Watts. It allows all 30 watts to be consumed from the +5 VDC output. This Power Supply operates from an input voltage source in the range of 85 to 264 VAC or 100 to 300 VDC.

PWR330 Power supplies provide the following outputs:

- +5 VDC output
- Relay +24 VDC which provides power to circuits on Output Relay modules
- Isolated +24 VDC, which is used internally by some modules, can also be used to provide external power for 24 VDC Input modules

Power Supply IC694PWR330 must be installed in an Expansion backplane in an RX3i system. The battery backup and serial port functions are not available in Expansion Backplanes.

LEDs

The green PWR LED shows the operating state of the Power Supply. PWR is ON when the Power Supply has a correct source of power and is operating properly. It is OFF when a Power Supply fault occurs or power is not applied.

The green OK LED is steady ON if the PLC is operating properly. It is OFF if a problem is detected by the PLC.

The green RUN LED is ON when the PLC is in Run mode.

Specifications: IC694PWR330

Nominal Rated Voltage **Input Voltage Range** **AC** **DC**	120/240 VAC or 125 VDC 85 VAC to 264 VAC 100 VDC to 300 VDC
Input Power **(Maximum with Full Load)** **Inrush Current**	100 VA with VAC Input 50 W with VDC Input 4 Amperes peak, 250ms maximum
Output Power	5 VDC: 30 Watts maximum 24 VDC Relay: 15 Watts maximum 24 VDC Isolated: 20 Watts maximum *NOTE: 30 Watts maximum total (all three outputs)*
Output Voltage	5 VDC: 5.0 VDC to 5.2 VDC (5.1 VDC nominal) 24 VDC Relay: 24 VDC to 28 VDC 24 VDC Isolated: 21.5 VDC to 28 VDC
Isolation (input to backplane):	1500 VAC (for 1 minute)
Protective Limits **Overvoltage:** **Overcurrent:**	 5 VDC output: 6.4 VDC to 7 VDC 5 VDC output: 7 Amperes maximum
Ride-through Time:	20 ms minimum. This is the length of time the Power Supply maintains valid outputs if the power source is interrupted.
Fuse	2 Amps, GE Fanuc part number 44A724627-109 (2). See chapter 2 for more information.

Overcurrent Protection

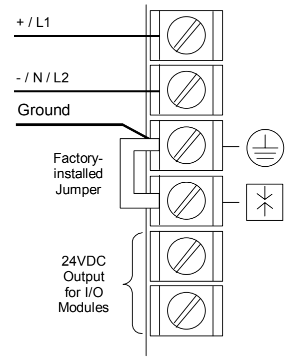
The 5 VDC output is electronically limited to 7 Amps. If an overload (including short circuits) occurs, it is sensed internally and the Power Supply shuts down. The Power Supply continually tries to restart until the overload condition is removed. An internal fuse in the input line is provided as a backup. The Power Supply usually shuts down before the fuse blows. The fuse also protects against internal supply faults.

Warning

The power supply's door must be closed. During normal operation with an AC power source either 120 VAC or 240 VAC is present on the AC Power Supply. The door protects against accidental shock hazard that could cause severe or fatal injury to personnel.

Field Wiring: IC694PWR330

AC Power Source Connections



The Hot, Neutral, and Ground wires from the 120 VAC power source or L1, L2, and Ground wires from the 240 VAC power source connect to the top three terminals on the Power Supply.

DC Power Source Connections

Connect the + and - wires from the 125 VDC power source to the top two terminals. These connections are not polarity-sensitive on Power Supply PWR330.

Warning

If the same external DC power source is used to provide power to two or more power supplies in the system, connection polarity must be identical at each power supply. A resulting difference in potential can injure personnel or cause damage to equipment. Also, each backplane must be connected to a common system ground.

The bottom two terminals of the power supply terminal strip provide output connections to the Isolated +24 VDC. This output can be used to provide power for external circuits (within power limitations of the supply).

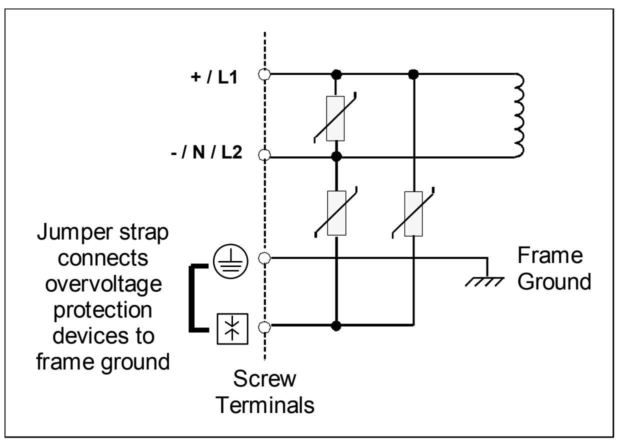
Caution

If the Isolated 24 VDC supply is overloaded or shorted, the PLC will stop operation.

Input Overvoltage Protection

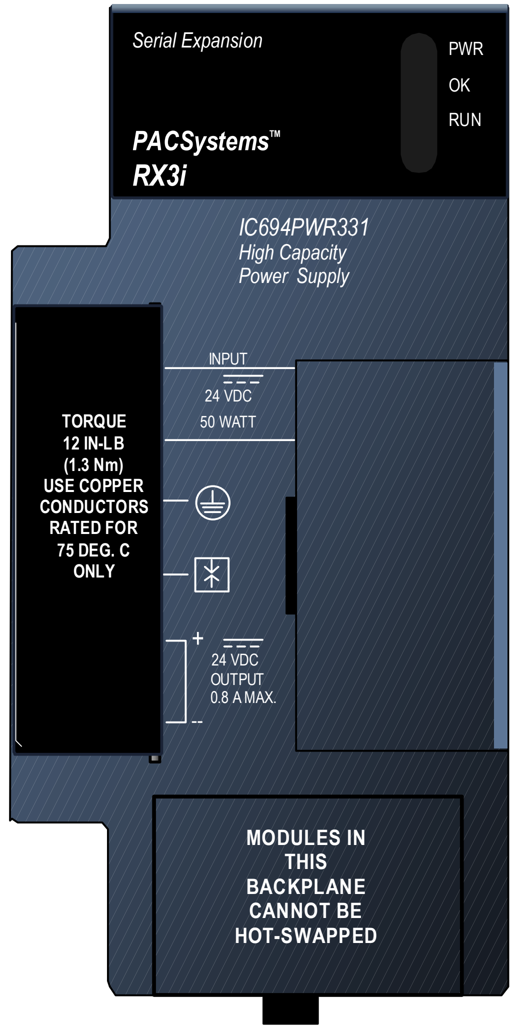
Terminal 4 is normally connected to frame ground (terminal 3) with a factory-installed jumper strap. If overvoltage protection is not required or is supplied upstream, this feature can be disabled by removing the jumper.

To Hi-pot test this supply, overvoltage protection must be disabled during the test by removing the terminal strip jumper. Re-enable overvoltage protection after testing by reinstalling the strap.



In systems with a floating neutral input (the neutral line is not referenced to Protective Earth Ground), this jumper must NOT be installed. In a floating neutral system, voltage surge protection devices such as MOVs **must** be installed from L1 to earth ground, and from L2 (Neutral) to earth ground.

Power Supply, 24 VDC High-Capacity: IC694PWR331



High Capacity Power Supply IC694 PWR331 is rated for 30 Watts output. For applications requiring greater +5 VDC current capacity than is available with a standard supply (PWR321), a High-Capacity Power Supply allows all 30 watts to be consumed from the +5 VDC supply. This supply can operate from an input voltage source in the range of 12 VDC to 30 VDC. Although it is capable of maintaining all outputs within specifications with input voltages as low as 12 VDC, it requires an initial input voltage of 18 VDC to start up.

PWR331 Power supplies provide the following outputs:

- +5 VDC output
- Relay +24 VDC, which provides power to circuits on Output Relay modules
- Isolated +24 VDC, which is used internally by some modules, can also be used to provide external power for 24 VDC Input modules

Power Supply IC694PWR331 must be installed in an Expansion backplane in an RX3i system. The battery backup and serial port functions are not available in Expansion Backplanes.

LEDs

The green PWR LED shows the operating state of the Power Supply. PWR is ON when the Power Supply has a correct source of power and is operating properly. It is OFF when a Power Supply fault occurs or power is not applied.

The green OK LED is steady ON if the PLC is operating properly. It is OFF if a problem is detected by the PLC.

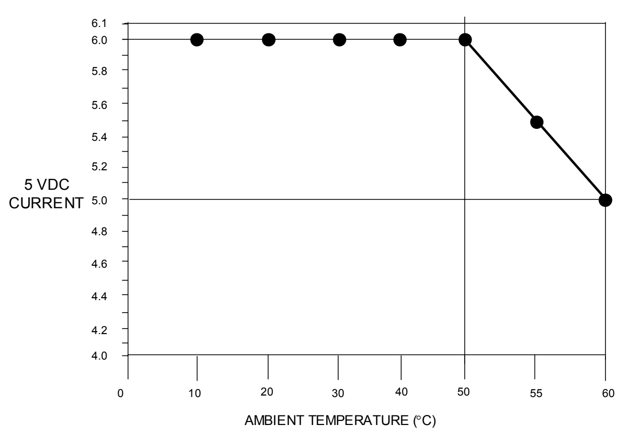
The green RUN LED is ON when the PLC is in Run mode.

Specifications: IC694PWR331

Nominal Rated Voltage **Input Voltage Range** **Start** **Run**	24 VDC 18 VDC to 30 VDC 12 VDC to 30 VDC
Input Power **Inrush Current**	50 Watts maximum at full load 4 Amps peak, 100 milliseconds, maximum
Output Power	5 VDC: 30 Watts maximum * 24 VDC Relay: 15 Watts maximum 24 VDC Isolated: 20 Watts maximum *NOTE: 30 watts maximum total (all three outputs)*
Output Voltage	5 VDC: 5.0 VDC to 5.2 VDC (5.1 VDC nominal) 24 VDC Relay: 19.2 VDC to 28.8 VDC 24 VDC Isolated: 19.2 VDC to 28.8 VDC
Isolation (input to backplane)	1500 VAC (for 1 minute)
Protective Limits **Overvoltage:** **Overcurrent;**	 5 VDC output: 6.4 VDC to 7 VDC 5 VDC output: 7 Amps maximum
Ride-through Time:	10 ms minimum. This is the length of time the Power Supply maintains valid outputs if the power source is interrupted
Fuse	5 Amps, GE Fanuc part number 44A724627-114 (2). See chapter 2 for more information.

* Derate as shown below at ambient temperatures above 50°C (122°F).

Thermal Derating



Overcurrent Protection

The 5 VDC output is electronically limited to 7 Amps. If an overload (including short circuits) occurs, it is sensed internally and the Power Supply shuts down. The Power Supply continually tries to restart until the overload condition is removed. An internal fuse in the input line is provided as a backup. The Power Supply usually shuts down before the fuse blows. The fuse also protects against internal supply faults.

Calculating Input Power Requirements: PWR331

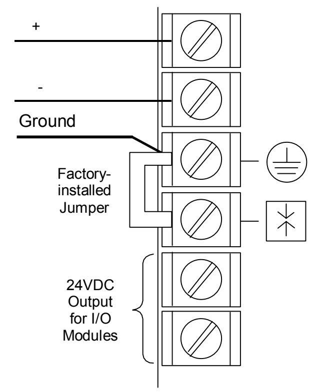
- Use the following procedure to determine input power requirements for the 24 VDC High Capacity Power Supply:
- Determine total output power load from typical specifications listed for individual modules in this chapter.
- Multiply the output power by 1.5 to determine the input power value.
- Divide the input power value by the operating source voltage to determine the input current requirements
- Use the lowest input voltage to determine the maximum input current
- Allow for start-up surge current requirements
- Allow margins (10% to 20%) for variations

Field Wiring: IC694PWR331

The + wire connects to the top terminal screw, and the - wire connects to the second. These connections are polarity-sensitive for PWR331.

Warning

If the same external DC power source is used to provide power to two or more power supplies in the system, connection polarity must be identical at each power supply. Do not cross the Positive (+) and Negative (-) lines. A resulting difference in potential can injure personnel or cause damage to equipment. Also, each backplane must be connected to a common system ground.



Ground connects to the third screw.

The bottom two terminals of the power supply terminal strip provide connections to the Isolated +24 VDC output. This output can be used to provide power for external circuits (within power limitations of the supply).

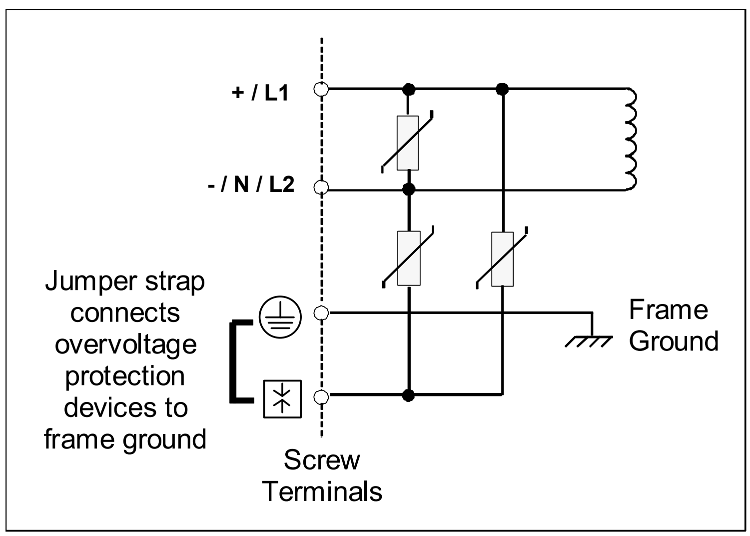
Caution

If the Isolated 24 VDC supply is overloaded or shorted, the PLC will stop operation.

Input Overvoltage Protection

Terminal 4 is normally connected to frame ground (terminal 3) with a factory-installed jumper strap. If overvoltage protection is not required or is supplied upstream, this feature can be disabled by removing the jumper.

To Hi-pot test this supply, overvoltage protection must be disabled during the test by removing the terminal strip jumper. Re-enable overvoltage protection after testing by reinstalling the jumper.

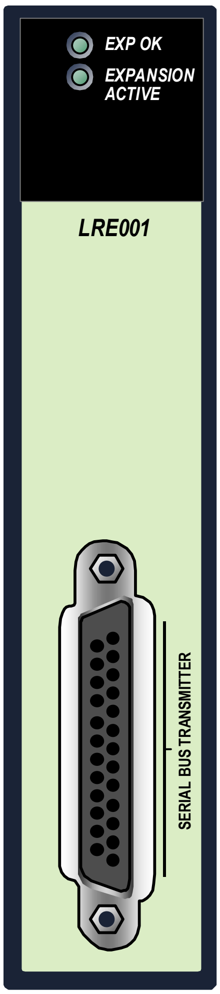


Chapter 5 Serial Bus Transmitter and Expansion Cables

This chapter describes the serial expansion module and expansions cables for PACSystems RX3i controllers. It also gives specifications for building custom expansion cables.

Description	*Catalog Number*
Serial Bus Transmitter Module	IC695LRE001
Expansion Cable, Wye, 1 meter (3 feet)	IC693CBL300
Expansion Cable, Wye, 2 meters (6 feet)	IC693CBL301
Expansion Cable, 2 Connectors, Built-inTerminating Resistor, 15 meters (50 feet) Length	IC693CBL302
Expansion Cable, Wye, 0.15 meter (0.5 feet) Length	IC693CBL312
Expansion Cable, Wye, 8 meters (25 feet) Length	IC693CBL313
Expansion Cable, Wye, 15 meters (50 feet) Length	IC693CBL314

Serial Bus Transmitter Module: IC695LRE001



The RX3i Serial Bus Transmitter Module, IC695LRE001, provides communications between a PACSystems RX3i Universal Backplane (IC695-model number), and serial expansion and remote backplanes (IC694- or IC693-model numbers). It translates the signal levels present in the Universal Backplane to the signal levels required by a Serial Expansion Backplane.

The Serial Bus Transmitter Module must reside in the special expansion connector on the right end of the Universal Backplane.

Two green LEDs indicate the operating status of the module and the status of the expansion link.

- The EXP OK LED is lit when backplane 5V power is applied to the module.
- The Expansion Active LED indicates the status of the expansion bus. This LED is ON when the Expansion module is communicating with expansion backplanes. It is OFF when they are not communicating.

The connector on the front of the module is used to attach the expansion cable.

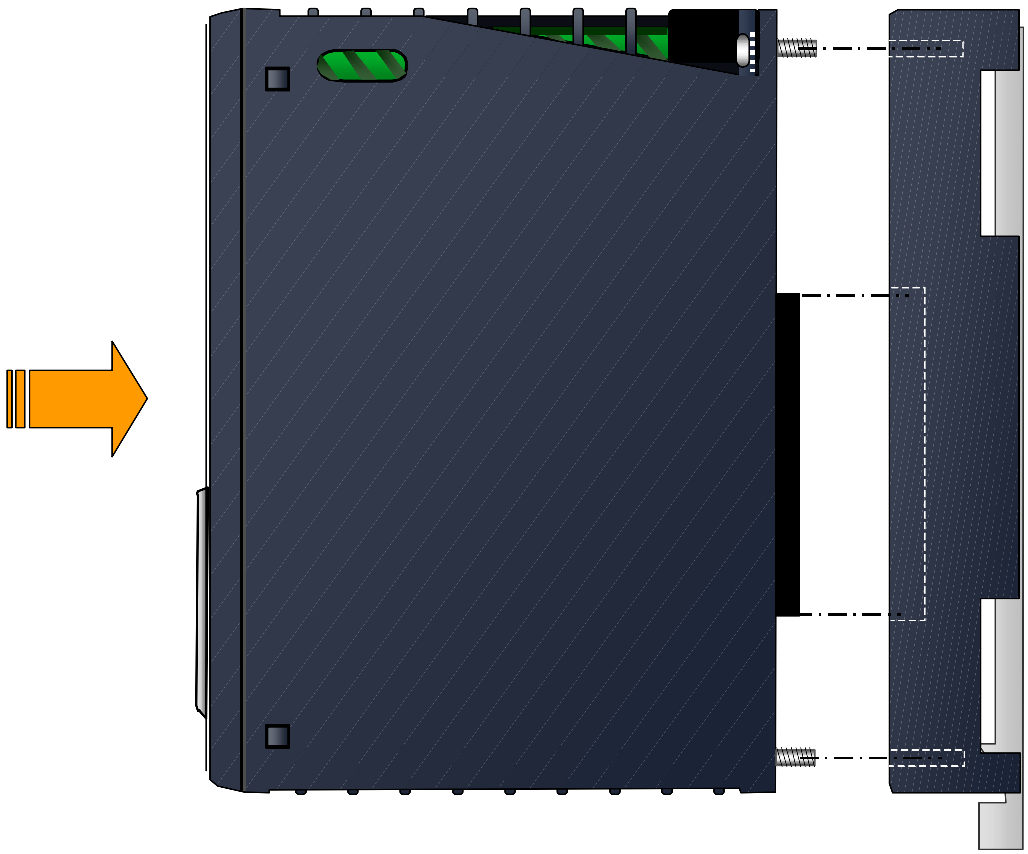
Specifications: LRE001

Current Required from Backplane	5.0V: 132mA 3.3V: 0 mA
Maximum Total Expansion Cable Length	15 meters (50 feet) – Expansion Backplanes 213 meters (700 feet) – Remote Backplanes
Effective Data Rate	500k Bytes per second if the expansion bus includes Remote backplanes.
Electrical Isolation	Non-isolated differential communications

Refer to Appendix A for product standards and general specifications.

Expansion Module Installation

The Serial Bus Transmitter Module must reside in the special expansion connector on the right end of the Universal Backplane. This module may NOT be hot-inserted in the backplane; power must be removed before installing or removing the Expansion Module. In addition, the expansion cable may not be attached or removed if the expansion rack has power applied.



Powering Down Individual Expansion or Remote Backplanes

Expansion and Remote Backplanes can be powered-down individually without affecting the operation of other backplanes; however, powering off a backplane generates a loss of module (LOSS_OF_MODULE) fault in the PLC Fault Table for each module in the backplane. When this fault condition occurs, and until the backplane is powered back on and all modules recovered, the lost I/O modules are not scanned.

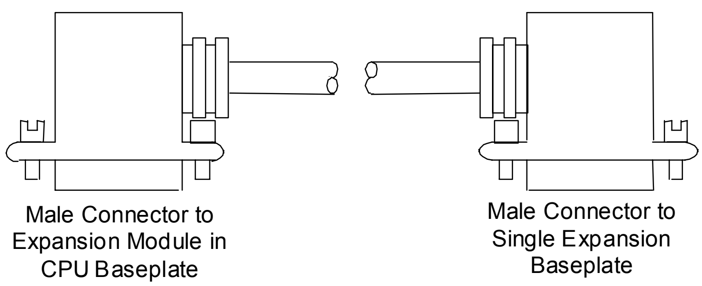
I/O Bus Expansion Cables: IC693CBL300, 301, 302 ,312, 313, 314

I/O Bus Expansion Cables are used to connect a Serial Bus Transmitter Module (IC695LRE001) in a Universal Backplane (IC695CHS012 or IC695CHS016) to a Serial Expansion Backplane (IC694/693CHS392 or IC694/693CHS398). These cables are also used to interconnect additional expansion and remote backplanes in the system. Several lengths of prefabricated cables are available (part numbers IC693CBL300, 301, 302, 312, 313, 314).

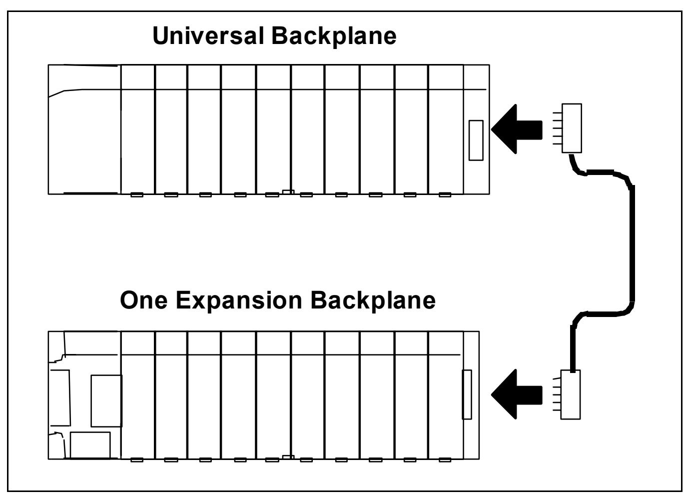
The prefabricated cables described in this section are made with a *continuous*, 100% shield. The braided cable shield is connected to the metal shell of the connector around the entire perimeter of the connector. That provides a low-impedance path to frame ground for any noise energy that is coupled onto the cable shield.

Cable with Two Connectors: IC693CBL302

Cable IC693CBL302 is 15 meters (50 feet) long and has one male connector on each end. This cable has I/O bus terminating resistors built into the end connector on the cable.

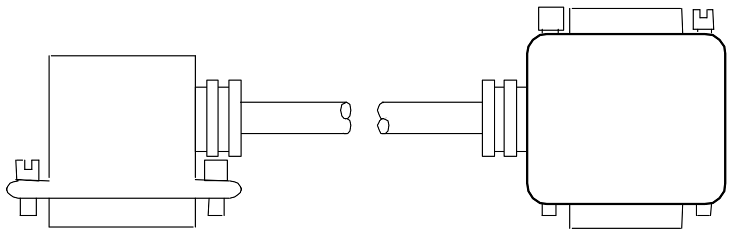


This cable does not require a separate termination block. It can only be used in a system with just one expansion backplane.



Cables with Three Connectors: IC693CBL300, 301, 312, 313, 314

Cables IC693CBL300, 301, 312, 313, and 314 have a male and female connector on one end and a male connector on the other end (“wye” cables).



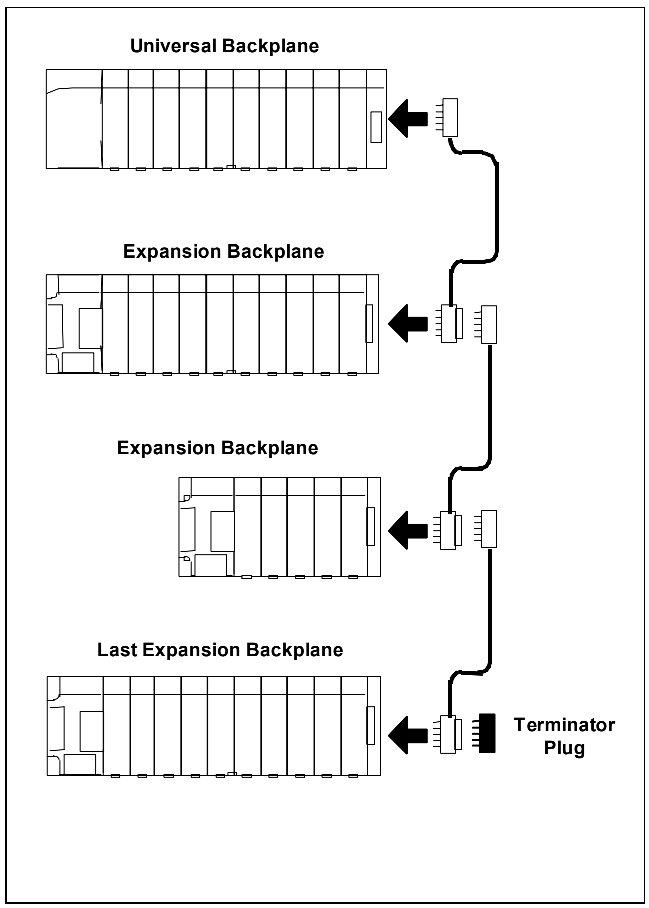
These cables are the same except for their lengths:

- IC693CBL312: 0.15 meter (0.5 feet)
- IC693CBL300: 1 meter (3 feet)
- IC693CBL301: 2 meters (6 feet)
- IC693CBL313: 8 meters (25 feet)
- IC693CBL314: 15 meters (50 feet)

Combinations of these cables can be used to daisy-chain up to seven expansion backplanes to the main backplane. Custom cables can also be made. Wiring information is given in this section.

These cables can also be used to provide connection points for custom point-to-point cables (IC693CBL300 is often used for this).

These cables do not have built-in termination. The last cable in the expansion system must be terminated as shown. Terminator Plug IC693ACC307 can be used for this purpose.



The maximum number of cables that can be included in an I/O expansion system is seven, and the total maximum cable length between the Universal Backplane and the last expansion backplane is 50 feet (15 meters). Failure to observe these limits could result in erratic system operation.

Specifications: IC693CBL300, 301, 302, 312, 313, 314

Cable	Belden 8107 only (no substitutes): Computer cable, overall braid over foil shield, twisted–pair 30 volt/80°C (176°F) 24 AWG (.22mm^2) tinned copper, 7 x 32 stranding Velocity of propagation = 70% Nominal impedance = 100 Ohms
25 Pin Male Connector	Crimp Plug = Amp 207464–1; Pin = Amp 66506–9 Solder Plug = Amp 747912–2
25 Pin Female Connector	Crimp Receptacle = Amp 207463–2; Pin = Amp 66504–9 Solder Receptacle = Amp 747913–2
Connector Shell	Kit – Amp 745833–5: Metal–plated plastic (plastic with nickel over copper) [Crimp ring – Amp 745508–1, split ring ferrule

Connector part numbers are provided for reference only. Any part meeting the same specifications could be used for making custom cables.

Expansion Port Pin Assignments

All connections between cables are point–to point, that is, pin 2 of one end to pin 2 of the opposite end, pin 3 to pin 3, etc.

Pin Number	Signal Name	Function
16	DIODT	I/O Serial Data Positive
17	DIODT/	I/O Serial Data Negative
24	DIOCLK	I/O Serial Clock Positive
25	DIOCLK/	I/O Serial Clock Negative
20	DRSEL	Remote Select Positive
21	DRSEL/	Remote Select Negative
12	DRPERR	Parity Error Positive
13	DRPERR/	Parity Error Negative
8	DRMRUN	Remote Run Positive
9	DRMRUN/	Remote Run Negative
2	DFRAME	Cycle Frame Positive
3	DFRAME/	Cycle Frame Negative
1	FGND	Frame Ground for Cable Shield
7	0V	Logic Ground

The I/O expansion bus *must be terminated* at the last backplane in an expansion system. Each signal pair must be terminated with 120 ohm, 1/4 watt resistors wired between the appropriate pins: 16 – 17; 24 – 25; 20 – 21; 12 – 13; 8 – 9; 2 – 3

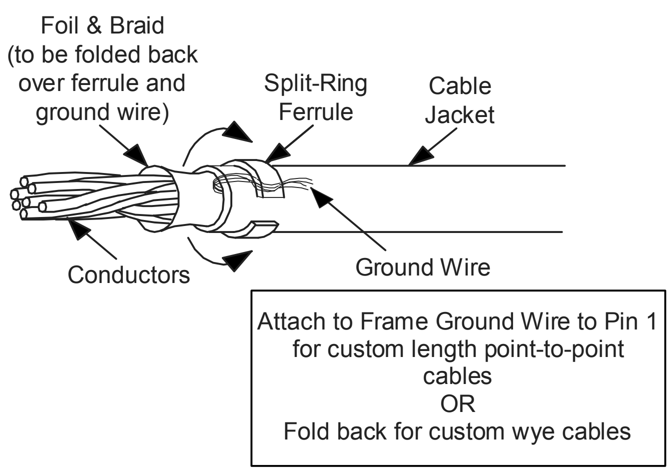
Building Cables

For custom length cables, the best noise immunity is achieved when using a metalized connector cover that makes contact with the cable's braided and foil shielding and with the connector shell on the terminating end. *It is not sufficient* to only solder the drain wire to the connector shell. The cable's shield must be continuous across the entire length of the cable, including at the terminations.

When using 100% shielded cables all CPU and expansion backplanes in the system must be solidly referenced to the same ground point or a potential difference between backplanes could disturb signal transmission.

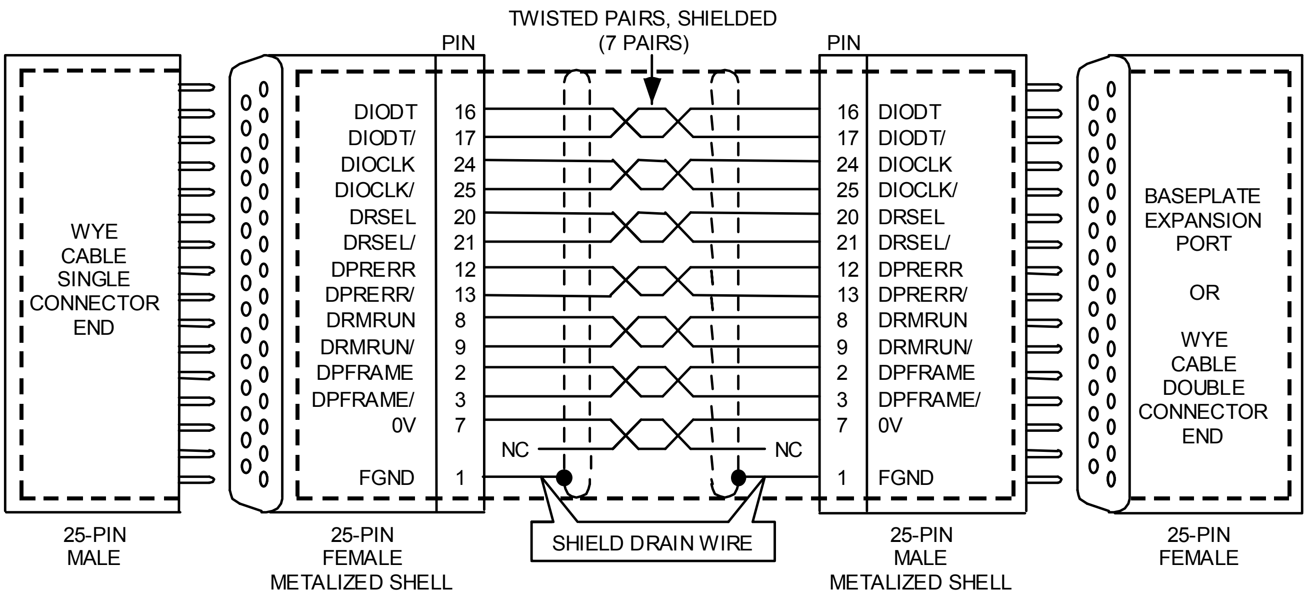
Use the following steps to build a 100% shielded cable:

1. Strip approximately 5/8 inch of insulation from the cable to expose the shield.
2. Put a split–ring ferrule over the cable insulation.
3. Fold the shield back over the top of the cable insulation and ferrule.



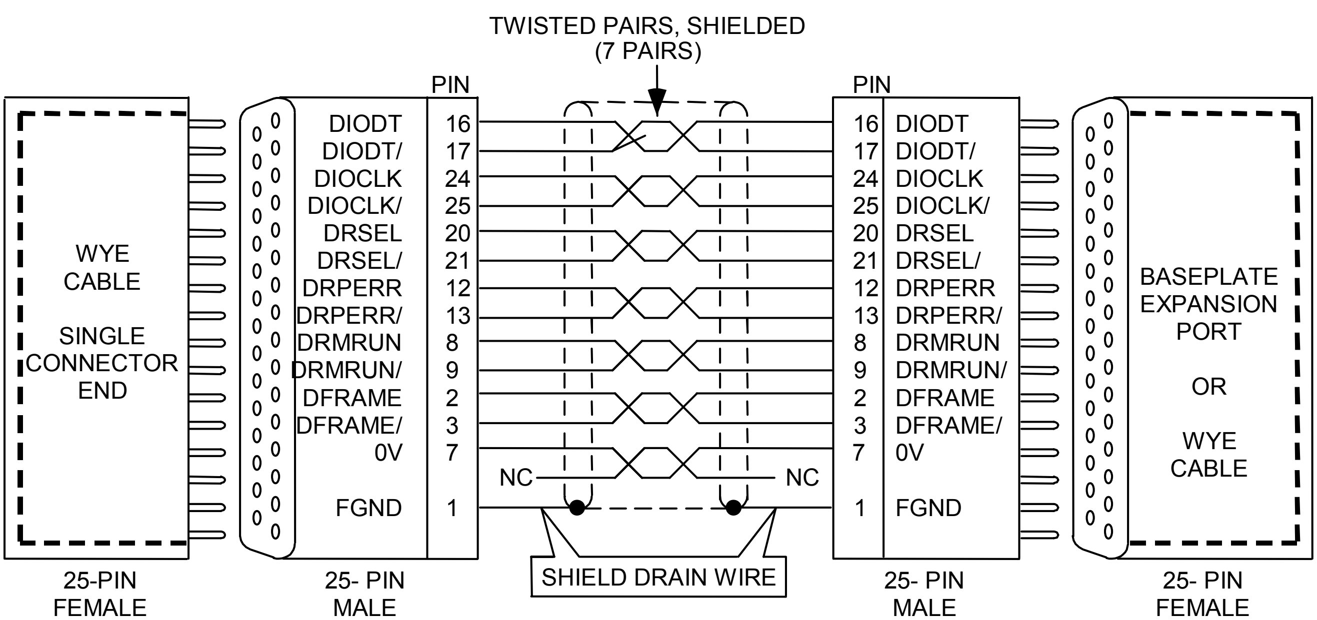
4. Place the collar of the metal hood over the top of the folded shield, and securely clamp the hood.
5. Test the cable for continuity between both connector shells. Connect an ohmmeter between the shells and flex the cable at both ends. If the metallic connector hood is not making proper contact with the cable shield at either end, the connection will show intermittent continuity on the ohmmeter.
6. Plug the metal hooded cable into an expansion port and securely tighten the two screws. Installing and tightening the screws electrically connects the shield to the backplane frame ground, which should be connected to earth ground.

Cable with Continuous Shielding



NOTE:
Bold dashed line shows continuous (100%) shielding when metallized shell connectors are plugged together.

Cable for Applications Requiring Less Noise Immunity



Termination Requirement for Expansion or Remote System

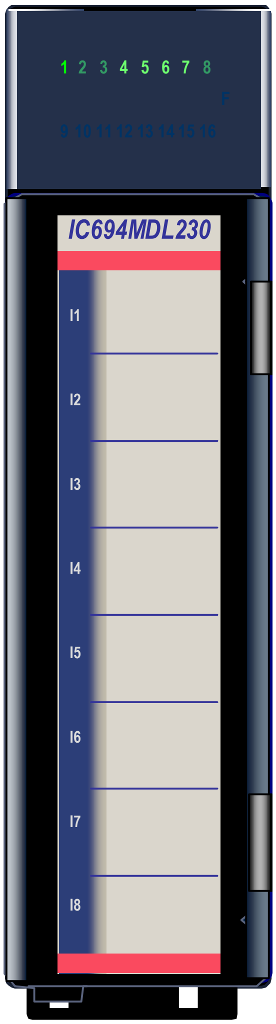
When two or more backplanes are connected via the I/O Bus Expansion System, the I/O Expansion Bus must be properly terminated. The most common method of terminating the I/O Expansion Bus is by installing a termination resistor pack (IC693ACC307) on the open connector on the last (most distant from the CPU) Expansion or Remote backplane in the system. The resistor pack is physically mounted inside of a connector. Although a termination resistor pack is shipped with each backplane, only the last backplane in the chain needs to have this termination connector installed. Unused termination packs can be discarded. The prewired 50 foot (15 meter) cable (IC693CBL302) has termination resistors wired inside the connector on one end of the cable. This cable can be used if only one expansion rack is needed in a system and a 50 foot cable link is required (the IC693ACC307 resistor pack is not needed in this case). Also, a custom-built cable with built-in resistors would eliminate the need for the IC693ACC307 resistor pack.

Chapter 6 Discrete Input Modules

This chapter describes discrete input modules for PACSystems RX3i systems.

Discrete Input Module	***Catalog Number***
Input 120 VAC 8 Point Isolated	IC694MDL230
Input 240 VAC 8 Point Isolated	IC694MDL231
Input 120 VAC 16 Point	IC694MDL240
Input 24 VAC/VDC 16 Point Pos/Neg Logic	IC694MDL241
Input 120 VAC 16 Point Isolated	IC694MDL250
Input 120 VAC 32 Point Grouped	IC694MDL260
Input 125 VDC 8 Point Pos/Neg Logic	IC694MDL632
Input 24 VDC 8 Point Pos/Neg Logic	IC694MDL634
Input 24 VDC 16 Point Pos/Neg Logic	IC694MDL645
Input 24 VDC 16 Point Pos/Neg Logic Fast	IC694MDL646
Input 5/12 VDC (TTL) 32 Point Pos/Neg Logic	IC694MDL654
Input 24 VDC 32 point Pos/Neg Logic	IC694MDL655
Input 24 VDC 32 Point Pos/Neg Logic	IC694MDL660
Input Simulator Module	IC694ACC300

Input Module, 120 Volt AC, 8 Point Isolated: IC694MDL230



The ***120 volt AC Isolated Input*** module, IC694MDL230, provides 8 isolated input points, each with a common power input terminal. Because the inputs are isolated, each input can be powered by a separate AC power source.

The input circuits are reactive (resistor/capacitor) inputs. Current into an input point results in a logic 1 in the input status table (%I). Input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied by the user. This module requires an AC power source; *it cannot be used with a DC power source.*

Eight green LEDs indicate the ON/OFF status of points 1 through 8. The red bands on the label show that MDL230 is a high-voltage module.

This module can be installed in any I/O slot in an RX3i system.

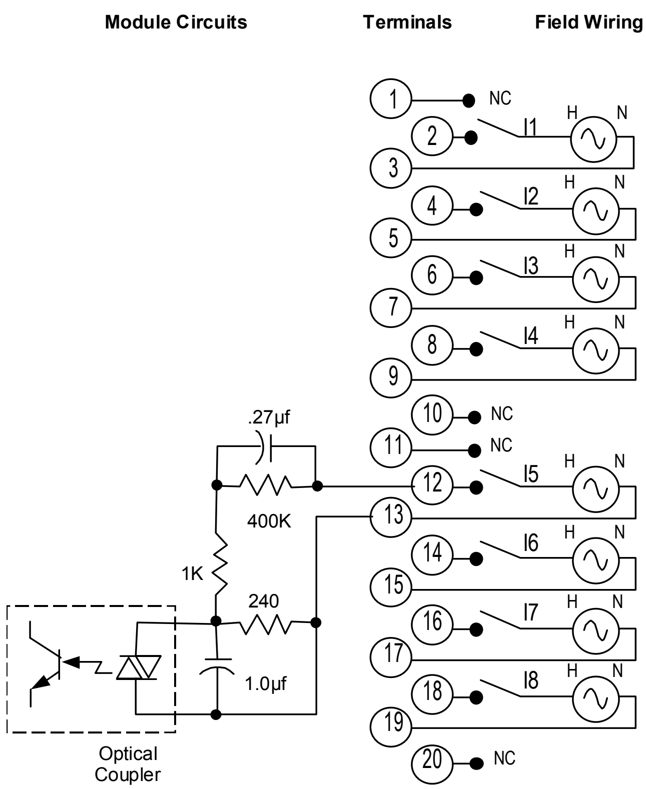
Specifications: MDL230

Rated Voltage **Input Voltage Range**	120 volts AC, 50/60 Hz 0 to 132 volts AC, 50/60 Hz
Inputs per Module	8 (each input point has a separate common)
Isolation:	
Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for one minute
Point to Point	250 VAC continuous; 1500 VAC for one minute
Input Current	14.5 mA (typical) at rated voltage
Input Characteristics:	
On–state Voltage	74 to 132 volts AC
Off–state Voltage	0 to 20 volts AC
On–state Current	6mA minimum
Off–state Current	2.2mA maximum
On response Time	30ms maximum
Off response Time	45ms maximum
Power Consumption	60mA (all inputs on) from 5 volt bus on backplane

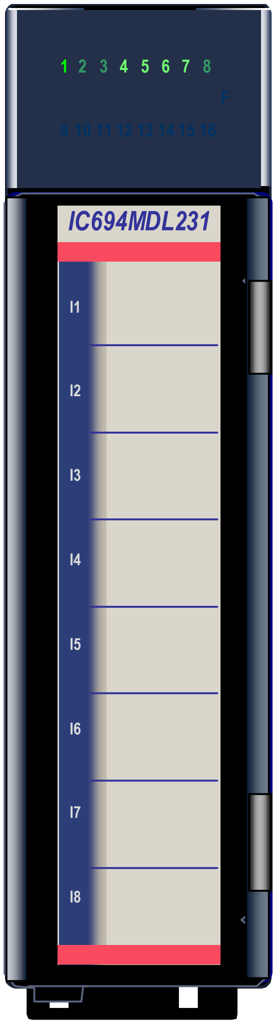
Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL230

Terminals	***Connections***
1	No connection
2	Input 1
3	Input 1 Return
4	Input 2
5	Input 2 Return
6	Input 3
7	Input 3 Return
8	Input 4
9	Input 4 Return
10	No connection
11	No connection
12	Input 5
13	Input 5 Return
14	Input 6
15	Input 6 Return
16	Input 7
17	Input 7 Return
18	Input 8
19	Input 8 Return
20	No connection



Input Module, 240 Volt AC, 8 Point Isolated: IC694MDL231



The ***240 volt AC Isolated Input*** module, IC694MDL231, provides 8 isolated input points, each with a common power input terminal. The input circuits are reactive (resistor/capacitor) inputs. Current into an input point results in a logic 1 in the input status table (%I). Input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches.

Because the inputs are isolated, each input can be powered by a separate AC power source. Power to operate the field devices must be supplied by the user. This module requires an AC power source; *it cannot be used with a DC power source*.

Eight green LEDs indicate the ON/OFF status of points 1 through 8. The red bands on the label show that MDL231 is a high-voltage module.

This module can be installed in any I/O slot in an RX3i system.

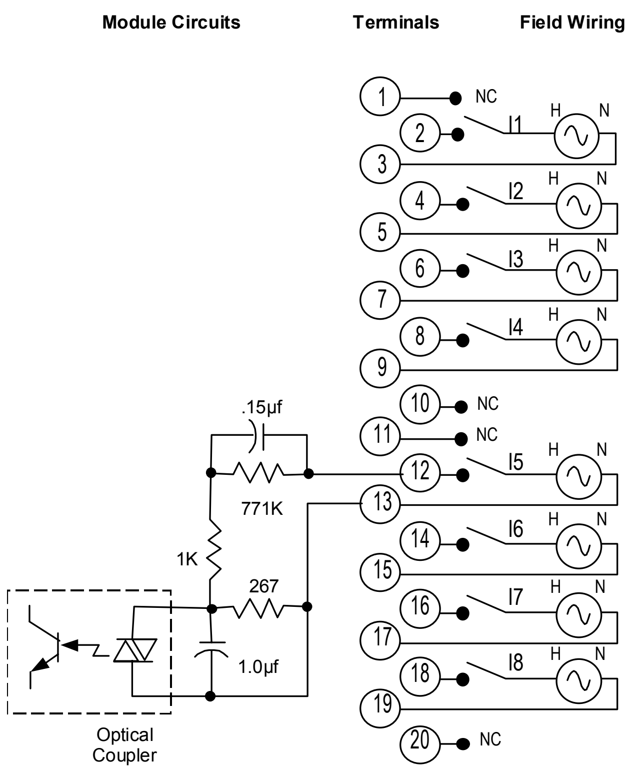
Specifications: MDL231

Rated Voltage	240 volts AC, 50/60 Hz
Input Voltage Range	0 to 264 volts AC, 50/60 Hz
Inputs per Module	8 (each input point has a separate common)
Isolation:	
Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for one minute
Point to Point	250 VAC continuous; 1500 VAC for one minute
Input Current	15 mA (typical) at rated voltage
Input Characteristics:	
On–state Voltage	148 to 264 volts AC
Off–state Voltage	0 to 40 volts AC
On–state Current	6mA minimum
Off–state Current	2.2mA maximum
On response Time	30ms maximum
Off response Time	45ms maximum
Power Consumption	60mA (all inputs on) from 5 volt bus on backplane

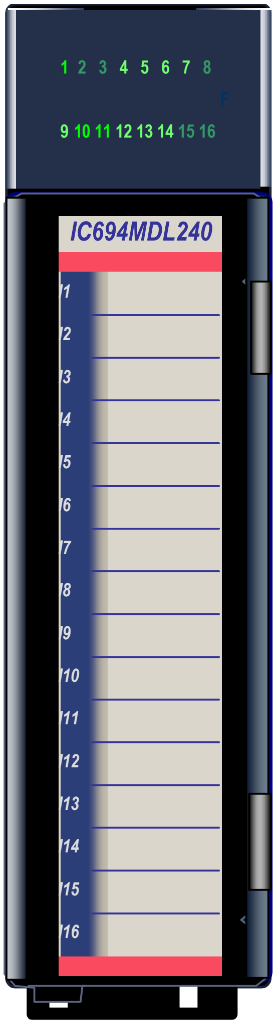
Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL231

Terminals	***Connections***
1	No connection
2	Input 1
3	Input 1 Return
4	Input 2
5	Input 2 Return
6	Input 3
7	Input 3 Return
8	Input 4
9	Input 4 Return
10	No connection
11	No connection
12	Input 5
13	Input 5 Return
14	Input 6
15	Input 6 Return
16	Input 7
17	Input 7 Return
18	Input 8
19	Input 8 Return
20	No connection



Input Module, 120 Volt AC, 16 Point: IC694MDL240



The ***120 volt AC Input*** module, IC694MDL240, provides 16 input points with one common power input terminal. The input circuits are reactive (resistor/capacitor) inputs. Current into an input point results in a logic 1 in the input status table (%I). Input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate the field devices must be supplied by the user. This module requires an AC power source; *it cannot be used with a DC power source.*

Sixteen green LEDs indicate the ON/OFF status of points 1 through 16. The red bands on the label show that MDL240 is a high-voltage module.

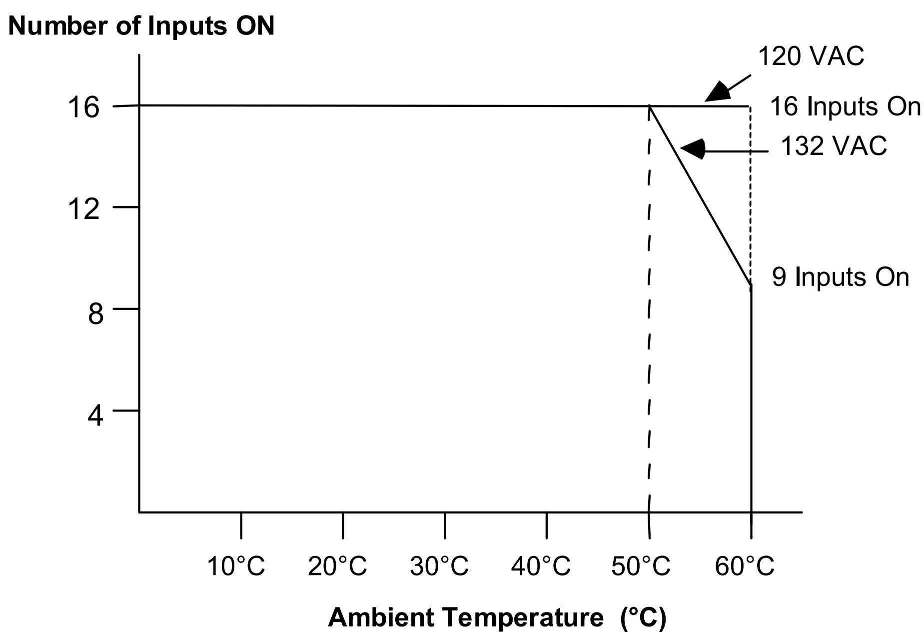
This module can be installed in any I/O slot in an RX3i system.

Specifications: MDL240

Rated Voltage	120 volts AC
Input Voltage Range	0 to 132 volts AC, 50/60 Hz
Inputs per Module	16 (one group with a single common)
	The maximum number of inputs on at the same time depends on the ambient temperature as shown below.
Isolation: Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for one minute
Input Current	12 mA (typical) at rated voltage
Input Characteristics:	
On–state Voltage	74 to 132 volts AC
Off–state Voltage	0 to 20 volts AC
On–state Current	6mA minimum
Off–state Current	2.2mA maximum
On response Time	30ms maximum
Off response Time	45ms maximum
Power Consumption	90mA (all inputs on) from 5 volt bus on backplane

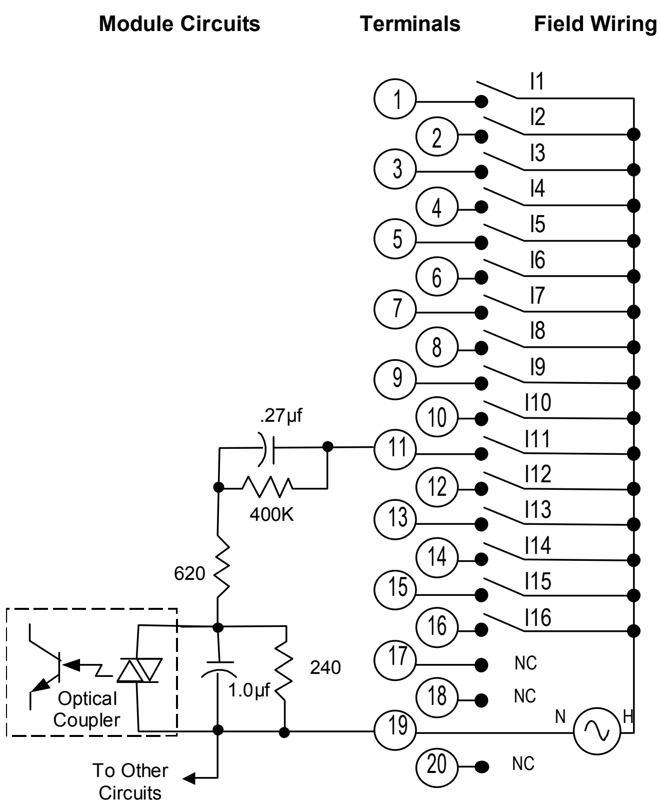
Refer to Appendix A for product standards and general specifications.

Input Points vs. Temperature

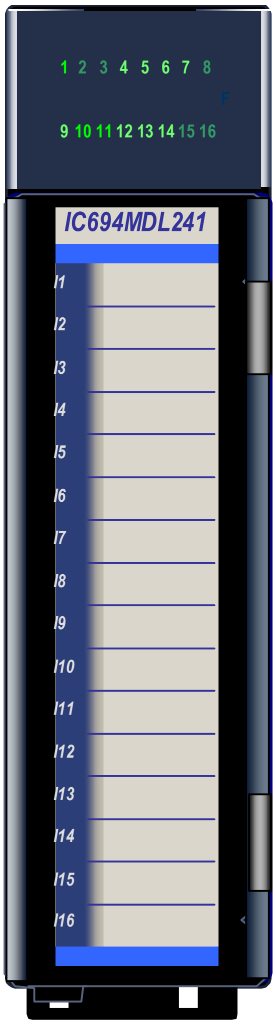


Field Wiring: MDL240

Terminals	*Connections*
1	Input 1
2	Input 2
3	Input 3
4	Input 4
5	Input 5
6	Input 6
7	Input 7
8	Input 8
9	Input 9
10	Input 10
11	Input 11
12	Input 12
13	Input 13
14	Input 14
15	Input 15
16	Input 16
17	No connection
18	No connection
19	Inputs 1-16 Common (Return)
20	No connection



Input Module, 24 VAC/ VDC 16 Point Pos/NegLogic: IC694MDL241



The ***24VAC/VDC 16 Point C Positive/Negative Logic Input*** module, IC694MDL241, provides 16 input points in one group with a common power input terminal. This module can be used with AC or DC field inputs. In DC mode, it can be wired for either positive or negative logic. Input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Current into an input point results in a logic 1 in the input status table (%I). Power to operate AC input devices must be supplied by the user. DC Inputs can be powered by the backplane 24V supply.

Sixteen green LEDs indicate the ON/OFF status of points 1 through 16. The blue bands on the label show that MDL241 is a low-voltage module.

This module can be installed in any I/O slot in an RX3i system.

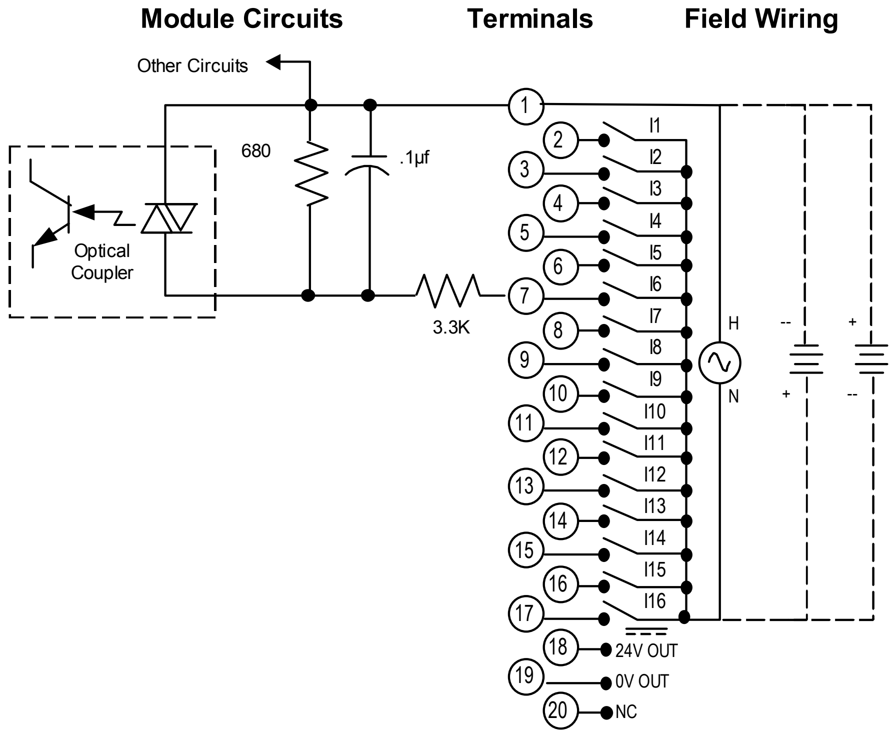
Specifications: MDL241

Rated Voltage	24 volts AC or 24 volts DC
Input Voltage Range	0 to +30 volts DC or 0 to +30 volts AC, 50/60Hz
Inputs per Module	16 (one group with a single common)
Isolation: Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for one minute
Input Current	7 mA (typical) at rated voltage
Input Characteristics	
On–state Voltage	11.5 to 30 volts AC or DC
Off–state Voltage	0 to +4 volts AC or DC
On–state Current	3.2mA minimum
Off–state Current	1 mA maximum
On response Time	12ms typical
Off response Time	28ms typical
Power Consumption: 5V	80mA (all inputs on) from 5 volt bus on backplane
Power Consumption: 24V	125mA from the Isolated 24 volt backplane bus or from user supplied power

Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL241

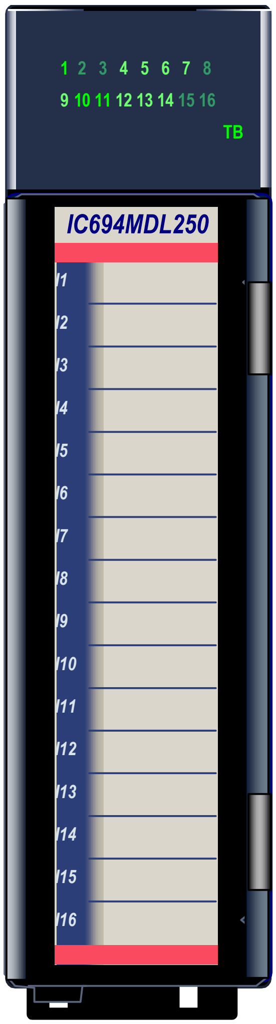
Terminals	*Connections*
1	Inputs 1-16 Common (Return)
2	Input 1
3	Input 2
4	Input 3
5	Input 4
6	Input 5
7	Input 6
8	Input 7
9	Input 8
10	Input 9
11	Input 10
12	Input 11
13	Input 12
14	Input 13
15	Input 14
16	Input 15
17	Input 16
18	24VDC for input devices
19	0V for input devices
20	No connection



Note: If the 24V OUT pin is used to connect to input devices in the field, the isolation specification for this module changes to:

Field to Backplane (optical) and to frame ground: 50 VAC continuous; 500 VAC for 1 minute

Input Module, 120VAC 16-Point Isolated, IC694MDL250



The ***120VAC 16-Point Isolated Input*** module, IC694MDL250, provides 16 isolated input points. Input points can be used on different phases of the AC supply or powered from the same supply. An RC snubber protects each input against transient electrical noise on the power line.

The module's input filtering time can be changed during system operation by the application program. No DIP switch settings are required.

This module can be used with a Box-style (IC694TBB032), Extended Box-style (IC694TBB132), Spring-style (IC694TBS032), or Extended Spring-style (IC694TBS132) Terminal Block. Extended terminal blocks provide the extra shroud depth typically needed for field wiring to AC devices. See chapter 15 for more information about Terminal Blocks. Terminal Blocks are ordered separately.

Individually numbered LEDs show the ON/OFF status of each Input point. The TB LED is green when the module's removable terminal block is locked in place. It is red when the terminal block is not locked. The red bands on the door card indicate the MDL250 is a high-voltage module.

This module can be installed in any I/O slot in an RX3i system. It must be used with RX3i CPU release 3.50 or later. It cannot be used with a Series 90-30 PLC CPU.

Specifications: MDL250

Rated Voltage	120VAC
Input Voltage Range	0 – 132VAC (47 to 63 Hz), 120VAC nom.
Inputs per Module	16 isolated
Isolation:	
Field to Backplane	250 VAC continuous; 1500 VAC for 1 minute
Group to Group	250 VAC continuous; 1500 VAC for 1 minute
Input Current	7.0 mA per point (typical) at rated voltage
Input Filter Times	20 msec – 2540 msec in 20 msec increments. Sent from CPU.
Power Consumption	220mA (all inputs on) from 5 volt bus on backplane
Diagnostics	Field side terminal block reported to RX3i CPU.
Input Characteristics:	
On–state Voltage	70-132VAC
Off–state Voltage	0 to 20VAC
On–state Current	5mA minimum
Off–state Current	2.5mA maximum
On/Off Response Time	$\pm$0-1 AC cycles for filter times up to 840ms $\pm$1-2 AC cycles for filter times of 840 to 1600ms $\pm$2-3 AC cycles for filter times of 1600 to 1920ms $\pm$3-4 AC cycles for filter times of 1920ms or more

Refer to Appendix A for product standards and general specifications.

Input Filter Setup

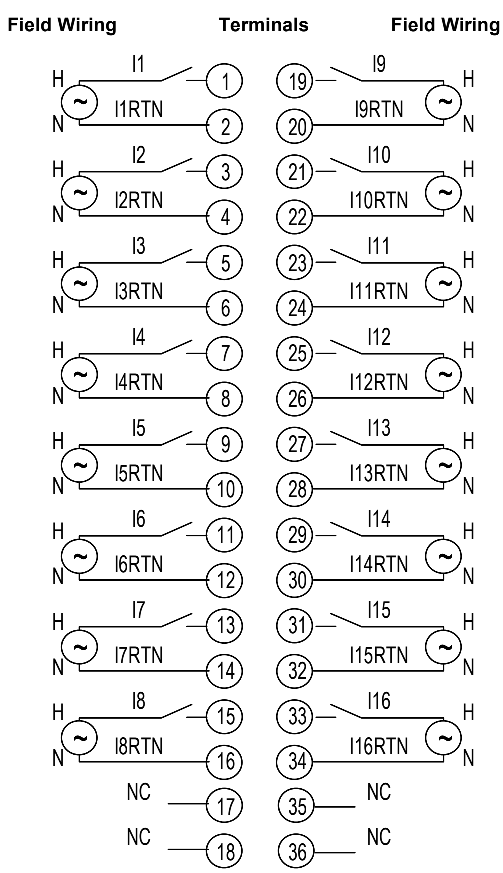
If an input filter time should be applied to all the module's inputs, input filtering should be enabled in the module's software configuration. The Digital Filter Settings Length must be set to 16, and a memory location to be used for the filter value must be specified. Configuring a Digital Filter Settings Length of 0 disables the input filter.

During system operation, the input filter time can be changed from the programmer by entering a filter setting value from 1 to 127 decimal (1_{hex} to $7F_{hex}$) into the assigned memory location. This filter setting value is equal to the new filter time divided by 20 decimal. For example, to change the filter time to 200ms, enter the value 10_{dec} ($0A_{hex}$) into the memory location. Some example filter times and their hexadecimal setting values are listed below.

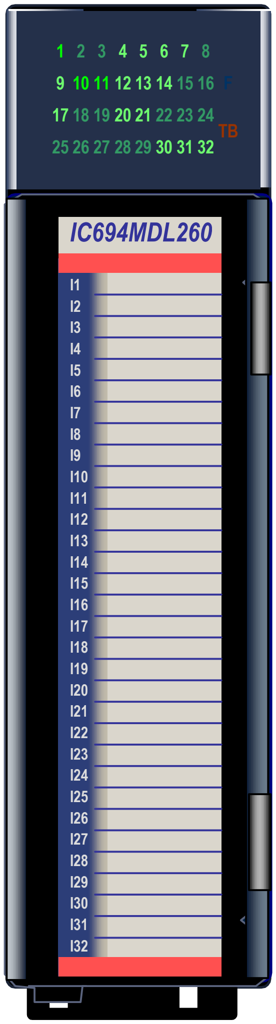
Setting (hexadecimal)	*Filter Time in ms*	*Setting (hexadecimal)*	*Filter Time in ms*	*Setting (hexadecimal)*	*Filter Time in ms*
0A	200	21	660	5A	1800
0F	300	22	680	5F	1900
11	340	2A	840	71	2260
12	360	2F	940	72	2280
1A	520	51	1620	7A	2240
1F	620	52	1660	7F	2540

Field Wiring: IC694MDL250

Connections	*Terminals*	*Terminals*	*Connections*
Input 1	1	19	Input 9
Input 1 Return	2	20	Input 9 Return
Input 2	3	21	Input 10
Input 2 Return	4	22	Input 10 Return
Input 3	5	23	Input 11
Input 3 Return	6	24	Input 11 Return
Input 4	7	25	Input 12
Input 4 Return	8	26	Input 12 Return
Input 5	9	27	Input 13
Input 5 Return	10	28	Input 13 Return
Input 6	11	29	Input 14
Input 6 Return	12	30	Input 14 Return
Input 7	13	31	Input 15
Input 7 Return	14	32	Input 15 Return
Input 8	15	33	Input 16
Input 8 Return	16	34	Input 16 Return
No connection	17	35	No connection
No connection	18	36	No connection



Input Module, 120 Volt AC, 32 Point: IC694MDL260



The ***120VAC Grouped Input*** module, IC694MDL260, provides 32 discrete input points. The inputs are arranged in four isolated groups of eight. Isolation is provided between the four groups of inputs, however all inputs within a group are referenced to the same user common connection.

Module MDL260 can be used with a Box-style (IC694TBB032), Extended Box-style (IC694TBB132), Spring-style (IC694TBS032), or Extended Spring-style (IC694TBS132) Terminal Block. Extended terminal blocks provide the extra shroud depth typically needed for field wiring to AC devices. See chapter 15 for more information about Terminal Blocks. The Terminal Block is ordered separately.

Input filter times can be set from the programmer using the module's assigned output data references.

Individually-numbered LEDs indicate the ON/OFF status of points 1 through 32. The red/green TB LED is green when the module's removable terminal block is locked in place. It is red when the terminal block is not locked. The module also sends an Terminal Block status message to the RX3i CPU.

The red bands on the label show that MDL260 is a high-voltage module.

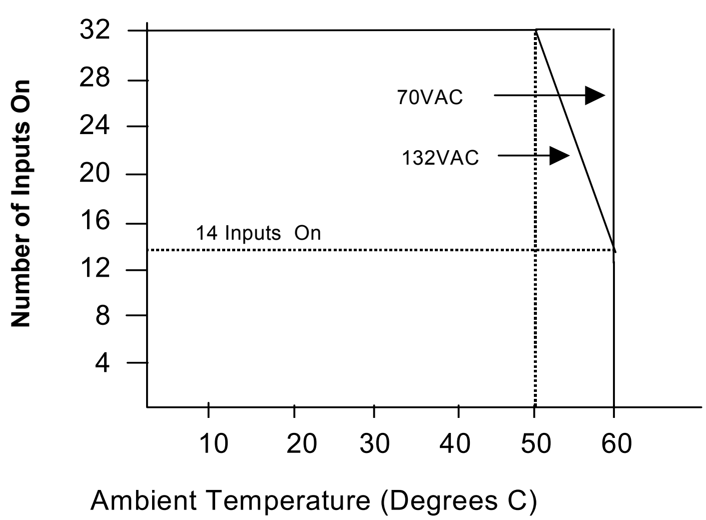
This module can be installed in any I/O slot in an RX3i system. It must be used with an RX3i CPU (release 3.50 or greater). It cannot be used with a Series 90-30 PLC CPU.

Specifications: IC694MDL260

Rated Voltage	120 volts AC
Input Voltage Range	0 to 132 VAC (47 to 63Hz)
Inputs per Module	32 (four isolated groups of 8 inputs)
Input Filter Times	20ms to 2540ms in 20ms increments. Sent from CPU.
Input Current	7.0 mA per point (typical) at rated voltage
Isolation:	
Field to Backplane (optical)	264VAC continuous; 1500 VAC for one minute
Group to Group	264VAC continuous; 1500 VAC for one minute
Thermal Derating	See next page
Power Consumption	220mA at 5VDC with all inputs on
Diagnostics	Terminal block presence reported to RX3i CPU
Input Characteristics:	
On–state Voltage	70 to 132 VAC
Off–state Voltage	0 to 20 VAC
On–state Current	5mA minimum
Off–state Current	2.5mA maximum
On/Off response Time	±0-1 AC cycles for filter times up to 840ms ±1-2 AC cycles for filter times of 840 to 1600ms ±2-3 AC cycles for filter times of 1600 to 1920ms ±3-4 AC cycles for filter times of 1920ms or more

Thermal Derating

The number of inputs that can be on at the same time depends on the ambient temperature:



Input Filter Setup

If an input filter time should be applied to all the module's inputs, input filtering should be enabled in the module's software configuration. For an MDL260 module installed in an RX3i main backplane, this is done by setting the Digital Filter Settings Length to 16 and specifying a memory location for the data. Configuring a Digital Filter Settings Length of 0 disables the input filter.

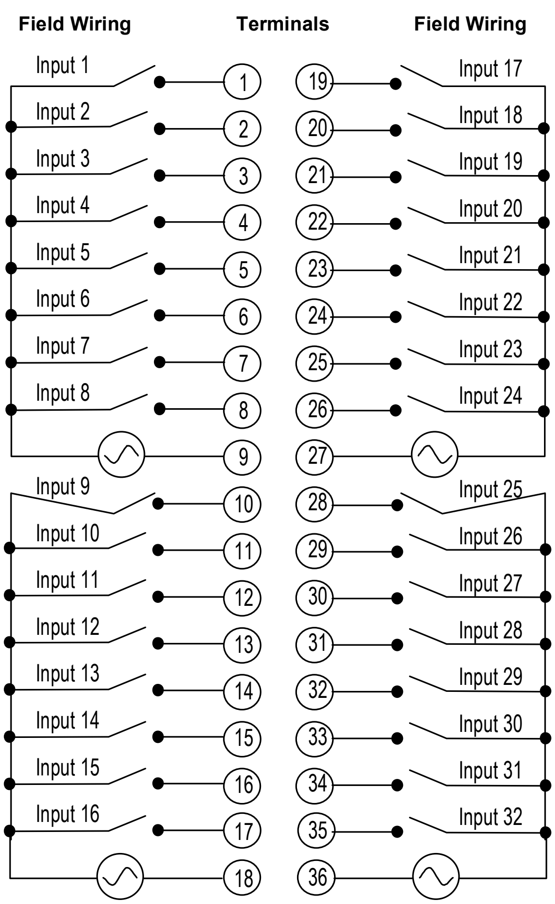
During system operation, the input filter time can easily be changed from the programmer by entering a filter setting value from 1 to 127 decimal (1_{hex} to $7F_{hex}$) into the assigned memory location. This filter setting value is equal to the new filter time divided by 20. For example, to change the filter time to 200ms, enter the value 10_{dec} (200 / 20 = 10) into the memory location. The input filter time is automatically sent to the module each scan.

Some example filter times and their hexadecimal setting values are listed below.

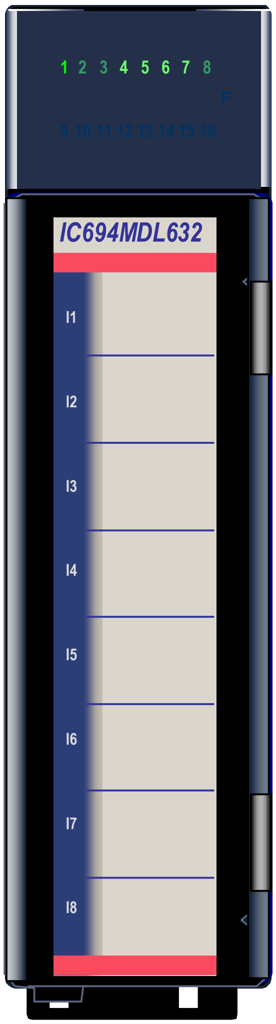
Setting (hexadecimal)	*Filter Time in ms*	*Setting (hexadecimal)*	*Filter Time in ms*	*Setting (hexadecimal)*	*Filter Time in ms*
0A	200	21	660	5A	1800
0F	300	22	680	5F	1900
11	340	2A	840	71	2260
12	360	2F	940	72	2280
1A	520	51	1620	7A	2240
1F	620	52	1660	7F	2540

Field Wiring: MDL260

Connections	***Terminals***	***Terminals***	***Connections***
Input 1	1	19	Input 17
Input 2	2	20	Input 18
Input 3	3	21	Input 19
Input 4	4	22	Input 20
Input 5	5	23	Input 21
Input 6	6	24	Input 22
Input 7	7	25	Input 23
Input 8	8	26	Input 24
Common 1 - 8	9	27	Common 17 - 24
Input 9	10	28	Input 25
Input 10	11	29	Input 26
Input 11	12	30	Input 27
Input 12	13	31	Input 28
Input 13	14	32	Input 29
Input 14	15	33	Input 30
Input 15	16	34	Input 31
Input 16	17	35	Input 32
Common 9 - 16	18	36	Common 25 - 32



Input Module, 125 Volt DC Pos/Neg, 8 Point: IC694MDL632



The ***125 volt DC Positive/Negative Logic Input*** module, IC694MDL632, provides 8 input points in two isolated groups with four points in each group. Each group has a separate common (the two commons are not tied together inside the module). Each group can be wired for either positive or negative logic. Current into an input point results in a logic 1 in the input status table (%I). Input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Power to operate field devices must be supplied by the user.

Eight green LEDs indicate the ON/OFF status of points 1 through 8. The red bands on the label show that MDL632 is a high-voltage module.

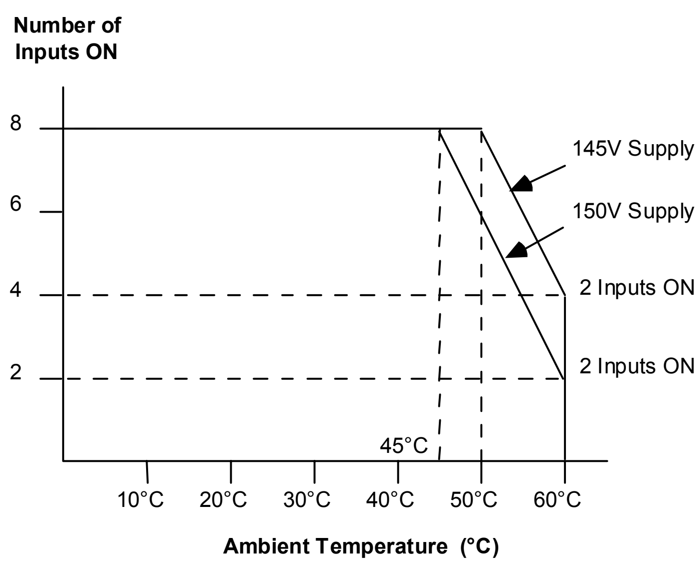
This module can be installed in any I/O slot in an RX3i system.

Specifications: MDL632

Rated Voltage	125 volts DC (Positive or Negative Logic)
Input Voltage Range	0 to +150 volts DC
Inputs per Module	8 (two groups of four inputs) Maximum number of inputs on at the same time depends on ambient temperature as shown.
Isolation:	
Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for one minute
Group to Group	250 VAC continuous; 1500 VAC for one minute
Input Current	4.5 mA typical
Input Characteristics	
On–state Voltage	90 to 150 volts DC
Off–state Voltage	0 to 30 volts DC
On–state Current	3.1mA
Off–state Current	1.1mA maximum
On response Time	7ms typical
Off response Time	7ms typical
Power Consumption	40mA from the 5 volt bus on the backplane 36mA (typical) from user input supply (all inputs ON)

Refer to Appendix A for product standards and general specifications.

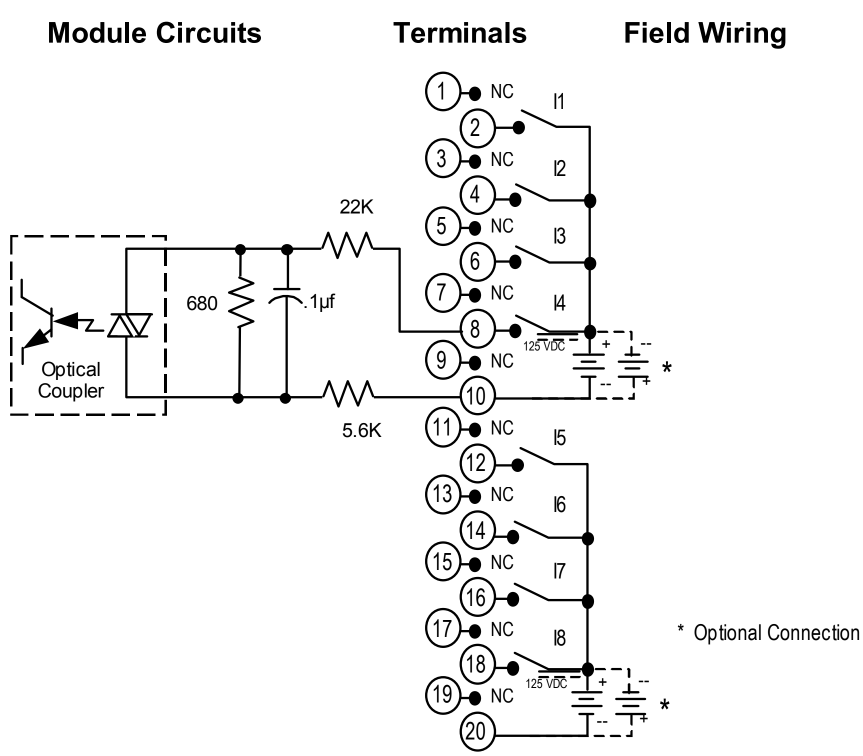
Input Points vs. Temperature



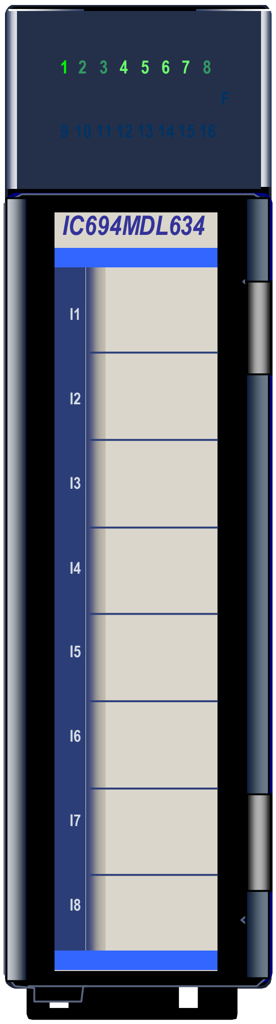
Field Wiring: MDL632

Terminals	***Connections***
1	No connection
2	Input 1
3	No connection
4	Input 2
5	No connection
6	Input 3
7	No connection
8	Input 4
9	No connection
10	Inputs 1-4 Common
11	No connection
12	Input 5
13	No connection
14	Input 6
15	No connection
16	Input 7
17	No connection
18	Input 8
19	No connection
20	Inputs 5-8 Common

Negative logic connections are shown with dashed lines in the diagram below.



Input Module, 24 Volt DC Pos/Neg, 8 Point: IC694MDL634



The ***24 volt DC Positive/Negative Logic Input*** module, IC694MDL634, provides 8 input points in one group with a common power input terminal. This input module can be wired for either positive logic or negative logic. Input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Current into an input point results in a logic 1 in the input status table (%I). Field devices can be powered from an external supply. Depending on their requirements, some input devices can be powered from the module's +24V OUT and 0V OUT terminals.

Eight green LEDs indicate the ON/OFF status of points 1 through 8. The blue bands on the label show that MDL634 is a low-voltage module. This module can be installed in any I/O slot in an RX3i system.

Specifications: MDL634

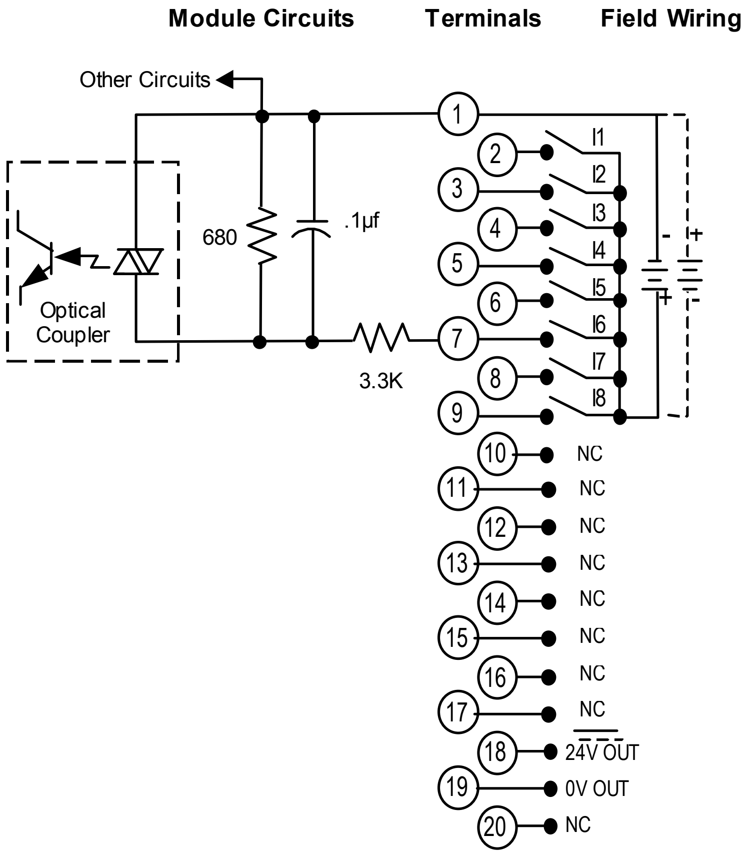
Rated Voltage	24 volts DC
Input Voltage Range	0 to +30 volts DC
Inputs per Module	8 (one group with a single common)
Isolation: Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for one minute
Input Current	7mA (typical) at rated voltage
Input Characteristics	
On–state Voltage	11.5 to 30 volts DC
Off–state Voltage	0 to +5 volts DC
On–state Current	3.2mA minimum
Off–state Current	1.1mA maximum
On response Time	7ms typical
Off response Time	7ms typical
Power Consumption: 5V	45mA (all inputs on) from 5 volt bus on backplane
Power Consumption: 24V	62mA from the Isolated 24 volt backplane bus or from user supplied power

Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL634

Terminals	**Connections**
1	Inputs 1-8 Common
2	Input 1
3	Input 2
4	Input 3
5	Input 4
6	Input 5
7	Input 6
8	Input 7
9	Input 8
10	No connection
11	No connection
12	No connection
13	No connection
14	No connection
15	No connection
16	No connection
17	No connection
18	24VDC for input devices
19	0V for input devices
20	No connection

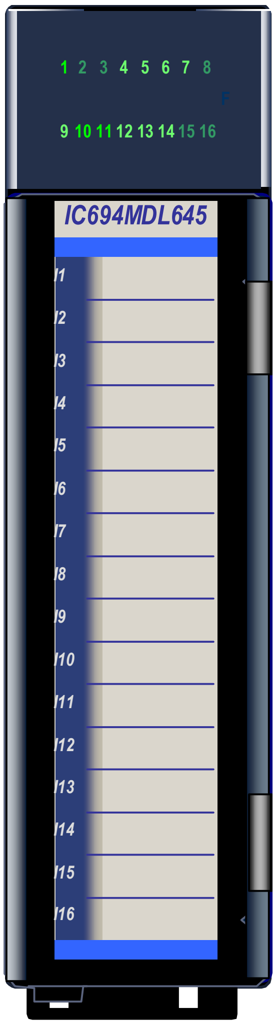
Negative logic connections are shown with dashed lines in the diagram below.



Note: If the 24V OUT pin is used to connect to input devices in the field, the isolation specification for this module changes to:

Field to Backplane (optical) and to frame ground: 50 VAC continuous; 500 VAC for 1 minute

Input Module, 24 Volt DC Pos/Neg, 16 Point: IC694MDL645



The ***24 volt DC Positive/Negative Logic Input*** module, IC694MDL645, provides 16 input points in one group with a common power input terminal. This input module can be wired for either positive logic or negative logic. Input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Current into an input point results in a logic 1 in the input status table (%I). Field devices can be powered from an external supply. Depending on their requirements, some input devices can be powered from the module's +24V OUT and 0V OUT terminals.

Sixteen green LEDs indicate the ON/OFF status of points 1 through 16. The blue bands on the label show that MDL645 is a low-voltage module.

This module can be installed in any I/O slot in an RX3i system.

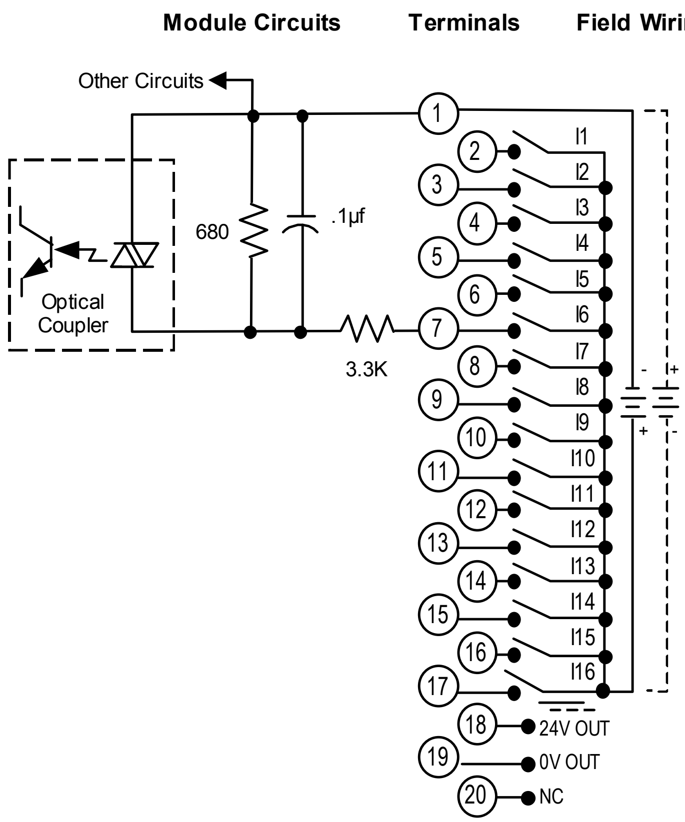
Specifications: MDL645

Rated Voltage	24 volts DC
Input Voltage Range	0 to +30 volts DC
Inputs per Module	16 (one group with a single common)
Isolation: Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for one minute
Input Current	7mA (typical) at rated voltage
Input Characteristics	
On–state Voltage	11.5 to 30 volts DC
Off–state Voltage	0 to +5 volts DC
On–state Current	3.2mA minimum
Off–state Current	1.1mA maximum
On response Time	7ms typical
Off response Time	7ms typical
Power Consumption: 5V	80mA (all inputs on) from 5 volt bus on backplane
Power Consumption: 24V	125mA from the Isolated 24 volt backplane bus or from user supplied power

Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL645

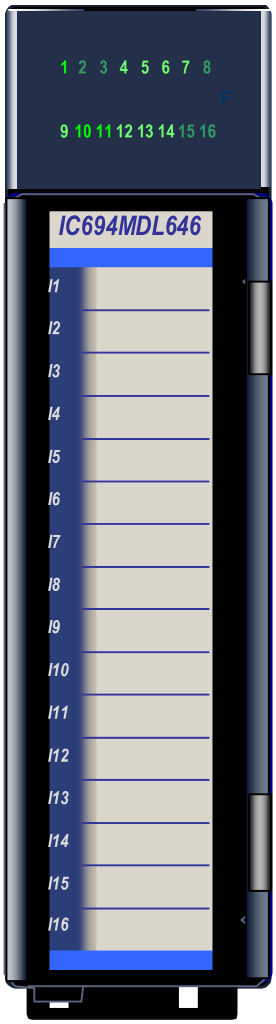
Terminals	*Connections*
1	Inputs 1-16 Common
2	Input 1
3	Input 2
4	Input 3
5	Input 4
6	Input 5
7	Input 6
8	Input 7
9	Input 8
10	Input 9
11	Input 10
12	Input 11
13	Input 12
14	Input 13
15	Input 14
16	Input 15
17	Input 16
18	24VDC for input devices
19	0V for input devices
20	No connection



Note: If the 24V OUT pin is used to connect to input devices in the field, the isolation specification for this module changes to:

Field to Backplane (optical) and to frame ground: 50 VAC continuous; 500 VAC for 1 minute

Input Module: 24 Volt DC 16 Point Pos/Neg Logic: IC694MDL646



The ***24VDC Positive/Negative Logic 16 Point Input*** module, IC694MDL646, provides 16 input points in one group with a common power input terminal. *The on and off response times for this module are typically 1 ms.* This input module can be wired for either positive logic or negative logic. Input characteristics are compatible with a wide range of input devices, such as pushbuttons, limit switches, and electronic proximity switches. Current into an input point results in a logic 1 in the input status table (%I). Field devices can be powered from an external supply. Depending on their requirements, some input devices can be powered from the module's +24V OUT and 0V OUT terminals.

Sixteen green LEDs indicate the ON/OFF status of points 1 through 16. The blue bands on the label show that MDL646 is a low-voltage module.

This module can be installed in any I/O slot in an RX3i system.

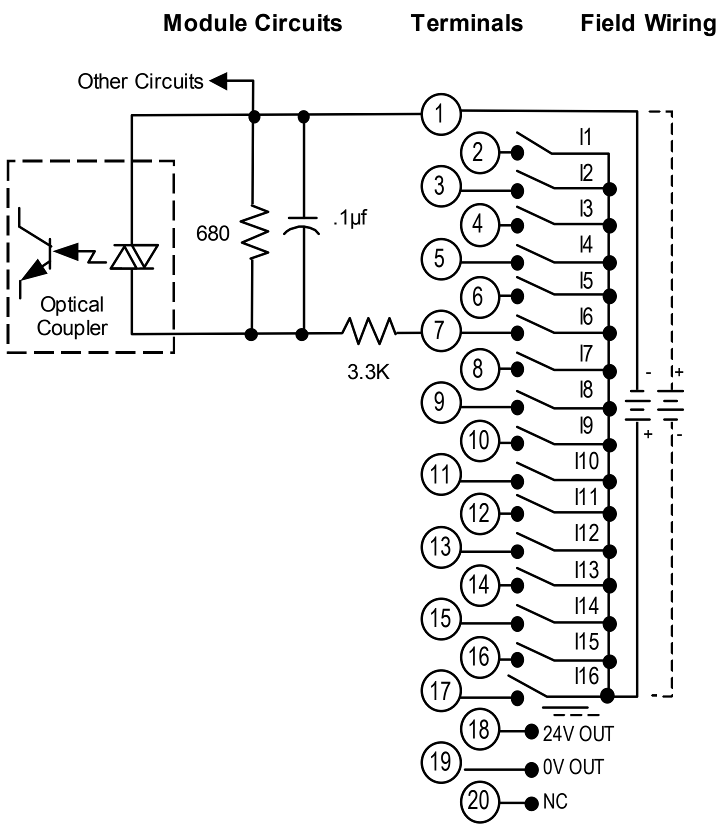
Specifications: MDL646

Rated Voltage	24 volts DC
Input Voltage Range	0 to +30 volts DC
Inputs per Module	16 (one group with a single common)
Isolation: Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for one minute
Input Current	7mA (typical) at rated voltage
Input Characteristics	
On–state Voltage	11.5 to 30 volts DC
Off–state Voltage	0 to +5 volts DC
On–state Current	3.2mA minimum
Off–state Current	1.1mA maximum
On response Time	1ms typical
Off response Time	1ms typical
Power Consumption: 5V	80mA (all inputs on) from 5 volt bus on backplane
Power Consumption: 24V	125mA from the Isolated 24 volt backplane bus or from user supplied power

Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL646

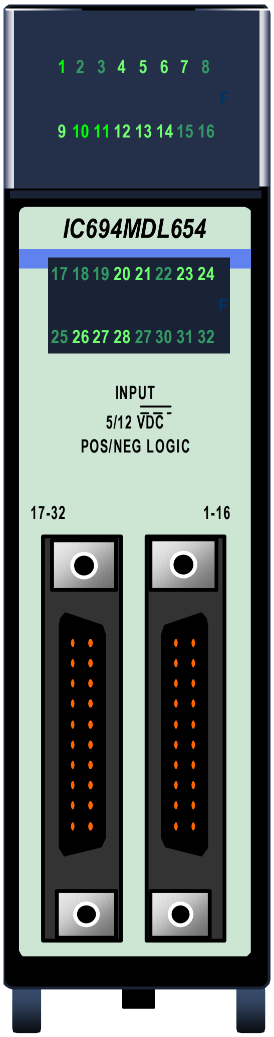
Terminals	*Connections*
1	Inputs 1-16 Common
2	Input 1
3	Input 2
4	Input 3
5	Input 4
6	Input 5
7	Input 6
8	Input 7
9	Input 8
10	Input 9
11	Input 10
12	Input 11
13	Input 12
14	Input 13
15	Input 14
16	Input 15
17	Input 16
18	24VDC for input devices
19	0V for input devices
20	No connection



Note: If the 24V OUT pin is used to connect to input devices in the field, the isolation specification for this module changes to:

Field to Backplane (optical) and to frame ground: 50 VAC continuous; 500 VAC for 1 minute

Input Module, 5/12 VDC (TTL) 32 Point Pos/Neg Logic: IC694MDL654



The ***5/12VDC (TTL) 32 Point Positive/Negative Logic Input*** module, IC694MDL654 provides 32 discrete TTL voltage threshold input points. The inputs are arranged in four isolated groups of eight. Each group has its own common. The inputs are positive or negative logic inputs that operate at levels up to 15V.

A single, regulated +5V supply (current limited to approximately 150mA) is available through the I/O connectors on the front of the module. This supply is generated on the module and is isolated from the backplane. Its power input comes from the +5V logic supply on the PLC backplane. By installing jumpers on the I/O connector, you can choose to power the inputs from this internal supply instead of powering them with an external user provided supply.

This module does not report special fault or alarm diagnostics. Green LEDs indicate the ON/OFF status of each input point. The blue band on the front label shows that MDL654 is a low-voltage module.

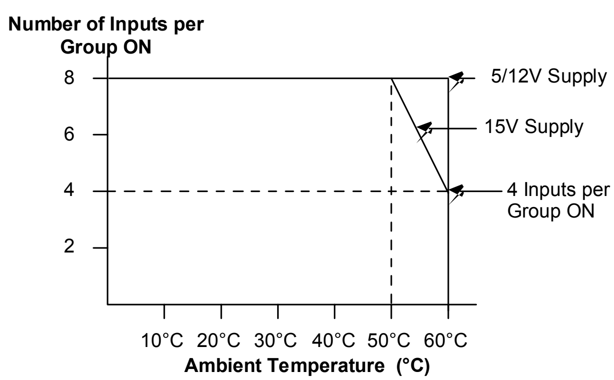
This module can be installed in any I/O slot in the RX3i system.

Specifications: MDL654

Rated Voltage	5 to 12 volts DC, Positive or Negative Logic
Input Voltage Range	0 to 15 volts DC
Inputs per Module	32 (four groups of eight inputs each) *98.4 feet (30 meters), maximum cable length* Maximum number of inputs per group on at the same time depends on the ambient temperature as shown below.
Isolation:	
Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for one minute
Group to Group	50 VAC continuous; 500 VAC for one minute
Input Current	3.0mA (typical ON current @ 5VDC) 8.5mA (typical ON current @ 12VDC)
Input Characteristics	
On–state Voltage	4.2 to 15 volts DC
Off–state Voltage	0 to 2.6 volts DC
On–state Current	2.5mA (minimum)
Off–state Current	1.2mA (maximum)
On response Time	1ms maximum
Off response Time	1ms maximum
Internal Power Consumption	195mA (maximum) from +5V bus on backplane; (29mA + 0.5mA/point ON + 4.7mA/LED ON) 440mA (maximum) from +5V bus on backplane (if module isolated +5V supply used to power inputs and all 32 inputs ON) 96mA (typical) from user input supply @ 5VDC and 32 inputs ON) 272mA (typical) from user input supply @ 12VDC and 32 inputs ON)
Isolated +5V Supply	+5 volts DC +/-5%
Current limit	150mA (typical)

Refer to Appendix A for product standards and general specifications.

Input Points vs. Temperature

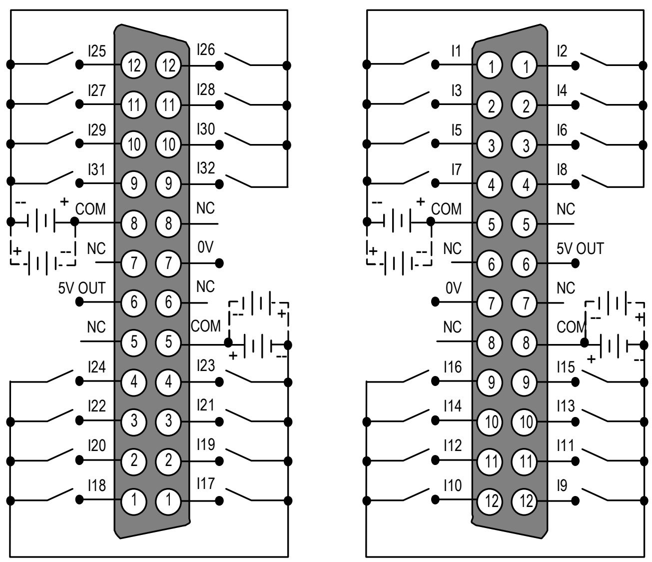


Field Wiring: MDL654

The blue band on the label shows that MDL654 is a low-voltage module.

Connections are made to two male 24–pin connectors (Fujitsu FCN–365P024–AU) on the front of the module. Wiring from the connectors to field devices is made through a cable having a mating female connector on one end and stripped and tinned wires on the other end. You can purchase a pair of pre–wired cables, catalog numbers IC693CBL327 and IC693CBL328 or build cables. See Appendix B for more information.

Conventional TTL wiring practices should be followed when installing this module. For noise immunity, I/O control lines connected to the module must be less than 30 meters in length (signal attenuation limits wiring length to less than this maximum).

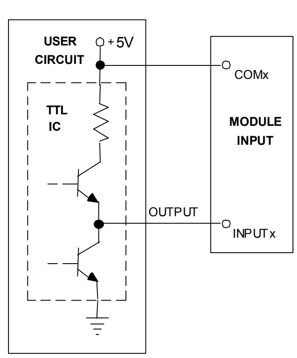


Note: If the 24V OUT pin is used to connect to input devices in the field, the isolation specification for this module changes to: Note: If the 24V OUT pin is used to connect to input devices in the field, the isolation specification for this module changes to:

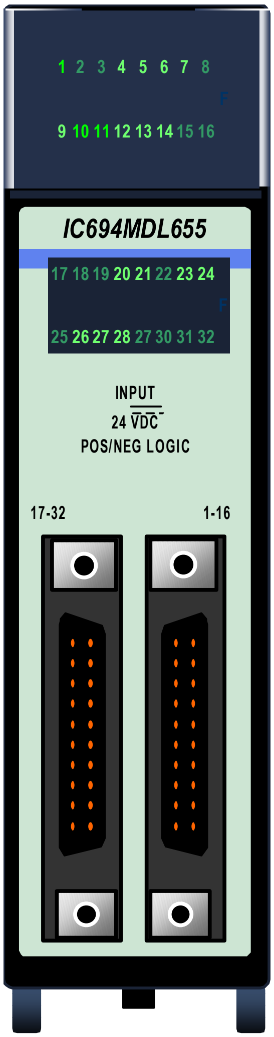
Field to Backplane (optical) and to frame ground: 50 VAC continuous; 500 VAC for 1 minute

TTL Wiring

To be compatible with TTL outputs, the negative logic configuration should be used as shown below.



Input Module, 24 VDC Pos/Neg Logic, 32 Point: IC694MDL655



The ***24VDC Positive/Negative Logic Input*** module, IC694MDL655, provides 32 discrete input points. The inputs are positive or negative logic inputs and will operate at levels up to 30V.

The inputs are arranged in four isolated groups of eight; each group has its own common. Isolation is provided between the four groups of inputs, however each group of eight inputs is referenced to the same user common connection. This module reports no special fault or alarm diagnostics.

Power to operate field devices can come from an external supply or from the module’s isolated +24 VDC output.

Green LEDs indicate the ON/OFF status of each point. The blue band on the front shows that MDL655 is a low-voltage module.

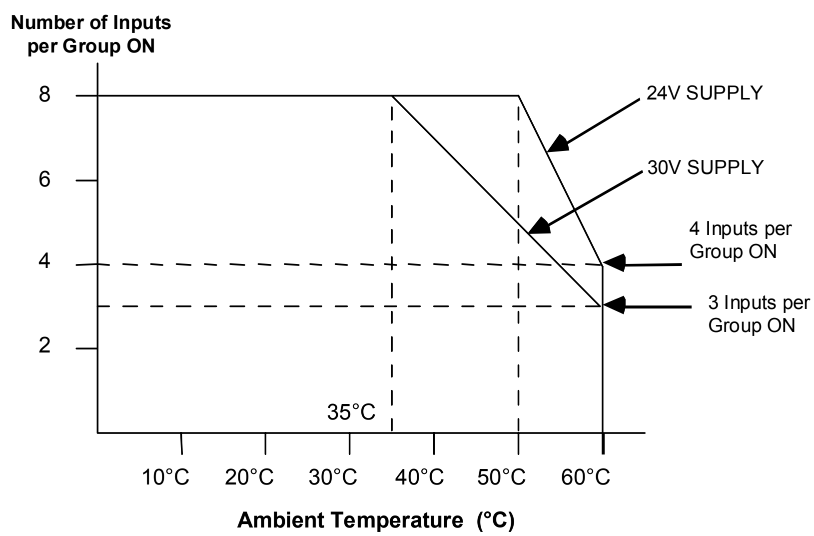
This module can be installed in any I/O slot in the RX3i system.

Specifications: MDL655

Rated Voltage	24 volts DC, Positive or Negative Logic
Input Voltage Range	0 to 30 volts DC
Inputs per Module	32 (four groups of eight inputs each) The maximum number of inputs on at the same time depends on the ambient temperature, as shown below.
Isolation:	
Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for one minute
Group to Group	50 VAC continuous; 500 VAC for one minute
Input Current	7.0mA (typical ON current @ 24 VDC)
Input Characteristics	
On–state Voltage	11.5 to 30 volts DC
Off–state Voltage	0 to 5 volts DC
On–state Current	3.2mA (minimum)
Off–state Current	1.1mA (maximum)
On response Time	2ms maximum
Off response Time	2ms maximum
Internal Power Consumption	195mA (maximum) from +5V bus on backplane; (29mA +0.5mA/point ON +4.7mA/LED ON) 224mA (typical) from isolated +24V bus on backplane or from user input supply @ 24VDC and all 32 inputs ON)

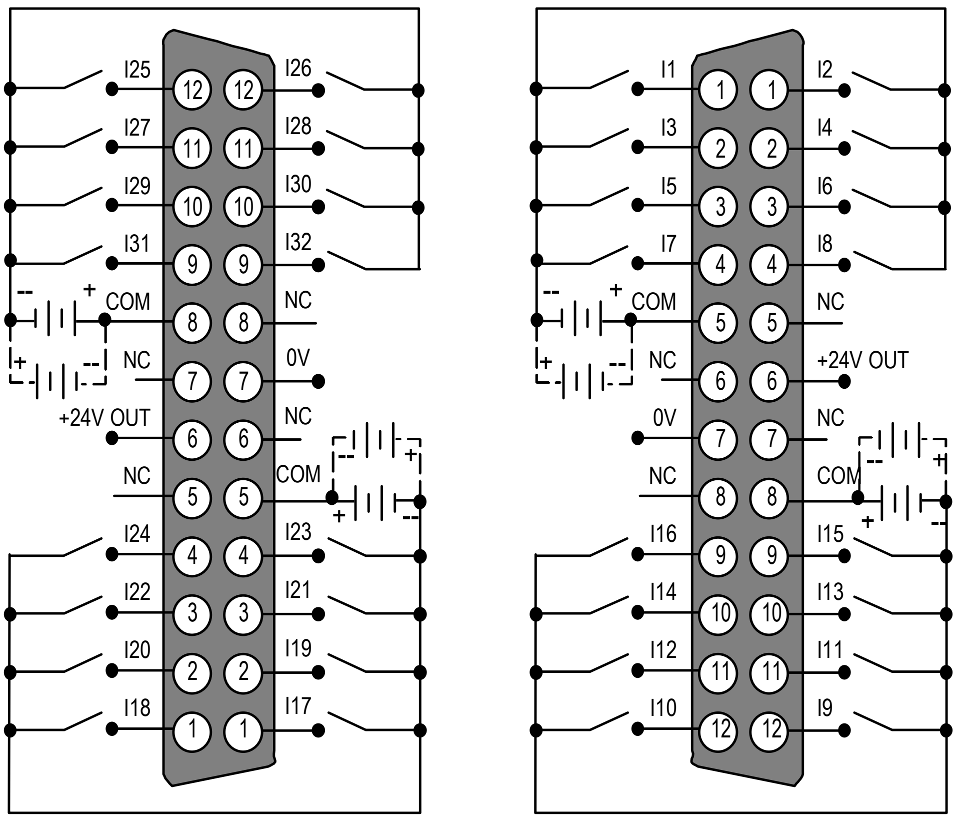
Refer to Appendix A for product standards and general specifications.

Input Points vs. Temperature



Field Wiring: MDL655

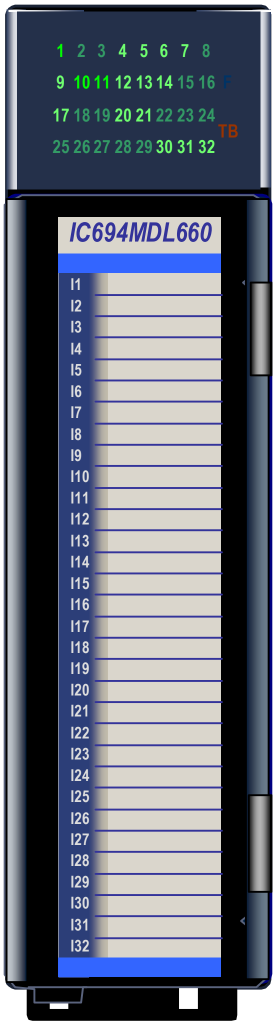
Connections are made to two male 24–pin connectors (Fujitsu FCN–365P024–AU) on the front of the module. Wiring from the module's connectors to field devices is made through a cable having a mating female connector on one end and stripped and tinned wires on the other end. You can purchase a pair of pre–wired cables, catalog numbers IC693CBL327 and IC693CBL328 or build cables. See appendix B for more information.



Note: If the 24V OUT pin is used to connect to input devices in the field, the isolation specification for this module changes to:

Field to Backplane (optical) and to frame ground: 50 VAC continuous; 500 VAC for 1 minute

Input Module, 24 VDC 32 Point Grouped: IC694MDL660



The ***24 VDC Positive/Negative Logic Input*** module, IC694MDL660, provides 32 discrete input points. The inputs are positive or negative logic inputs and will operate at levels up to 30V.

The inputs are arranged in four isolated groups of eight; each group has its own common. Isolation is provided between the four groups of inputs, however each group of eight inputs is referenced to the same user common connection.

Module MDL660 provides seven selectable input filter times. Filter times can be set from the programmer using the module's assigned output data references.

This module can be used with either a Box-style (IC694TBB032) or Spring-style (IC694TBS032) front Terminal Block. The Terminal Block is ordered separately.

32 green LEDs indicate the ON/OFF status of points 1 through 32. The red/green TB LED is green when the module's removable terminal block is locked in place. It is red when the terminal block is not locked. The module also sends an *Addition of Terminal Block* or *Loss of Terminal Block* message to the RX3i CPU to report the terminal block status.

The blue bands on the label show that MDL660 is a low-voltage module.

This module can be installed in any I/O slot in an RX3i system. It must be used with an RX3i CPU (release 2.90 or later). It cannot be used with a Series 90-30 PLC CPU.

Module MDL660 uses 48 input bits and 16 output bits to exchange point status and filter information with the RX3i CPU.

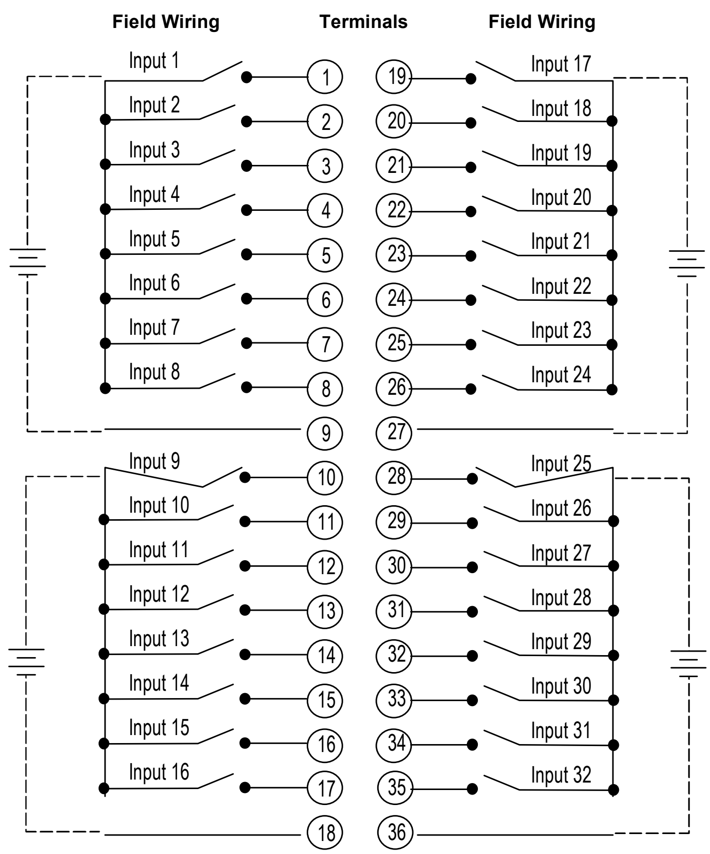
Specifications: MDL660

Rated Voltage	24 volts DC
Input Voltage Range	0 to 30 volts DC
Inputs per Module	32 (four isolated groups of 8 inputs)
Isolation:	
Field to Backplane (optical)	250 VAC continuous; 1500 VAC for one minute
Group to Group	250VAC continuous; 1500 VAC for one minute
Input Current	7.0 mA per point (typical) at rated voltage
Module ID	0x058h
Input Characteristics:	
On–state Voltage	11.5 to 30 VDC
Off–state Voltage	0 to 5 VDC
On–state Current	3.2mA minimum
Off–state Current	1.1mA maximum
Input Filter Times	0.5ms, 1.0ms, 2.0ms, 5ms, 10ms, 50ms and 100ms, selectable per module
On response time	0.5ms, 1.0ms, 2.0ms, 5.0ms, 10.0ms, 50.0ms & 100.0ms (as per filter setting)
Off response time	0.5ms, 1.0ms, 2.0ms, 5.0ms, 10.0ms, 50.0ms & 100.0ms (as per filter setting)
Power Consumption	300mA (all inputs on) from 5 volt bus on backplane
Diagnostics	Terminal block presence reported to RX3i CPU

Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL660

Connections	Terminals	Terminals	Connections
Input 1	1	19	Input 17
Input 2	2	20	Input 18
Input 3	3	21	Input 19
Input 4	4	22	Input 20
Input 5	5	23	Input 21
Input 6	6	24	Input 22
Input 7	7	25	Input 23
Input 8	8	26	Input 24
Common 1 - 8	9	27	Common 17 - 24
Input 9	10	28	Input 25
Input 10	11	29	Input 26
Input 11	12	30	Input 27
Input 12	13	31	Input 28
Input 13	14	32	Input 29
Input 14	15	33	Input 30
Input 15	16	34	Input 31
Input 16	17	35	Input 32
Common 9 - 16	18	36	Common 25 - 32

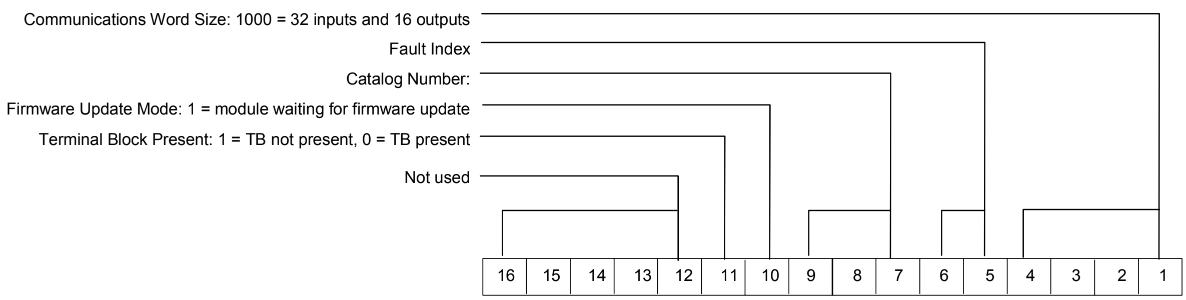


Module Data: IC694MDL660

Discrete Input Module IC694MDL660 uses 48 input reference bits and 16 output reference bits in the CPU.

Input Data: MDL660

The module uses the first 11 input bits to report its status information to the RX3i CPU. It has the following content:



Bits 12 – 16 are not used.

The CPU uses the information contained in these input bits to uniquely identify the module, and to monitor its Board Ready and Terminal Block status.

The module reports input point data in bits 17 - 48.

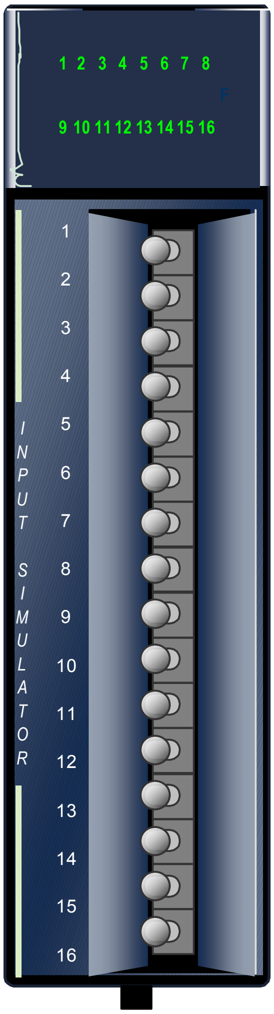
Input Status Bits			
Input Group 1	*Input Group 2*	*Input Group 3*	*Input Group 4*
Bits 17-24	Bits 25-32	Bits 33-40	Bits 41-48

Output Data: MDL660

The module receives 16 bits of output data from the RX3i CPU. Bits 0- 8 contains the filter time configuration data as shown below. Bits 9 - 16 are not used.

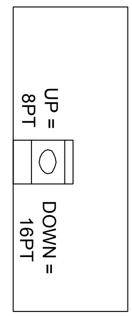
Binary Value in the Output Reference Bits	***Filter Time***
0000	0.5ms
0001	1ms
0011	2ms
1001	5ms
10011	10ms
1100011	50ms
11000111	100ms

Input Simulator, 8/16 Point: IC694ACC300



The ***Input Simulator*** module, IC694ACC300, can be used to simulate the operation of 8-point or 16-point discrete input modules. The Input Simulator has no field connections.

The Input Simulator can be substituted for actual inputs until the program or system is debugged. It can also remain permanently installed to provide either 8 or 16 conditional input contacts for manual control of output devices.



Before the Input Simulator module is installed, a switch in the back of the module can be used to set it up for either 8 point- or 16 point-operation. When this switch is set for 8 points, only the first 8 toggle switches on the front of the Input Simulator can be used.

Toggle switches on the front of the Input Simulator simulate the operation of discrete input devices. A switch in the ON position results in a logic 1 in the input table (%I).

Individual green LEDs indicate the ON or OFF position of each toggle switch. This module can be installed in any I/O slot in an RX3i system.

Specifications: ACC300

Inputs per Module	8 or 16 (switch selectable)
Off Response Time	20 milliseconds maximum
On Response Time	30 milliseconds maximum
Internal Power Consumption	120mA (all inputs on) from 5 volt bus on backplane

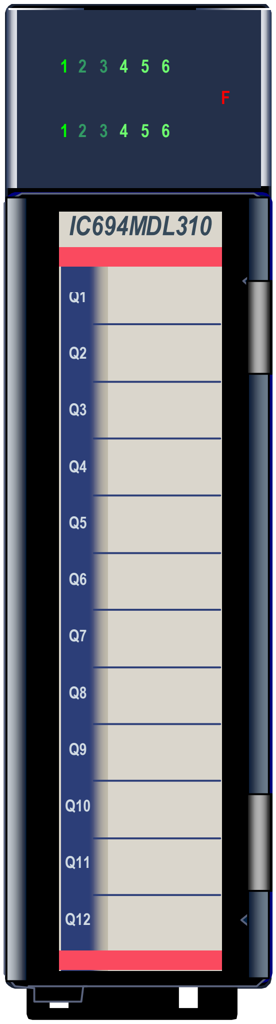
Refer to Appendix A for product standards and general specifications.

Chapter 7 Discrete Output Modules

This chapter describes discrete output modules for PACSystems RX3i controllers.

Discrete Output Module	*Catalog Number*
Output 120 VAC 0.5 A 12 Point	IC694MDL310
Output 120/240 VAC 2 A 8 Point	IC694MDL330
Output 120 VAC 0.5 A 16 Point	IC694MDL340
RX3i Output 124/240 VAC Isolated 16 Point	IC694MDL350
Output 120/240 VAC 2 A 5 Point Isolated	IC694MDL390
Output 12/24 VDC 0.5 A 8 Point Positive Logic	IC694MDL732
Output 125 VDC 1 A 6 Point Isolated Pos/Neg Logic	IC694MDL734
Output 12/24 VDC 0.5 A 16 Point Positive Logic	IC694MDL740
Output 12/24 VDC 0.5 A 16 Point Negative Logic	IC694MDL741
Output 12/24 VDC 1 A 16 Point Positive Logic ESCP	IC694MDL742
Output 5/24 VDC (TTL) 0.5 A 32 Point Negative Logic	IC694MDL752
Output 12/24 VDC 0.5 A 32 Point Positive Logic	IC694MDL753
Output 12/24VDC ESCP 0.75A 32 Point Grouped, Pos.	IC694MDL754
Output Isolated Relay N.O. 4 A 8 Point	IC694MDL930
Output Isolated Relay N.C. and Form C 3 A 8 Point	IC694MDL931
Output Relay N.O. 2 A 16 Point	IC694MDL940

Output Module, 120 Volt AC, 0.5 Amp, 12 Point: IC694MDL310



The ***120 volt, 0.5 Amp AC Output*** module, IC694MDL310, provides 12 output points in two isolated groups of six points. Each group has a separate common. The two commons are not tied together inside the module. The groups can be used on different phases of the AC supply or powered from the same supply. Each group is protected with a 3 Amp fuse. An RC snubber for each output protects against transient electrical noise on the power line. This module provides a high degree of inrush current (10x the rated current) so the outputs can control a wide range of inductive and incandescent loads. AC power to operate loads connected to outputs must be user supplied. This module requires an AC power source; *it cannot be used with a DC power source*.

Individual numbered LEDs show the ON/OFF status of each output point. The red LED (F) turns ON if an output fuse blows. The red bands on the label show that MDL310 is a high-voltage module.

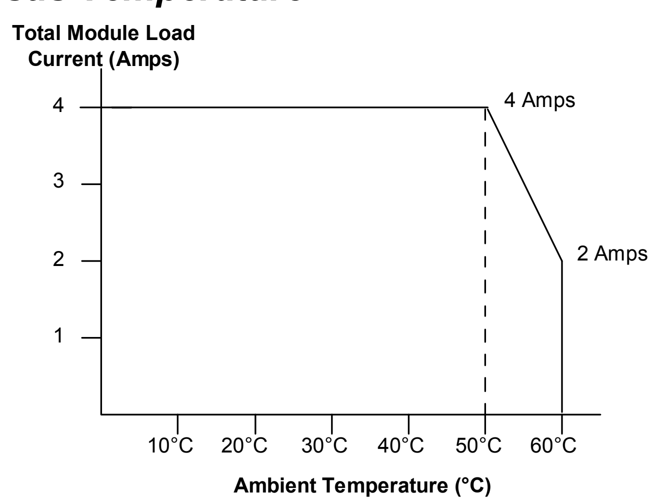
This module can be installed in any I/O slot in an RX3i system.

Specifications: MDL310

Rated Voltage	120 volts AC
Output Voltage Range	85 to 132 volts AC, 50/60 Hz
Outputs per Module	12 (two groups of six outputs each)
Isolation:	
Field to Backplane (optical) and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Group to Group	250 VAC continuous; 1500 VAC for 1 minute
Output Current	0.5 Amp maximum per point 1 Amp maximum per group at 60°C (140°F) 2 Amps maximum per group at 50°C (122°F) Maximum load current depends on ambient temperature as shown below
Output Characteristics	
Inrush Current	5 Amps maximum for one cycle
Minimum Load Current	50mA
Maximum Load Current	
Output Voltage Drop	1.5 volts maximum
Output Leakage Current	3mA maximum at 120 volts AC
On Response Time	1ms maximum
Off Response Time	1/2 cycle maximum
Power Consumption	210mA (all outputs on) from 5 volt bus on backplane
Fuses (quantity 2)	3 Amps, GE Fanuc part #44A724627-111(1). See chapter 2 for more information.

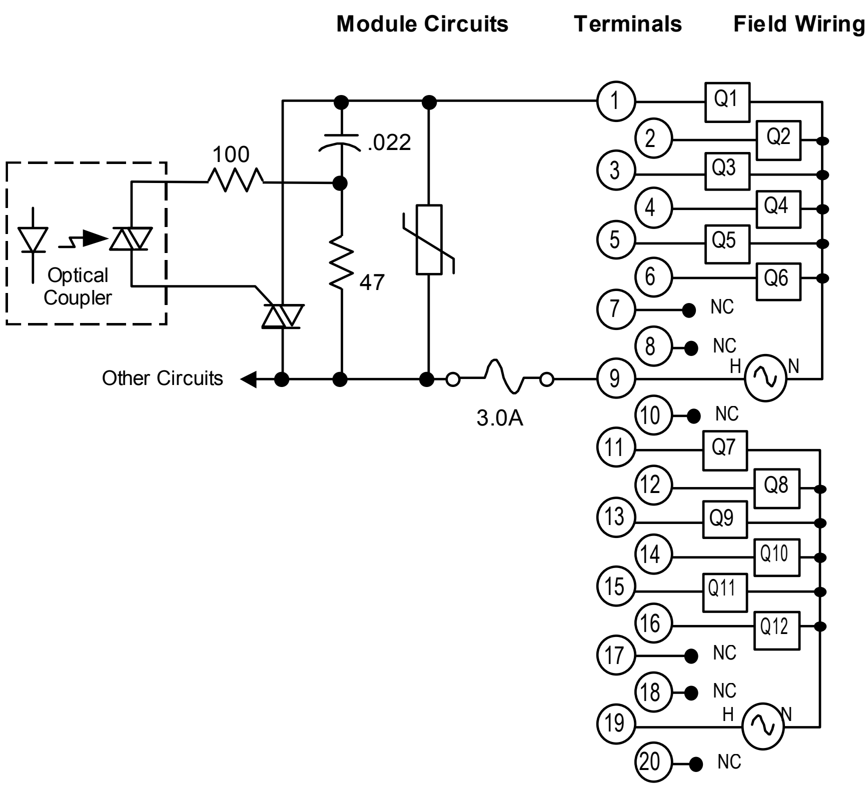
Refer to Appendix A for product standards and general specifications.

Load Current versus Temperature

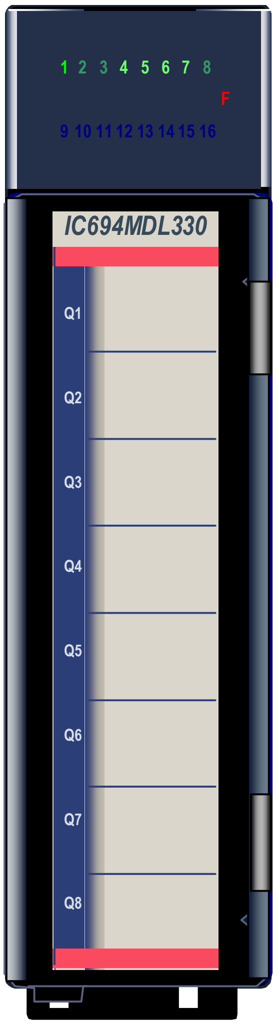


Field Wiring: MDL310

Terminal	*Connection*
1	Output 1
2	Output 2
3	Output 3
4	Output 4
5	Output 5
6	Output 6
7	No connection
8	No connection
9	Outputs 1 - 6 common (return)
10	No connection
11	Output 7
12	Output 8
13	Output 9
14	Output 10
15	Output 11
16	Output 12
17	No connection
18	No connection
19	Outputs 7-10 common (return)
20	No connection



Output Module, 120/240 Volt AC, 2 Amp, 8 Point: IC694MDL330



The ***120/240volt, 2 Amp AC Output*** module, IC694MDL330, provides eight output points in two isolated groups of four points. Each group has a separate common. The two commons are not tied together inside the module. The groups can be used on different phases of the AC supply or powered from the same supply. AC power to operate loads connected to outputs must be user supplied. This module requires an AC power source; *it cannot be used with a DC power source*.

Each group is protected with a 5 Amp fuse for each common. An RC snubber for each output protects against transient electrical noise on the power line. This module provides a high degree of inrush current (10 times the rated current) so the outputs can control a wide range of inductive and incandescent loads.

Individual numbered LEDs show the ON/OFF status of each output point. The red LED (F) turns ON if an output fuse blows. The red bands on the label show that MDL330 is a high-voltage module.

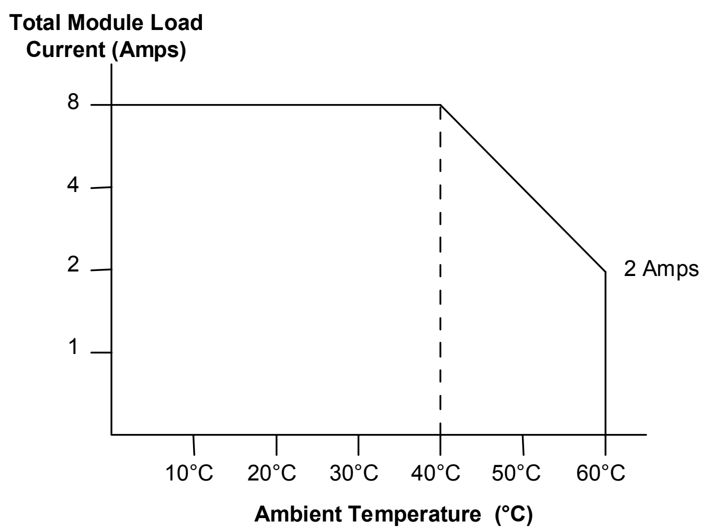
This module can be installed in any I/O slot in an RX3i system.

Specifications: MDL330

Rated Voltage	120/240 volts AC
Output Voltage Range	85 to 264 volts AC, 50/60 Hz
Outputs per Module	8 (two groups of four outputs each)
Isolation:	
Field to Backplane (optical) and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Group to Group	250 VAC continuous; 1500 VAC for 1 minute
Output Current	2 Amp maximum per point 4 Amps maximum per group at 40°C (104°F) Maximum load current depends on ambient temperature as shown below
Output Characteristics	
Inrush Current	20 Amps maximum for one cycle
Minimum Load Current	100mA
Output Voltage Drop	1.5 volts maximum
Output Leakage Current	3mA maximum at 120 volts AC 6mA maximum at 240 volts AC
On Response Time	1ms maximum
Off Response Time	1/2 cycle maximum
Power Consumption	160mA (all outputs on) from 5 volt bus on backplane
Fuses (quantity 2)	5 Amp, GE Fanuc part number 44A724627-114(1). See chapter 2 for more information.

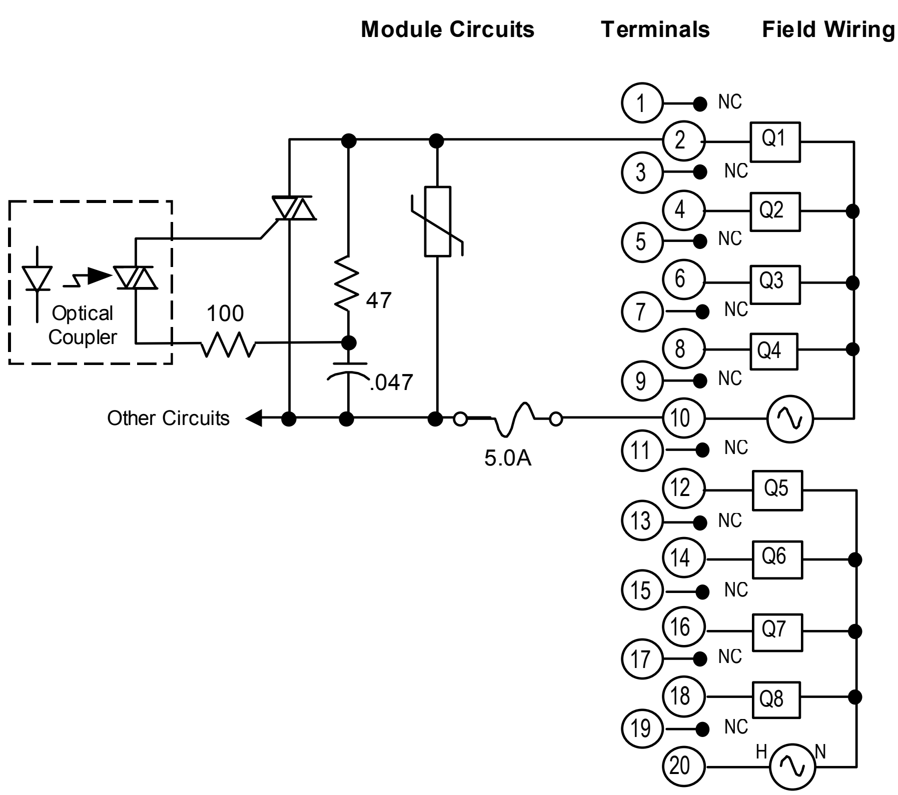
Refer to Appendix A for product standards and general specifications.

Load Current versus Temperature

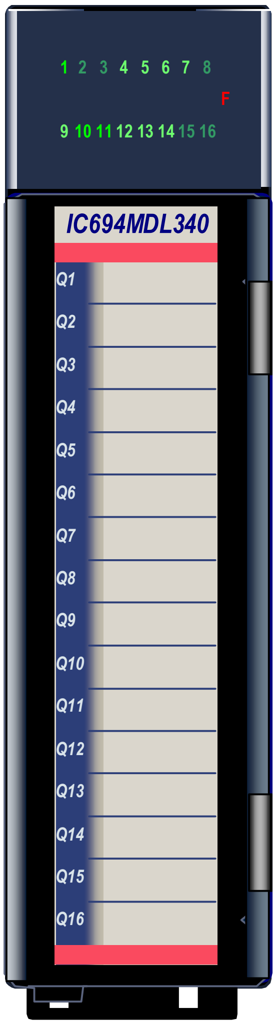


Field Wiring: MDL330

Terminal	Connection
1	No connection
2	Output 1
3	No connection
4	Output 2
5	No connection
6	Output 3
7	No connection
8	Output 4
9	No connection
10	Outputs 1 - 4 common (return)
11	No connection
12	Output 5
13	No connection
14	Output 6
15	No connection
16	Output 7
17	No connection
18	Output 8
19	No connection
20	Outputs 5 - 8 common (return)



Output Module, 120 Volt AC, 0.5 Amp, 16 Point: IC694MDL340



The ***120 volt, 0.5 Amp AC Output*** module, IC694MDL340, provides 16 output points in two isolated groups of eight points. Each group has a separate common. The two commons are not tied together inside the module. The groups can be used on different phases of the AC supply or powered from the same supply. Each group is protected with a 3 Amp fuse. An RC snubber protects each output against transient electrical noise on the power line. This module provides a high degree of inrush current; so the outputs can control a wide range of inductive and incandescent loads. AC Power to operate loads connected to outputs must be supplied by the user. This module requires an AC power source.

Individual numbered LEDs show the ON/OFF status of each output point. The red LED (F) turns ON if either of the fuses blows. A load must be connected to the blown fuse for the indicator to light. The red bands on the label show that MDL340 is a high-voltage module.

This module can be installed in any I/O slot in an RX3i system.

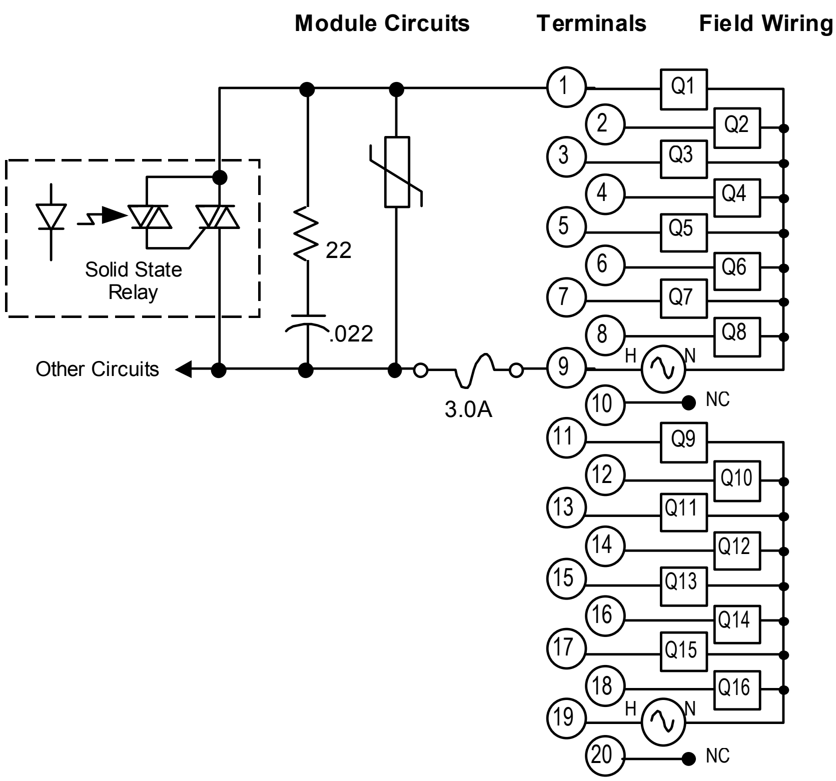
Specifications: MDL340

Rated Voltage	120 volts AC
Output Voltage Range	85 to 132 volts AC, 50/60 Hz
Outputs per Module	16 (two groups of eight outputs each)
Isolation:	
Field to Backplane (optical) and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Group to Group	250 VAC continuous; 1500 VAC for 1 minute
Output Current	0.5 amp maximum per point 3 amps maximum per group
Output Characteristics	
Inrush Current	20 amps maximum for one cycle
Minimum Load Current	50 mA
Output Voltage Drop	1.5 volts maximum
Output Leakage Current	2 mA maximum at 120 volts AC
On Response Time	1 ms maximum
Off Response Time	1/2 cycle maximum
Power Consumption	315 mA (all outputs ON) from 5 volt bus on backplane
Fuses (quantity 2)	3 Amps, GE Fanuc part number 44A724627-111(1). See chapter 2 for more information.

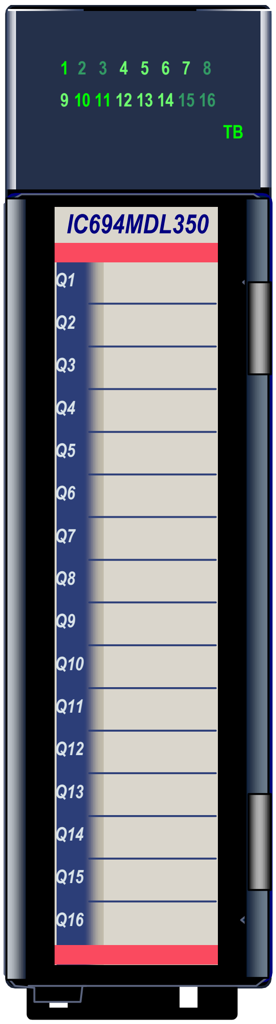
Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL340

Terminal	Connection
1	Output 1
2	Output 2
3	Output 3
4	Output 4
5	Output 5
6	Output 6
7	Output 7
8	Output 8
9	Outputs 1 – 8 common (return)
10	No connection
11	Output 9
12	Output 10
13	Output 11
14	Output 12
15	Output 13
16	Output 14
17	Output 15
18	Output 16
19	Outputs 9 - 16 common (return)
20	No connection



Output Module, 120VAC 16 Point Isolated, IC694MDL350



The ***120/240VAC 16-Point Isolated Output*** module, IC694MDL350, provides 16 individually-isolated output points. A high level of noise immunity minimizes the need for external snubbers to protect the outputs against transient electrical noise on the power line. The outputs can control a wide range of inductive and incandescent loads. Power to operate the output loads must be provided with an external AC power supply.

A DIP switch on back of the module is used to select the outputs' default mode: Force Off or Hold Last State. The module must be removed from the backplane to set this switch.

This module can be used with a Box-style (IC694TBB032), Extended Box-style (IC694TBB132), Spring-style (IC694TBS032), or Extended Spring-style (IC694TBS132) Terminal Block. Extended terminal blocks provide the extra shroud depth typically needed for field wiring to AC devices. See chapter 15 for more information on Terminal Blocks. Terminal Blocks are ordered separately.

Individually-numbered LEDs show the ON/OFF status of each output point. The TB LED indicates presence of the removable Terminal Block. The TB LED is green when the Terminal Block is present or red when the Terminal Block is not present. The red bands on the door card indicate the MDL350 is a high-voltage module.

The IC694MDL350 module can be installed in any I/O slot in an RX3i system. It must be used with an RX3i CPU release 3.50 or greater. It cannot be used with a Series 90-30 PLC CPU.

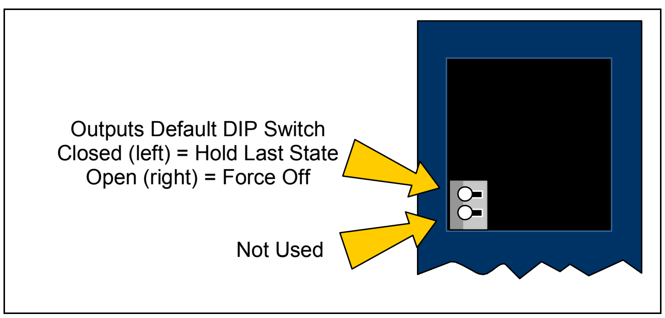
Specifications: IC694MDL350

Rated Voltage	120/240 volts AC
Output Voltage Range	74 – 265VAC (47 to 63 Hz), 120/240VAC nominal
Outputs per Module	16 isolated
Isolation:	
Field to Logic Side	250 VAC continuous; 1500 VAC for 1 minute
Group to Group	250 VAC continuous; 1500 VAC for 1 minute
Power Consumption	315 mA (with all outputs ON) from 5 volt bus on backplane
Diagnostics	Field side terminal block status reported to RX3i CPU
Output Current (Linear derating)	Per Point 2A max. @ 30°C, 1A max. @ 60°C Per Module 5A max. @ 30°C, 4A max. @ 60°C
Output Characteristics	
Inrush Current	20 Amps maximum for one cycle
Minimum Load Current	10 mA per point
Output Voltage Drop	1.5 volts maximum
Output Leakage Current	2 mA maximum
On, Off Response Times	1/2 cycle maximum
Fuses	No internal fusing. Use of appropriate external fuses is recommended for short circuit protection.

Refer to Appendix A for product standards and general specifications.

Setting the Output Defaults

The DIP switch on back of the module selects the default operation for the module's outputs. The module must be removed from the backplane to set this switch. Note that there are two DIP switches on the module. Only the upper switch is used for this module.



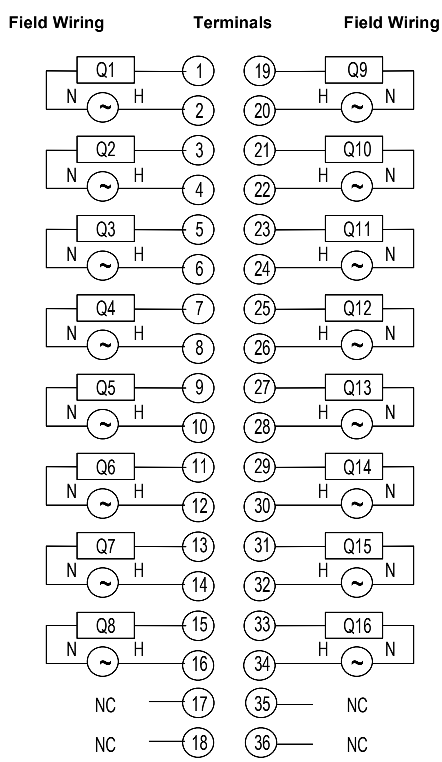
With the Outputs Default Mode switch in the right (open) position, the outputs will turn off whenever communication with the CPU is lost. When the switch is in the left position, the outputs will hold their last programmed value whenever communication with the CPU is lost.

Backplane power and power to the outputs must be present to Hold Last State. Otherwise, the module will default outputs regardless of the DIP switch setting.

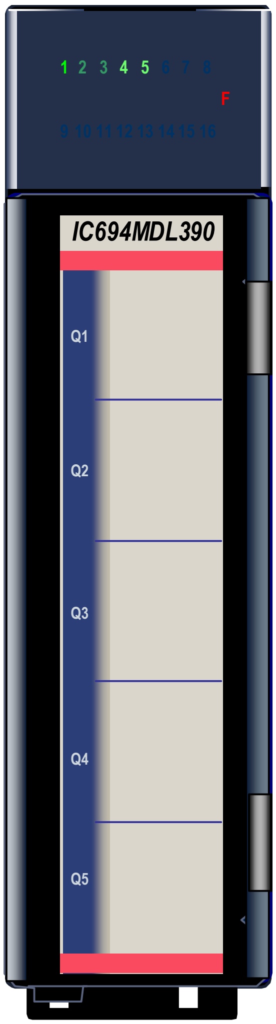
The Outputs Default Mode selection made with the DIP switch must match the selection made for this feature in the module's software configuration. If the two do not match, a warning message is displayed in the fault table.

Field Wiring: MDL350

Connections	***Terminals***	***Terminals***	***Connections***
Output 1	1	19	Output 9
Output 1 Supply	2	20	Output 9 Supply
Output 2	3	21	Output 10
Output 2 Supply	4	22	Output 10 Supply
Output 3	5	23	Output 11
Output 3 Supply	6	24	Output 11 Supply
Output 4	7	25	Output 12
Output 4 Supply	8	26	Output 12 Supply
Output 5	9	27	Output 13
Output 5 Supply	10	28	Output 13 Supply
Output 6	11	29	Output 14
Output 6 Supply	12	30	Output 14 Supply
Output 7	13	31	Output 15
Output 7 Supply	14	32	Output 15 Supply
Output 8	15	33	Output 16
Output 8 Supply	16	34	Output 16 Supply
No connection	17	35	No connection
No connection	18	36	No connection



Output Module, 120/240 Volt AC Isolated, 2 Amp, 5 Pt: IC694MDL390



The ***120/240 volt, 2 Amp Isolated AC Output*** module, IC694MDL390, provides five isolated output points, each with a separate common.   Each output circuit is isolated from the others relative to the AC power source. The commons are not tied together inside the module. The output circuits can be used on different phases of the AC supply or powered from the same supply.   AC Power to operate the loads connected to the outputs must be supplied by the user. *This module requires an AC power source, it cannot be used with a DC power source.*

Outputs are individually fused with a 3 Amp fuse. An RC snubber protects each output against transient electrical noise on the power line. This module provides a high degree of inrush current (greater than 10 times the rated current) so the outputs can control a wide range of inductive and incandescent loads.

Individual numbered LEDs show the ON/OFF status of each output point. The red LED (F) turns ON if an output fuse blows. The red bands on the label show that MDL390 is a high-voltage module.

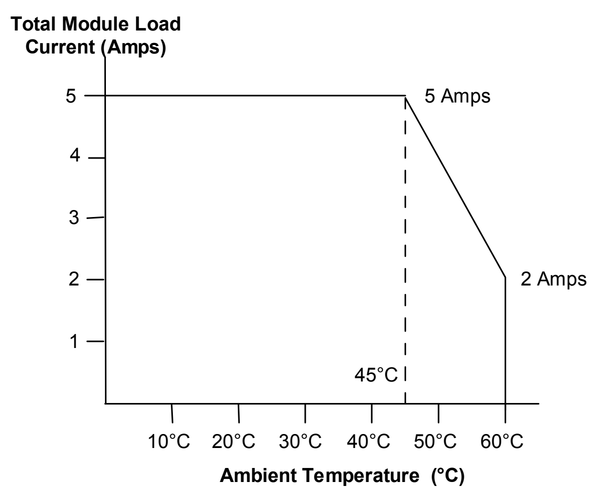
This module can be installed in any I/O slot in an RX3i system. It should be configured as an 8-point output module with programs referencing the five least significant bits.

Specifications: MDL390

Rated Voltage	120/240 volts AC
Output Voltage Range	85 to 264 volts AC, 50/60 Hz
Outputs per Module	5 (each output isolated from the others)
Isolation:	
Field to Backplane (optical) and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Point to Point	250 VAC continuous; 1500 VAC for 1 minute
Output Current	2 Amps maximum per point 5 Amps maximum per module at 45°C (113°F) 2 Amps maximum per module at 60°C (140°F) Maximum load current depends on ambient temperature as shown below
Output Characteristics	
Inrush Current	25 Amps maximum for one cycle
Minimum Load Current	100mA
Maximum Load Current	
Output Voltage Drop	1.5 volts maximum
Output Leakage Current	3mA maximum at 120 volts AC
	6mA maximum at 240 volts AC
On Response Time	1ms maximum
Off Response Time	1/2 cycle maximum
Power Consumption	110mA (all outputs on) from 5 volt bus on backplane
Fuses (quantity 5)	3 Amps, GE Fanuc part number 44A724627-111(1). See chapter 2 for more information.

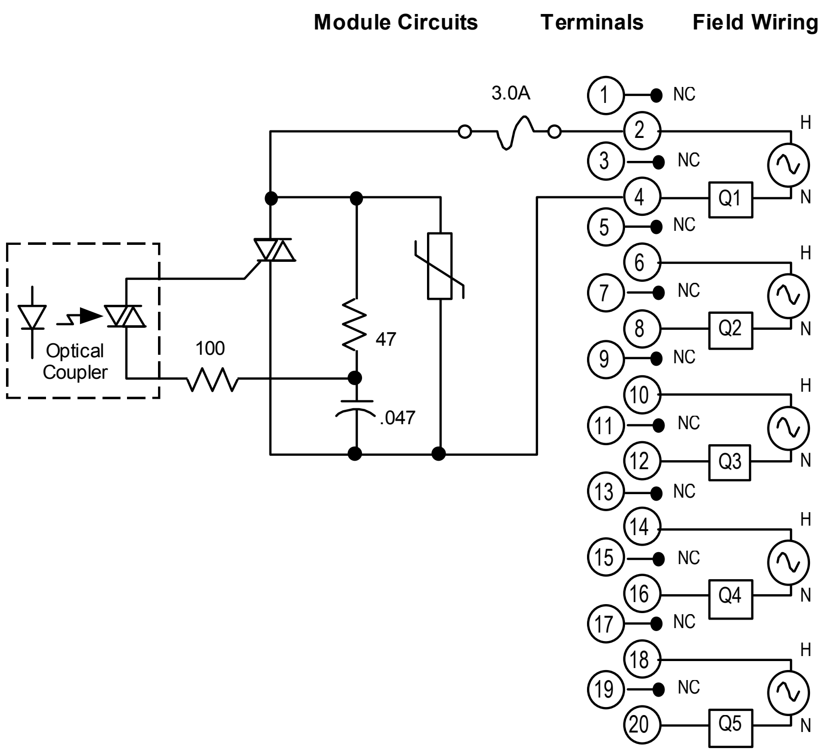
Refer to Appendix A for product standards and general specifications.

Load Current versus Temperature

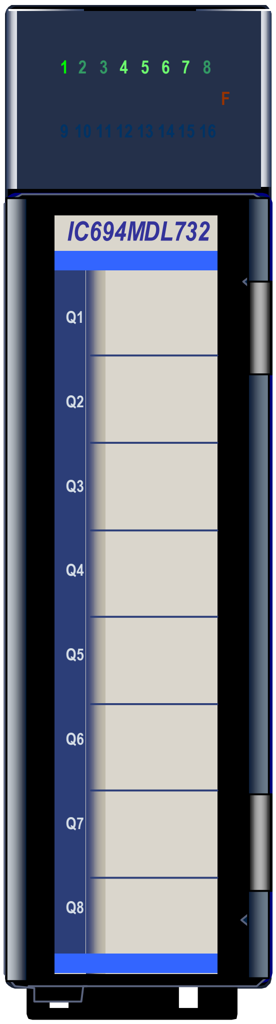


Field Wiring: MDL390

Terminal	*Connection*
1	No connection
2	Output 1 return
3	No connection
4	Output 1
5	No connection
6	Output 2return
7	No connection
8	Output 2
9	No connection
10	Output 3 return
11	No connection
12	Output 3
13	No connection
14	Output 4 return
15	No connection
16	Output 4
17	No connection
18	Output 5 return
19	No connection
20	Output 5



Output Module, 12/24 Volt DC Positive Logic 0.5A 8 Pt, IC694MDL732



The ***12/24 volt DC Positive Logic 0.5 Amp Outpu***t module, IC694MDL732, provides one group of eight outputs with a common power output terminal. This module has positive logic characteristics; it sources current to the loads from the user common or positive power bus. The output device is connected between the negative power bus and the module output. The output characteristics are compatible with a wide range of load devices, such as: motor starters, solenoids, and indicators. Power to operate the field devices must be supplied by the user.

Individual numbered LEDs show the ON/OFF status of each output point. There are no fuses on this module. The blue bands on the label show that MDL732 is a low-voltage module.

This module can be installed in any I/O slot in an RX3i system.

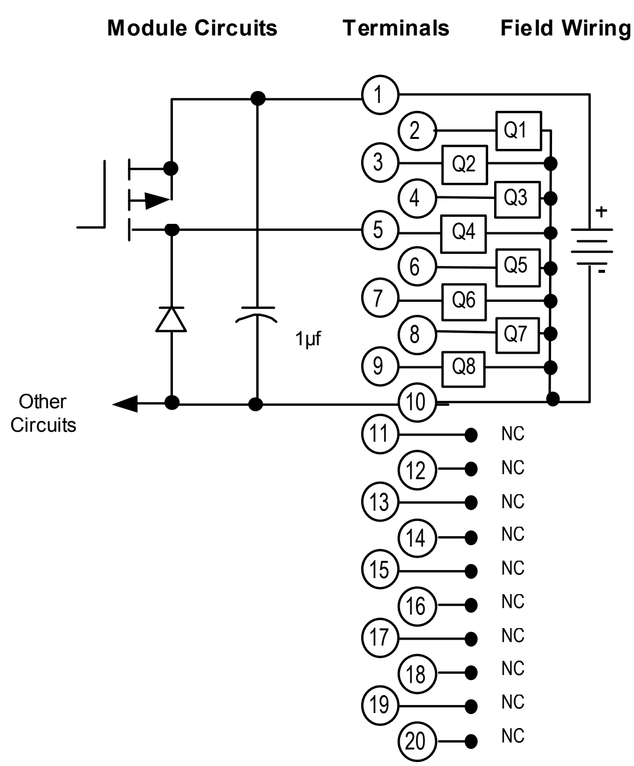
Specifications: MDL732

Rated Voltage	12/24 volts DC
Output Voltage Range	12 to 24 volts DC (+20%, -15%)
Outputs per Module	8 (one group of eight outputs)
Isolation: Field to Backplane (optical) and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Output Current	0.5 Amps maximum per point 2 Amps maximum per common
Output Characteristics	
Inrush Current	4.78 Amps for 10 ms
Output Voltage Drop	1 volt maximum
Off–state Leakage	1mA maximum
On Response Time	2ms maximum
Off Response Time	2ms maximum
Power Consumption	50mA (all outputs on) from 5 volt bus on backplane

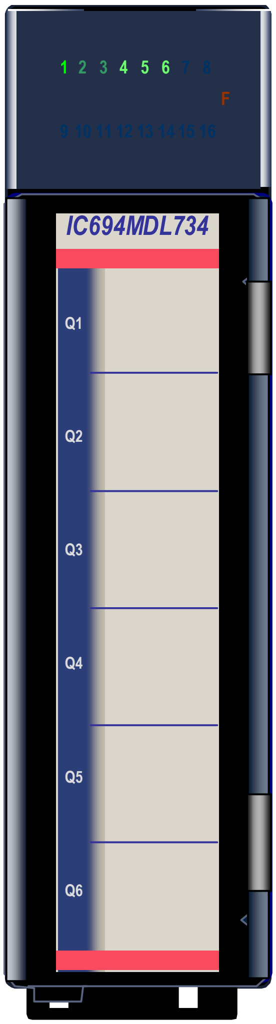
Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL732

Terminal	***Connection***
1	DC+
2	Output 1
3	Output 2
4	Output 3
5	Output 4
6	Output 5
7	Output 6
8	Output 7
9	Output 8
10	Outputs 1 - 8 common (return)
11	No connection
12	No connection
13	No connection
14	No connection
15	No connection
16	No connection
17	No connection
18	No connection
19	No connection
20	No connection



Output Module 125VDC Pos/Neg, 1 Amp, Isolated 6 Pt: IC694MDL734



The ***125 volt DC Positive/Negative Logic 1 Amp Output*** module, IC694MDL734, provides six isolated output points. Each output point has a separate common terminal. This output module can be wired to have either *positive logic* characteristics so that it sources current to the loads from the user common or positive power bus; or *negative logic* characteristics so that it sinks current from the loads to the user common or negative power bus. The output characteristics are compatible with a wide range of load devices, such as: motor starters, solenoids, and indicators. Power to operate the field devices must be supplied by the user. External fusing is recommended. Two Amp loads can be driven by wiring and driving two outputs in parallel.

Individual numbered LEDs show the ON/OFF status of each output point. There are no fuses on this module. The red bands on the label show that MDL734 is a high-voltage module.

This module can be installed in any I/O slot in an RX3i system.

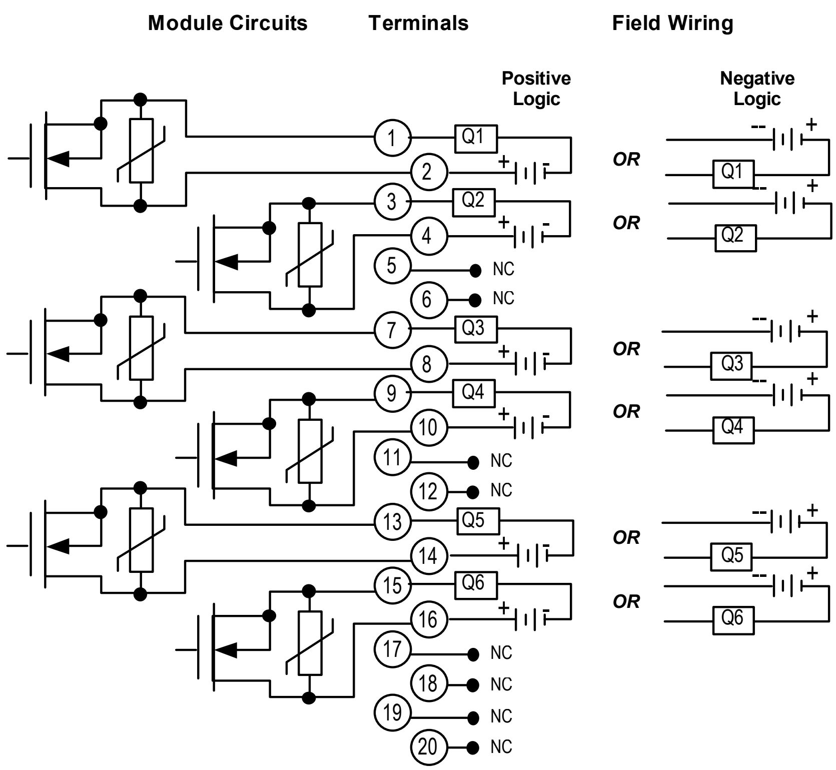
Specifications: MDL734

Rated Voltage	125 volts DC
Output Voltage Range	+10.8 to +150 volts DC
Outputs per Module	6 (isolated)
Isolation:	
Field to Backplane (optical) and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Point to Point	250 VAC continuous; 1500 VAC for 1 minute
Output Current	1 Amp maximum per point
Output Characteristics	
Inrush Current	15.89 Amps for 10 ms
Output Voltage Drop	1 volt maximum
Off–state Leakage	1mA maximum
On Response Time	7ms maximum
Off Response Time	5ms maximum
Power Consumption	90 mA (all outputs on) from 5 volt bus on backplane

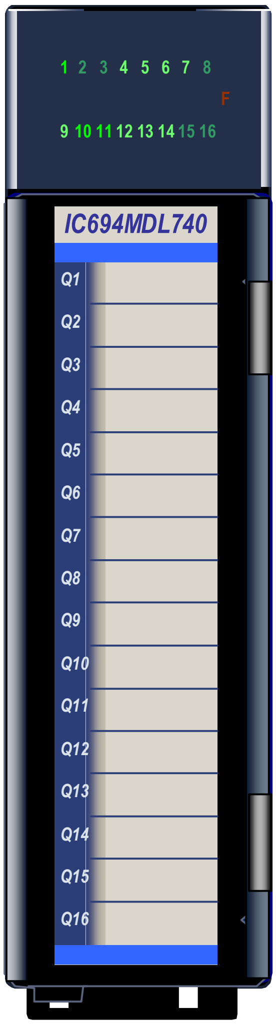
Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL734

Terminal	*Positive Logic Connection*	*Negative Logic Connection*
1	Output 1	Output 1 return (DC+)
2	Output 1 return (DC+)	Output 1
3	Output 2	Output 2 return (DC+)
4	Output 2 return (DC+)	Output 2
5	No connection	No connection
6	No connection	No connection
7	Output 3	Output 3 return (DC+)
8	Output 3 return (DC+)	Output 3
9	Output 4	Output 4 return (DC+)
10	Output 4 return (DC+)	Output 4
11	No connection	No connection
12	No connection	No connection
13	Output 5	Output 5 return (DC+)
14	Output 5 return (DC+)	Output 5
15	Output 6	Output 6 return (DC+)
16	Output 6 return (DC+)	Output 6
17	No connection	No connection
18	No connection	No connection
19	No connection	No connection
20	No connection	No connection



Output Module, 12/24VDC Pos. Logic, 0.5 Amp, 16 Pt: IC694MDL740



The ***12/24 volt DC Positive Logic 0.5 Amp Output*** module, IC694MDL740, provides 16 output points in two groups of eight. Each group has a common power output terminal. The module has positive logic characteristics; it sources current to the loads from the user common or positive power bus. Output devices are connected between the negative power bus and the module terminals. The module's output characteristics are compatible with a wide range of load devices, such as: motor starters, solenoids, and indicators. Power to operate the field devices must be supplied by the user.

Individual numbered LEDs show the ON/OFF status of each output point. There are no fuses on this module. The blue bands on the label show that MDL740 is a low-voltage module.

This module can be installed in any I/O slot in an RX3i system.

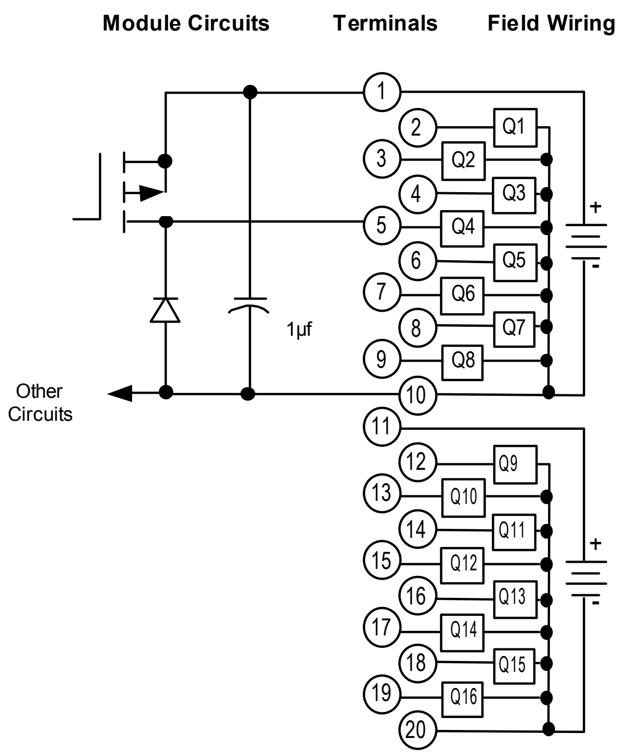
Specifications: MDL740

Rated Voltage	12/24 volts DC
Output Voltage Range	12 to 24 volts DC (+20%, -15%)
Outputs per Module	16 (two groups of eight outputs each)
Isolation:	
Field to Backplane (optical) and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Group to Group	250 VAC continuous; 1500 VAC for 1 minute
Output Current	0.5 Amps maximum per point 2 Amps maximum per common
Power Consumption	110mA (all outputs on) from 5 volt bus on backplane
Output Characteristics	
Inrush Current	4.78 Amps for 10 ms
Output Voltage Drop	1 volt maximum
Off–state Leakage	1mA maximum
On Response Time	2ms maximum
Off Response Time	2ms maximum

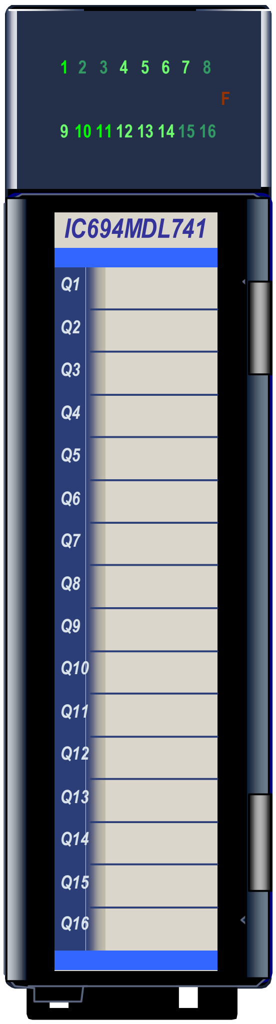
Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL740

Terminal	*Connection*
1	DC +
2	Output 1
3	Output 2
4	Output 3
5	Output 4
6	Output 5
7	Output 6
8	Output 7
9	Output 8
10	Outputs 1 – 8 common (return)
11	DC +
12	Output 9
13	Output 10
14	Output 11
15	Output 12
16	Output 13
17	Output 14
18	Output 15
19	Output 16
20	Outputs 9 - 16 common (return)



Output Module, 12/24VDC Neg. Logic 0.5 Amp, 16 Pt: IC694MDL741



The ***12/24 volt DC Negative Logic 0.5 Amp Output*** module, IC694MDL741, provides 16 output points in two groups. Each group has a common power output terminal. This output module has negative logic characteristics; it sinks current from the loads to the user common or negative power bus. Output devices are connected between the positive power bus and the output terminals. The module's output characteristics are compatible with a wide range of load devices, such as: motor starters, solenoids, and indicators. Power to operate the field devices must be supplied by the user.

Individual numbered LEDs show the ON/OFF status of each output point. There are no fuses on this module.

The blue bands on the label show that MDL741 is a low-voltage module.

This module can be installed in any I/O slot in an RX3i system.

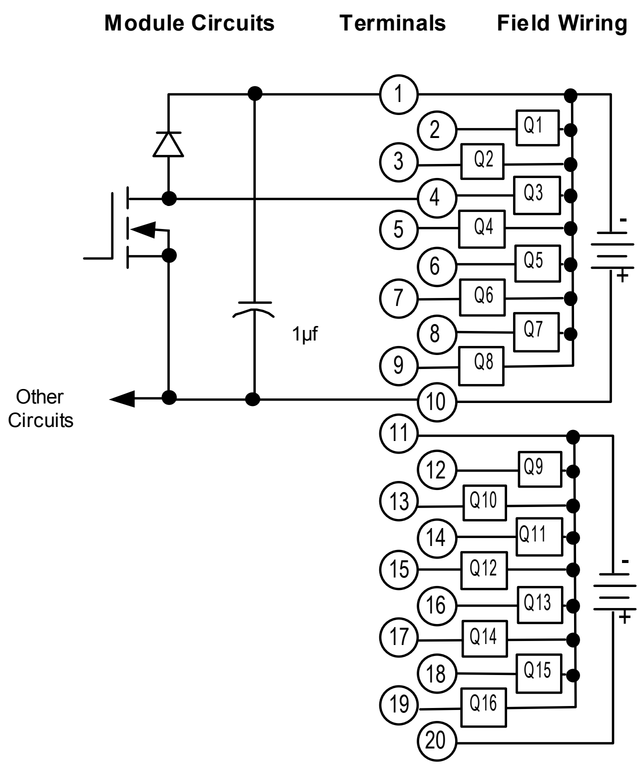
Specifications: MDL741

Rated Voltage	12/24 volts DC
Output Voltage Range	12 to 24 volts DC (+20%, -15%)
Outputs per Module	16 (two groups of eight outputs each)
Isolation:	
Field to Backplane (optical) and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Group to Group	250 VAC continuous; 1500 VAC for 1 minute
Output Current	0.5 Amps maximum per point 2 Amps maximum per common
Power Consumption	110mA (all outputs on) from 5 volt bus on backplane
Output Characteristics	
Output Voltage Drop	0.5 volts maximum
Off–state Leakage	1mA maximum
On Response Time	2ms maximum
Off Response Time	2ms maximum

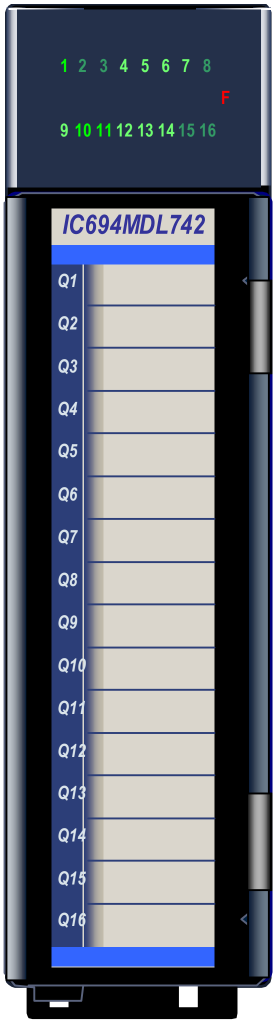
Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL741

Terminal	Connection
1	Outputs 1 – 8 common (return)
2	Output 1
3	Output 2
4	Output 3
5	Output 4
6	Output 5
7	Output 6
8	Output 7
9	Output 8
10	DC +
11	Outputs 9 - 16 common (return)
12	Output 9
13	Output 10
14	Output 11
15	Output 12
16	Output 13
17	Output 14
18	Output 15
19	Output 16
20	DC +



Output Module, 12/24VDC Positive Logic ESCP, 1A, 16 Pt: IC694MDL742



The ***12/24 volt DC Positive Logic 1 Amp Electronic Short Circuit Protection (ESCP) Output*** module, IC694MDL742, provides 16 output points in two groups of eight. Each group has a common power output terminal. This output module has positive logic characteristics: it sources current to the loads from the user common or positive power bus. Output devices are connected between the negative power bus and the output terminals. The nodule's output characteristics are compatible with a wide range of load devices, such as: motor starters, solenoids, and indicators. Power to operate the field devices must be supplied by the user.

Individual numbered LEDs show the ON/OFF status of each output point. There are no fuses on this module. The module's red LED (F) indicates electronic short circuit protection trips. The blue bands on the label show that MDL742 is a low-voltage module.

This module can be installed in any I/O slot in an RX3i system.

Electronic Short Circuit Protection

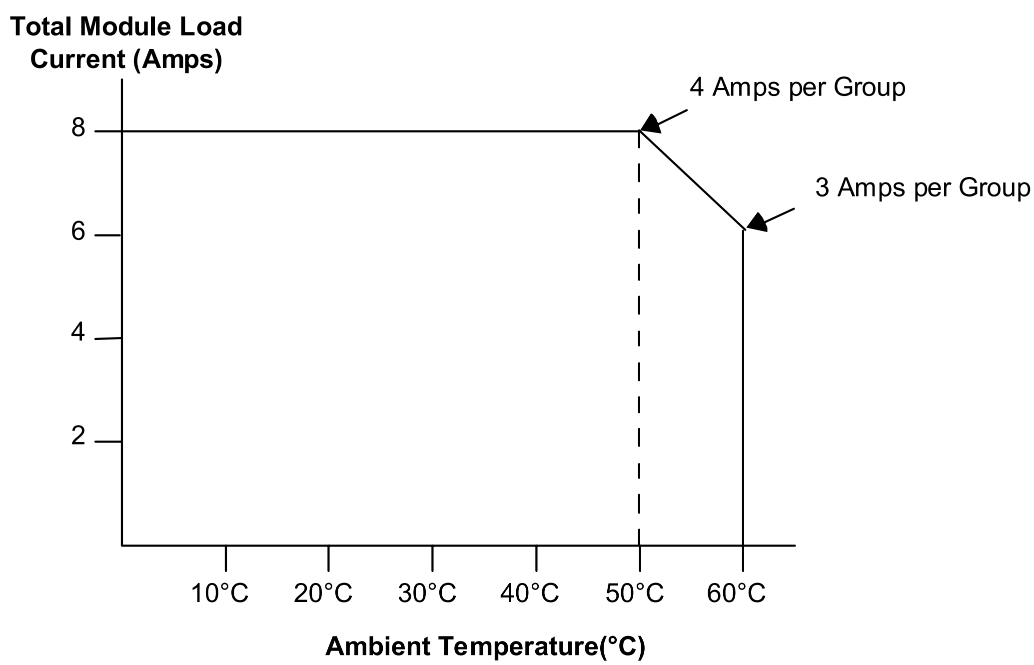
Module MDL742 has two Electronic Short Circuit Protection circuits. The first circuit protects points 1 to 8 and the second protect points 9 to 16. The module electronically monitors the common signal for each group. If a short circuit occurs, the module turns off the output points in that group, and turns on the red LED (F). The point LEDs do not turn off. Electronic Short Circuit Protection does not prevent individual outputs from exceeding their ratings, but it protects the module in case of a short-circuited load. Electronic Short Circuit Protection is reset by cycling the 12/24 VDC user power to the module.

Specifications: MDL742

Rated Voltage	12/24 volts DC
Output Voltage Range	12 to 24 volts DC (+20%, -15%)
Outputs per Module	16 (two groups of eight outputs each)
Isolation:	
Field to Backplane (optical) and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Group to Group	250 VAC continuous; 1500 VAC for 1 minute
Output Current	1 Amp maximum per point 4 Amps maximum per group at @ 50°C 3 Amps maximum per group @ 60°C Maximum total load current depends on the ambient temperature as shown below
Power Consumption	130mA (all outputs on) from 5 volt bus on backplane
Output Characteristics	
Inrush Current	5.2 Amps for 10 ms
Output Voltage Drop	1.2 volts maximum
Off–state Leakage	1mA maximum
On Response Time	2ms maximum
Off Response Time	2ms maximum

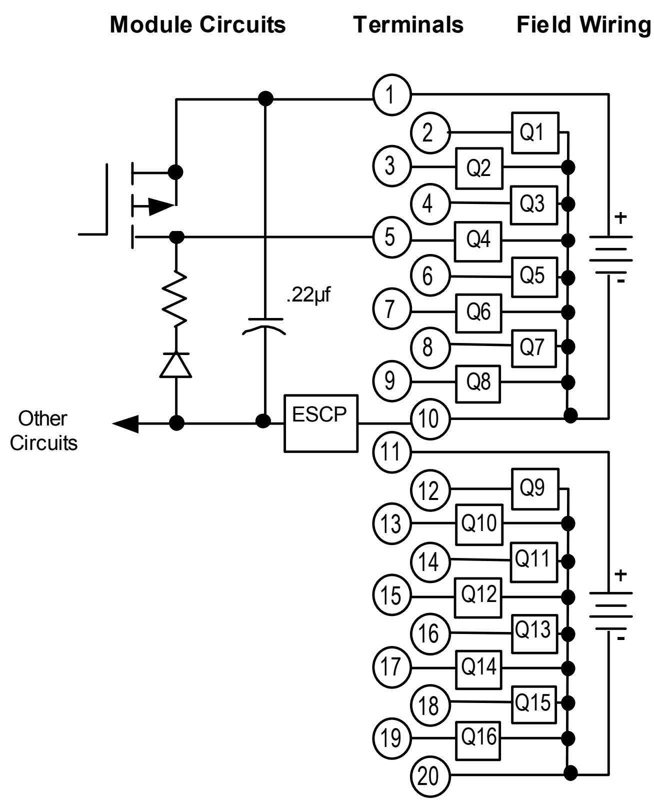
Refer to Appendix A for product standards and general specifications.

Load Current vs. Temperature

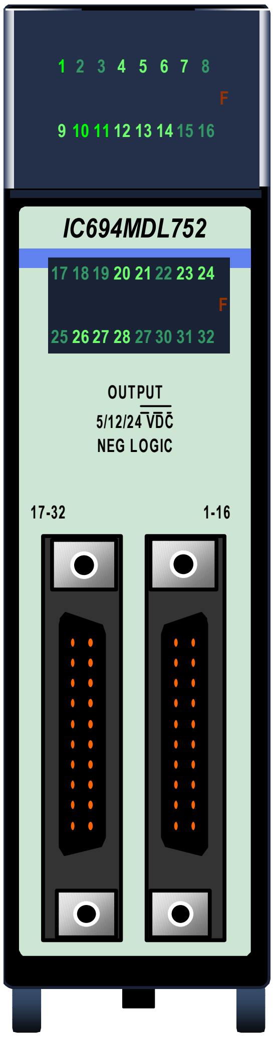


Field Wiring: MDL742

Terminal	***Connection***
1	DC +
2	Output 1
3	Output 2
4	Output 3
5	Output 4
6	Output 5
7	Output 6
8	Output 7
9	Output 8
10	Outputs 1 – 8 common (return)
11	DC +
12	Output 9
13	Output 10
14	Output 11
15	Output 12
16	Output 13
17	Output 14
18	Output 15
19	Output 16
20	Outputs 9 - 16 common (return)



Output Module, 5/24 VDC (TTL) Negative Logic, 32 Pt: IC694MDL752



The ***5/24 volt DC (TTL) Negative Logic Outpu***t module, IC694MDL752, provides 32 discrete outputs arranged in four isolated groups of eight. Each group has its own common. The outputs are negative logic or sinking-type outputs (the ON state for a point results in an active low output).

The module has two modes of operation. In TTL mode, the outputs can switch loads across +5 VDC (±5%) and are capable of sinking a maximum current of 25mA per point. In 12/24V mode, the outputs can switch loads over the range of +12 to -24 VDC (+20%, -15%) and are capable of sinking a maximum current of 0.5A per point.

There are two pins on the I/O connectors for each group common. Each pin has a current-handling capacity of 3 Amps. It is recommended that connections be made to both pins when connecting the common; however, it is required for high-current applications (between 3 and 4 Amps).

Each group can be used to drive different loads. For example, the module can drive TTL loads, 12 VDC loads, and 24 VDC loads on different groups. It is important to consider the effects of electrical noise when mixing TTL and inductive-type loads.

Each point has an internal pull–up resistor. The resistor passively pulls up the output to the user positive side power input (typically +5V for TTL mode) when the output point FET is OFF, providing a high logic level for TTL applications. All 32 outputs are forced OFF when the CPU is stopped. Power to provide current to the loads must be provided by the user. The module also draws a minimum amount of power from the user supply to provide gate drive to the output devices

Backplane isolation between the field side and logic side is provided by opto–couplers on the module. No special fault or alarm diagnostics are reported. Individual numbered LEDs show the ON/OFF status of each output.

This module can be installed in any I/O slot in an RX3i system.

Specifications: MDL752

Rated Voltage	5, and 12 through 24 volts DC, negative logic (active low)
Output Voltage Range	4.75 to 5.25 volts DC (TTL mode) 10.2 to 28.8 volts DC (12/24V mode)
Outputs per Module	32 (four groups of eight outputs each)
Isolation:	
Field to Backplane (optical) and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Group to Group	50 VAC continuous; 500 VAC for 1 minute
Output Current	25mA per point (maximum in TTL mode) 0.5 Amps per point (maximum in 12/24V mode); with 4 Amps maximum per group and 3 Amps maximum per group common pin
Power Consumption	260mA (maximum) from 5 volt bus on backplane; (13mA + 3 mA/point ON + 4.7 mA/LED) 12 mA (maximum) per group from user supply @ 5VDC and all eight outputs in group ON 25 mA (maximum) per group from user supply @ 12 VDC and all eight outputs in group ON 44 mA (maximum) per group from user supply @ 24 VDC and all eight outputs in group ON
Output Characteristics	
Inrush Current	4.6 Amps for 10ms
On–state (active low)	0.4 volts DC (maximum in TTL mode)
Voltage Drop	0.24 volts DC (maximum in 12/24V mode)
Off–state Leakage Current	0.1mA maximum
On Response Time	0.5ms maximum
Off Response Time	0.5ms maximum

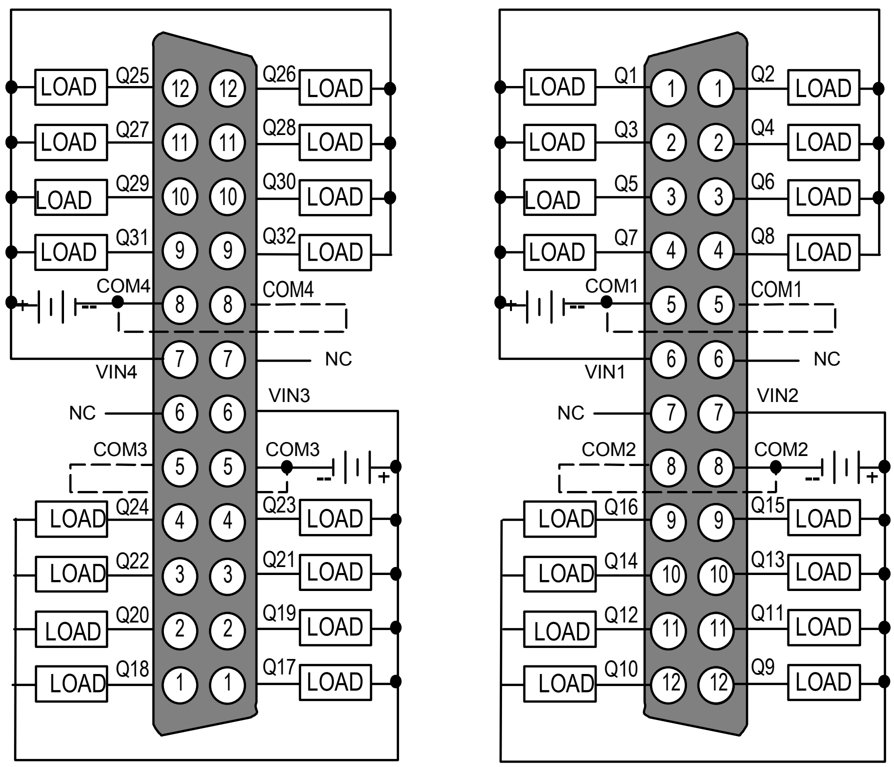
Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL752

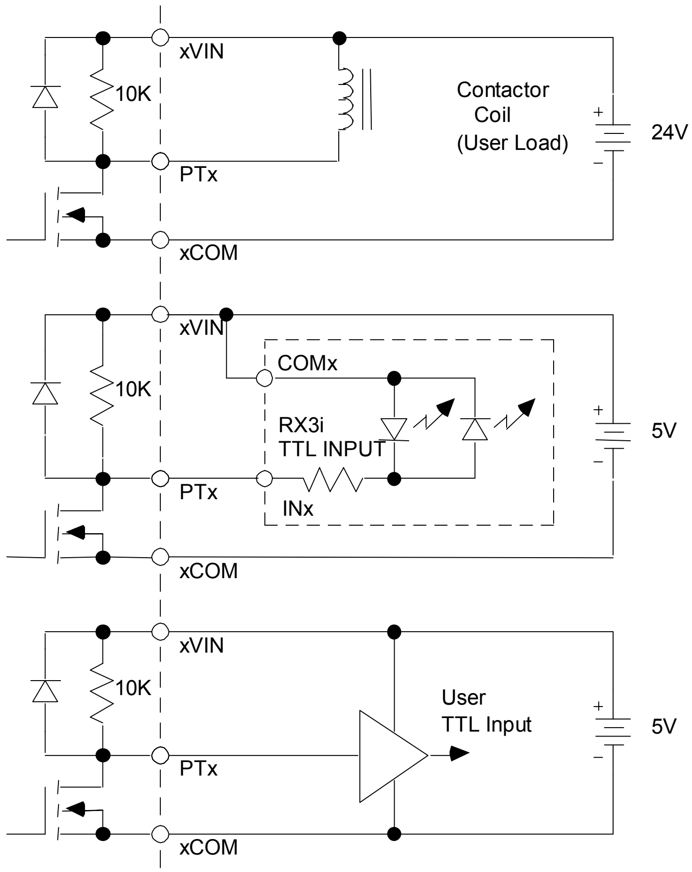
Connections to the output circuits are made from the load devices to two male 24–pin connectors (Fujitsu FCN–365P024–AU) on the front of the module.

The module's connectors can be connected directly to field devices using a cable having a mating female connector on one end and stripped and tinned wires on the other end. You can purchase a pair of pre–wired cables, catalog numbers IC694CBL327 and IC694CBL328 or build cables. Refer appendix B of this manual for more information.

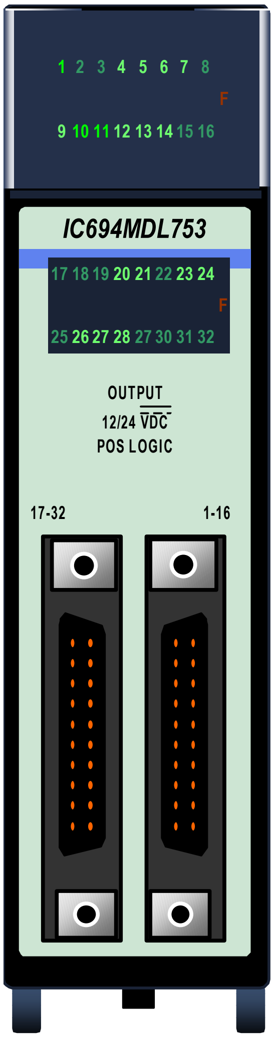
Connections can also be made a pair of cables with connectors on each end. These cables connect the module with DIN-rail mounted terminal blocks as described in appendix B.



Typical Connections: MDL752



Output Module, 12/24VDC, 0.5A Positive Logic, 32 Pt: IC694MDL753



The ***12/24 volt DC, 0.5A Positive Logic Output*** module, IC694MDL753, provides 32 discrete outputs in four isolated groups of eight. Each group has its own common. The outputs are positive logic or sourcing type outputs; they switch the loads on the positive side of the power supply, and supply current to the load. The outputs can switch user loads over the range of +12 to +24 VDC (+20%, -15%) and can source a maximum current of 0.5 Amps per point. There are two pins on the I/O connectors for each group common. Each pin has a current handling capacity of 3 Amps. It is recommended that connections be made to both pins when connecting the common; however, it is required for high-current applications (between 3 and 4 Amps).

Each group can be used to drive different loads. For example, three groups might drive 24 VDC loads, while the fourth was reserved for driving 12 VDC loads. Power to provide current to the loads must be provided by the user. The module also draws a minimum amount of power from the user supply to provide gate drive to the output devices. Backplane isolation between the field side and logic side is provided by opto–couplers on the module.

All 32 outputs are forced OFF when the CPU is stopped. There are no special fault or alarm diagnostics reported. Individual numbered LEDs show the ON/OFF status of each output.

This module can be installed in any I/O slot in an RX3i system.

Specifications: MDL753

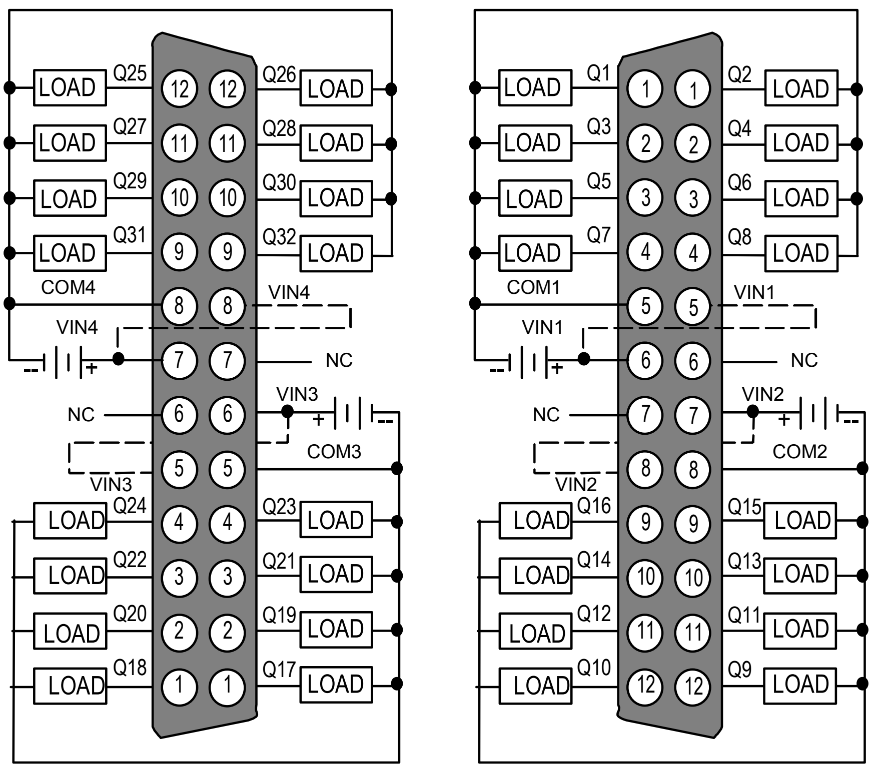
Rated Voltage **Output Voltage Range**	12 through 24 volts DC, positive logic 10.2 to 28.8 volts DC
Outputs per Module	32 (four groups of eight outputs each)
Isolation:	
Field to Backplane (optical) and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Group to Group	50 VAC continuous; 500 VAC for 1 minute
Output Current	0.5 Amps per point with 4 Amps maximum per group and 3 Amps maximum per group common pin
Power Consumption	260 mA (maximum) from 5 volt bus on backplane; (13mA + 3mA/point ON + 4.7mA/LED) 16.5mA (maximum) per group from user supply @ 24VDC and all eight outputs in group ON 9.6mA (maximum) per group from user supply @ 12VDC and all eight outputs in group ON
Output Characteristics	
Inrush Current	5.4 Amps for 10 ms
On–state Voltage Drop	0.3 volt DC
Off–state Leakage Current	0.1mA maximum
On Response Time	0.5ms maximum
Off Response Time	0.5ms maximum

Refer to Appendix A for product standards and general specifications.

Field Wiring: MDL753

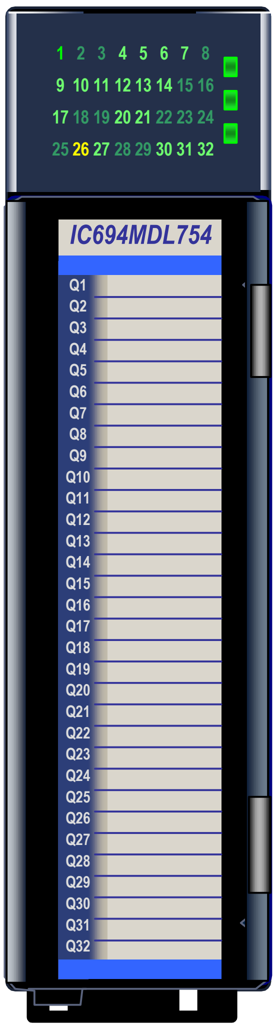
Connections to the output circuits are made from the load devices to two male 24–pin connectors (Fujitsu FCN–365P024–AU) on the front of the module. The module's connectors can be wired directly to field devices using a cable having a mating female connector on one end and stripped and tinned wires on the other end. You can purchase a pair of pre–wired cables, catalog numbers IC694CBL327 and IC694CBL328 or build cables. Refer to appendix B of this manual for more information.

Connections can also be made a pair of cables with connectors on each end. These cables connect the module with DIN-rail mounted terminal blocks as described in appendix B.



If the total current is greater than 3 Amps for a group, use both V_{IN} pins for the group by adding a second wire (shown by dashed lines above).

Output Module, 12/24VDC,ESCP 0.75A Pos. Logic, 32 Pt: IC694MDL754



The ***12/24 volt DC, ESCP 0.75A Positive Logic Output*** module, IC694MDL754, provides 32 discrete outputs in two isolated groups of 16. Each group has its own common. The outputs are positive logic or sourcing type outputs; they switch the loads on the positive side of the power supply, and supply current to the load. The outputs can switch user loads over the range of +12 to +24 VDC (+20%, -15%) and can source a maximum current of 0.75 Amps per point.

Each point has electronic overcurrent/short circuit protection and generates an individual fault if either condition exists. In addition to output driver faults being sent back to the RX3i controller, the module provides a loss of field side power fault, ESCP point failure within a group, field terminal block ON/OFF status and a DIP switch configuration mismatch fault.

Each group can be used to drive different loads. For example, one groups might drive 24 VDC loads, and the other could drive 12 VDC loads. Power for the loads must be provided by the user.

A DIP switch on back of the module is used to select the outputs default mode: Force Off or Hold Last State. The module must be removed from the backplane to set this switch.

This module can be used with either a Box-style (IC694TBB032) or Spring-style (IC694TBS032) front Terminal Block. The Terminal Block is ordered separately.

The blue bands on the label show that MDL754 is a low-voltage module.

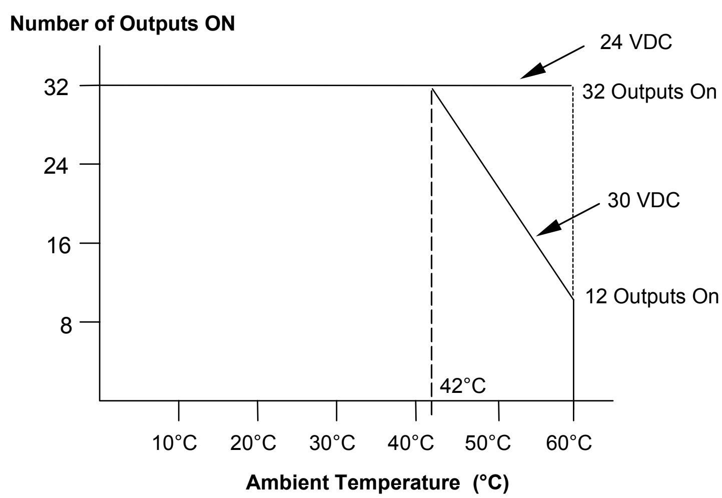
This module can be installed in any I/O slot in an RX3i system. It must be used with an RX3i CPU (release 2.90 or greater). It cannot be used with a Series 90-30 PLC CPU.

Specifications: MDL754

Rated Voltage **Output Voltage Range**	12/24 volts DC, nominal 10.2 to 30 volts DC
Outputs per Module	32 (two isolated groups of 16 outputs each)
Isolation:	
Field to Backplane (optical) and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Group to Group	250 VAC continuous; 1500 VAC for 1 minute
Module ID	0x059h
Output Current	0.75 Amps per point
Power Consumption	300 mA (maximum) from 5 volt bus on backplane;
Thermal Derating	No derating at 24VDC. At 30VDC, outputs are derated above 42 degrees C as shown below.
External Power Supply	+12 VDC to +30 VDC, 12/24 VDC nominal
Output Characteristics	
Inrush Current	3 Amps supplied for 10ms without ESCP trip
Output Voltage Drop	0.3 volt DC maximum
Steady-state overcurrent trip	5A typical per point
Output Leakage Current	0.1mA maximum
On Response Time	0.5ms maximum
Off Response Time	0.5ms maximum
Protection	Short-circuit protection, overcurrent protection, overtemperature protection, all with auto recovery .

Refer to Appendix A for product standards and general specifications.

Output Points vs. Temperature



LEDs

Outputs 1 – 16 Power Present
Outputs 17 – 32 Power Present
Terminal Block Present

32 green/yellow LEDs on the module indicate the ON/OFF status of points 1 through 32. These LEDs are green when the corresponding outputs are on, and yellow if the outputs are faulted. They are off when the corresponding outputs are off.

Two green/yellow LEDs indicate the presence of field power to each of the isolated output groups. They are green if field power is within limits. They are yellow if a point fault exists within their group. And they are off when field power is absent or outside operating limits.

The module's red/green Terminal Block LED is green when the module's removable terminal block is locked in place. It is red when the terminal block is not locked. The Terminal Block LED blinks if there is a non-recoverable module fault. The module also sends an *Addition of Terminal Block* or *Loss of Terminal Block* message to the RX3i CPU to report the Terminal Block status.

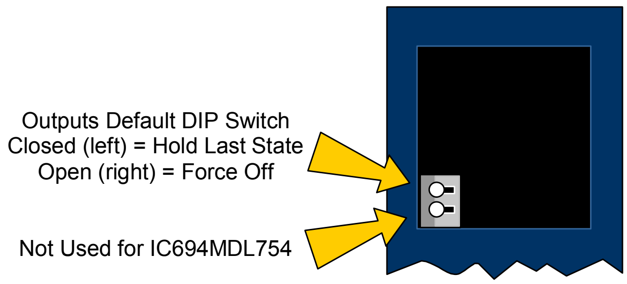
Electronic Short-circuit Protection

Each output point provides "self-recovering" protection against overcurrent, short circuit and overtemperature. The fault is present until the condition that caused the fault is removed or the faulted point is turned off. After the fault condition is removed the output driver automatically sets the output to the state it was in before the fault occurred.

Each output point provides transient voltage protection to clamp high voltages at or below 40VDC. Reverse voltage protection is provided for field power inputs.

Output Defaults

The DIP switch on back of the module selects the default operation for the module's outputs. The module must be removed from the backplane to set this switch. Note that there are two DIP switches on the module. Only the upper switch is used for this module.



With the Outputs Default switch in the right (open) position, the outputs mode is set to Force Off. In this mode, the outputs will go to zero whenever communication with the CPU is lost. When the switch is in the left position, the Outputs Default mode is set to Hold Last State. In this mode the outputs will retain their last programmed value whenever communication with the CPU is lost, and field power is present.

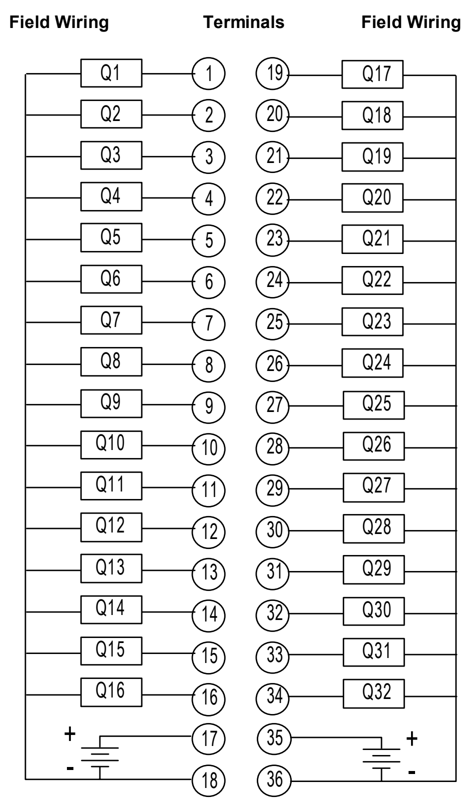
The Outputs Default selection made with the DIP switch must match the selection made for this feature in the module's software configuration. If the two do not match, a fault occurs.

The table below summarizes the operation of Outputs Default mode with and without backplane power and field (external) power.

Backplane Power	Field Power	Outputs Default	Operation
On	On	Force Off or Hold Last State	Normal Operation. If module fault detected, outputs are set to zero.
On	Off	Force Off or Hold Last State	Module detects loss of field power, communicates fault to CPU while setting outputs to Off state. After field power is restored, the outputs are held in Off state until the module receives new output data from the CPU. Point LEDs indicate desired output without field power.
Off	On	Force Off	Module detects loss of communications and turns off the outputs within 400ms. LEDs are off.
		Hold Last State	Module detects loss of communications and holds outputs on their last states until the CPU sends new output data. LEDs are off

Field Wiring: MDL754

Connections	***Terminals***	***Terminals***	***Connections***
Output 1	1	19	Output 17
Output 2	2	20	Output 18
Output 3	3	21	Output 19
Output 4	4	22	Output 20
Output 5	5	23	Output 21
Output 6	6	24	Output 22
Output 7	7	25	Output 23
Output 8	8	26	Output 24
Output 9	9	27	Output 25
Output 10	10	28	Output 26
Output 11	11	29	Output 27
Output 12	12	30	Output 28
Output 13	13	31	Output 29
Output 14	14	32	Output 30
Output 15	15	33	Output 31
Output 16	16	34	Output 32
DC+ for 1 - 16	17	35	DC+ for 17 - 32
DC- for 1 - 16	18	36	DC- for 17 - 32

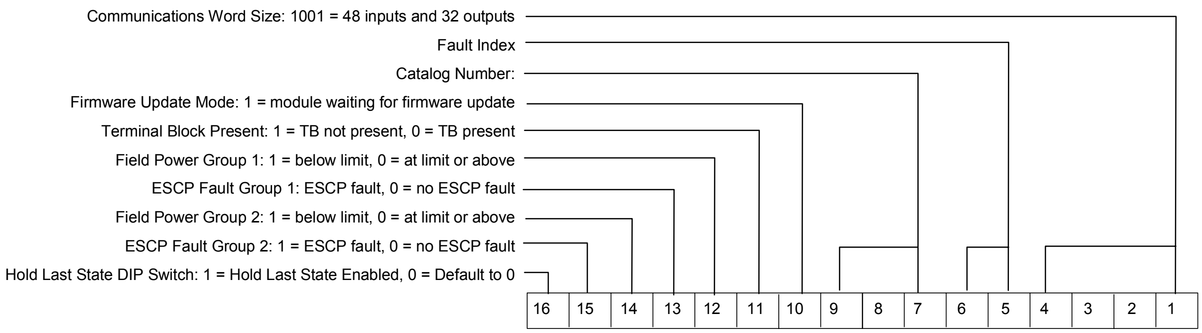


Module Data: IC694MDL754

Module MDL754 uses 48 input bits and 32 output bits to exchange point status and filter information with the RX3i CPU.

Input Data: MDL754

The module uses the first 16 input bits to report its status information to the RX3i CPU. It has the following content:



The CPU uses the information contained in these input bits to uniquely identify the module, and to monitor its status.

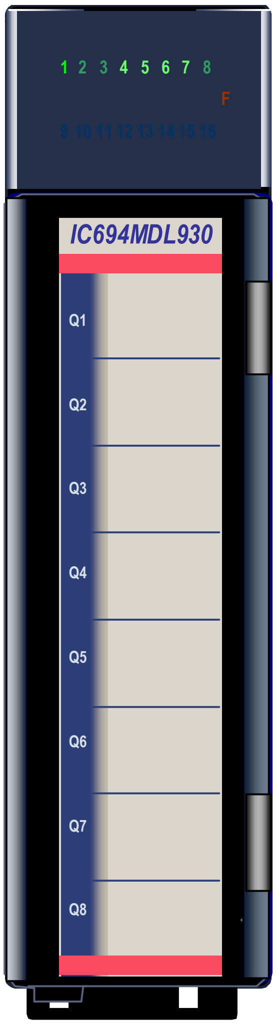
The module reports the ESCP fault status of the outputs in input bits 17 - 48.

Output ESCP Status Bits	
Output Group 1	*Output Group 2*
17-32	33 - 48

Output Data: MDL754

The module receives 32 bits of output data from the RX3i CPU.

Output Module, Isolated Relay, N.O., 4 Amp, 8 Point: IC694MDL930



The ***4 Amp Isolated Relay Output*** module, IC694MDL930, provides eight normally–open relay circuits for controlling output loads. The output switching capacity of each circuit is 4 Amps. Each output point is isolated from the other points, and each point has a separate common power output terminal. The relay outputs can control a wide range of output devices, such as: motor starters, solenoids, and indicators. The user must supply the AC or DC power to operate the field devices connected to this module.

Individual numbered LEDs show the ON/OFF status of each output point. There are no fuses on this module. The red bands on the label show that MDL930 is a high-voltage module.

This module can be installed in any I/O slot in an RX3i system.

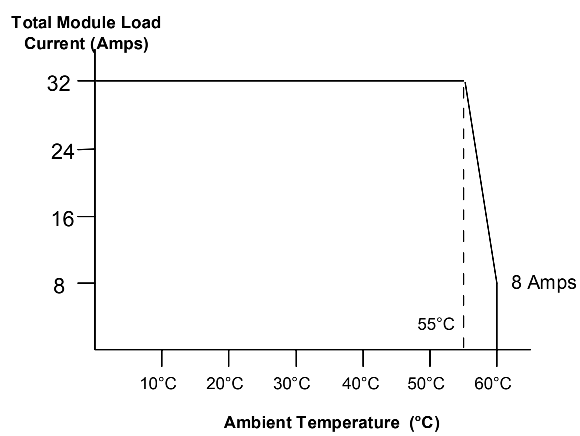
Specifications: MDL930

Rated Voltage	24 volts DC, 120/240 volts AC (nominal - see the following table for exceptions)
Operating Voltage	5 to 30 volts DC
	5 to 250 volts AC, 50/60 Hz
Outputs per Module	8 isolated outputs
Isolation:	
Field to Backplane and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Point to Point	250 VAC continuous; 1500 VAC for 1 minute
Maximum Load	4 Amps resistive maximum per output
	2 Amps pilot duty per output
	20 Amps maximum per module for UL installations
	Maximum Load depends on the ambient temperature as shown below
Minimum Load	10mA
Maximum Inrush	5 Amps
On Response Time	15ms maximum*
Off Response Time	15ms maximum*
Power Consumption	6mA (all outputs on) from 5 volt bus on backplane
	70mA (all outputs on) from relay 24V bus on backplane

Refer to Appendix A for product standards and general specifications.

* When this module is used with DC power supply IC695PSD040 or PSD140, special precautions should be taken because dropouts in the source voltage will be seen by this module and may cause relay dropouts.

Load Current vs. Temperature



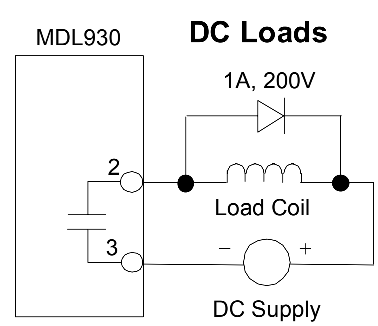
Load Current Limitations

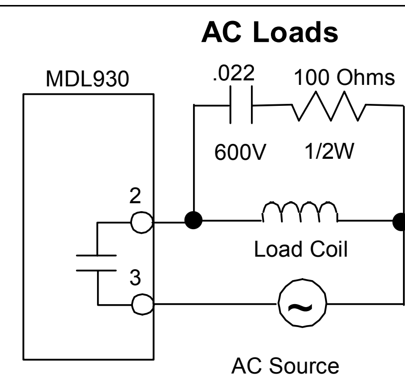
Operating Voltage	Maximum Current for Load Type		Typical Contact Life (Number of Operations)
	Resistive	Lamp or Solenoid *	
24 to 120 VAC	4 Amps	2 Amps	150,000
24 to 120 VAC	1 Amp	0.5 Amp	500,000
24 to 120 VAC	0.1 Amp	0.05 Amp	1,000,000
240 VAC	4 Amps	2 Amps	50,000
240 VAC	0.1 Amp	0.05 Amp	500,000
240 VAC	1 Amp	0.5 Amp	200,000
24 VDC	–	3 Amps	50,000
24 VDC	4 Amps	2 Amps	100,000
24 VDC	1 Amp	0.5 Amp	500,000
24 VDC	0.1 Amp	0.05 Amp	1,000,000
125 VDC	0.2 Amp	0.1 Amp	300,000

* Assumes a 7ms time constant

Relay contact life, when switching inductive loads, will approach resistive load contact life if suppression circuits are used. Examples of typical suppression circuits for AC and DC loads are shown below. The 1A, 200V diode shown in the DC load typical suppression example is an industry standard 1N4935. The resistor and capacitor shown for AC load suppression are standard components, available from most electronics distributors.

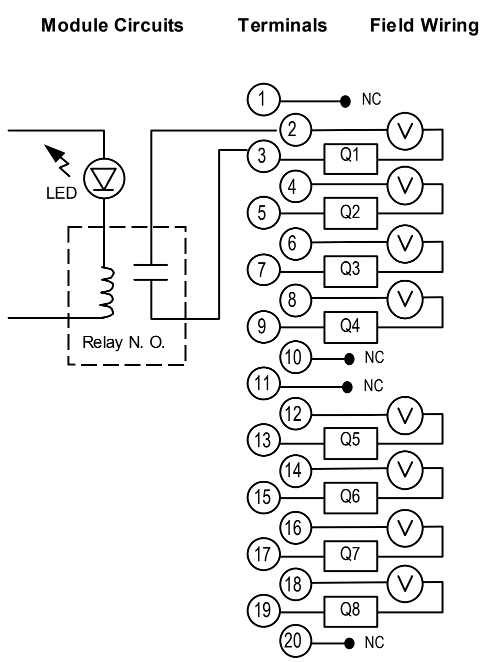
Load Suppression Examples for Output Module IC694MDL930



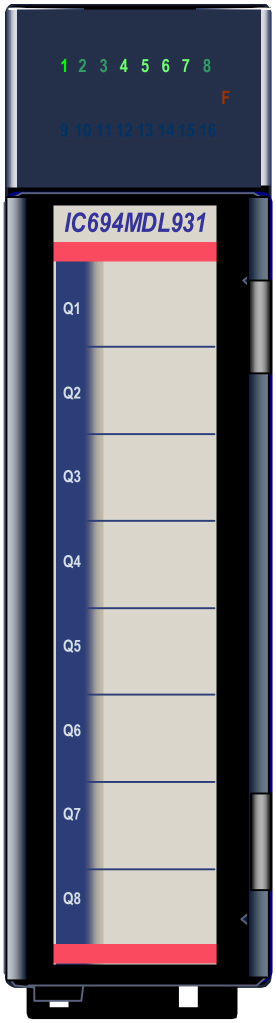


Field Wiring: MDL930

Terminal	*Connection*
1	No connection
2	Output 1-1
3	Output 1-2
4	Output 2-1
5	Output 2-2
6	Output 3-1
7	Output 3-2
8	Output 4-1
9	Output 4-2
10	No connection
11	No connection
12	Output 5-1
13	Output 5-2
14	Output 6-1
15	Output 6-2
16	Output 7-1
17	Output 7-2
18	Output 8-1
19	Output 8-2
20	No connection



Output Module, Isolated Relay, N.C. and Form C, 8A , 8 Pt: IC694MDL931



The ***8 Amp Isolated Relay Output*** module, IC694MDL931, provides 4 normally-closed and 4 Form C relay circuits for controlling output loads provided by the user. The output switching capacity of each circuit is 8 Amps. Each output relay is isolated from the other relays, and each relay has a separate common power output terminal. The relay outputs can control a wide range of load devices, such as: motor starters, solenoids, and indicators. The user must supply the AC or DC power to operate the field devices.

Individual numbered LEDs show the ON/OFF status of each output point. There are no fuses on this module. The red bands on the label show that MDL931 is a high-voltage module.

This module can be installed in any I/O slot in an RX3i system.

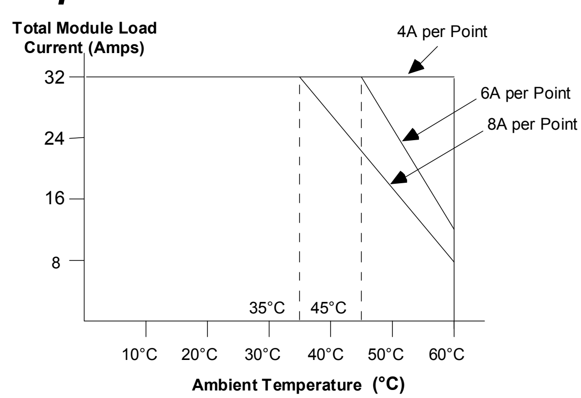
Specifications: MDL931

Rated Voltage	24 volts DC, 120/240 volts AC, 50/60 Hz (nominal - see the following table for exceptions)
Output Voltage Range	5 to 30 volts DC
	5 to 250 volts AC, 50/60 Hz
Outputs per Module	8 isolated outputs
Isolation:	
Field to Backplane and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Point to Point	250 VAC continuous; 1500 VAC for 1 minute
Maximum Load	8 Amps resistive maximum per output
	20 Amps maximum per module for UL installations
	Maximum load depends on ambient temperature as shown.
Minimum Load	10mA
Inrush Current	8 Amps maximum for one cycle
On Response Time	15ms maximum*
Off Response Time	15ms maximum*
Output Leakage Current	1mA maximum at 250 volts AC, (25°C (77°F))
Power Consumption	6mA (all outputs on) from 5 volt bus on backplane
	110mA (all outputs on) from relay 24V bus on backplane

Refer to Appendix A for product standards and general specifications.

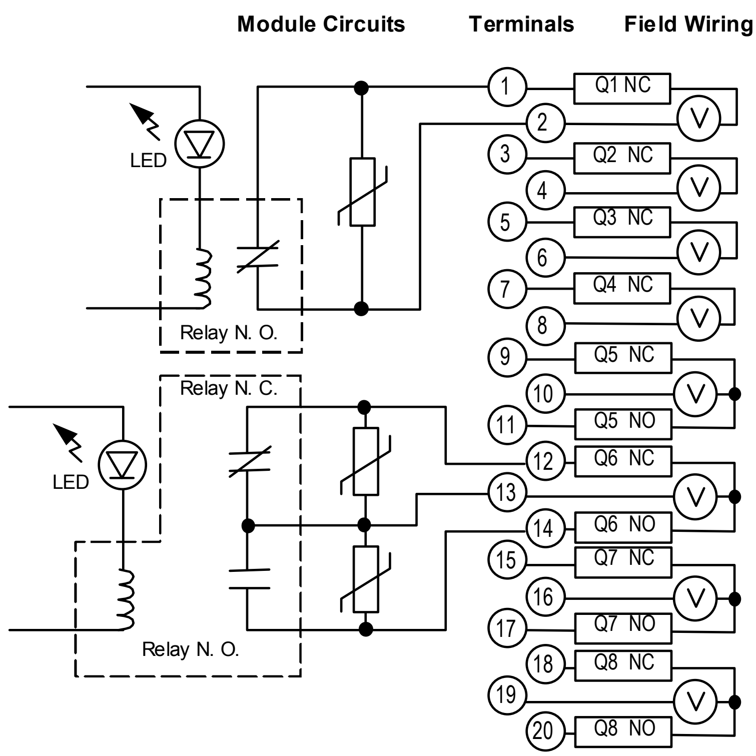
* When this module is used with DC power supply IC695PSD040 or PSD140, special precautions should be taken because dropouts in the source voltage will be seen by this module and may cause relay dropouts.

Load Current vs. Temperature



Field Wiring: MDL931

Terminal	***Connection***
1	Output 1
2	Output 1 return
3	Output 2
4	Output 2 return
5	Output 3
6	Output 3 return
7	Output 4
8	Output 4 return
9	Output 5 (if normally-closed relay)
10	Output 5 return
11	Output 5 (if normally-open relay)
12	Output 6 (if normally-closed relay)
13	Output 6 return
14	Output 6 (if normally-open relay)
15	Output 7 (if normally-closed relay)
16	Output 7 return
17	Output 7 (if normally-open relay)
18	Output 8 (if normally-closed relay)
19	Output 8 return
20	Output 8 (if normally-open relay)



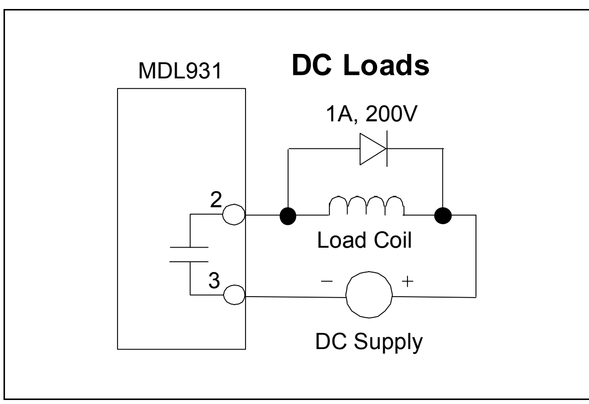
Load Current Limitations for MDL931

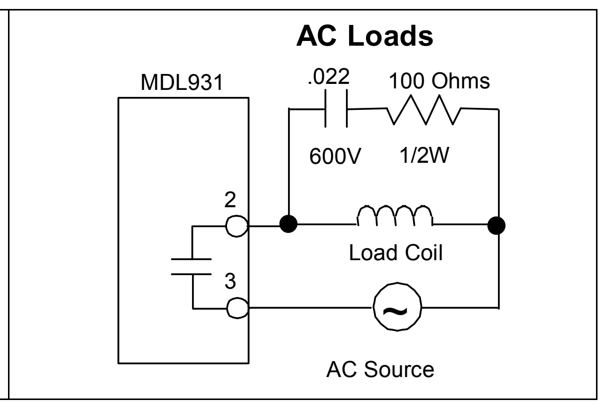
Operating Voltage	Maximum Current for Load Type		Typical Contact Life
	Resistive	Lamp or Solenoid *	(Number of operations)
5 to 120 VAC	8 Amps	3 Amps	200,000
	6 Amps	2.5 Amps	300,000
	4 Amps	1.5 Amps	400,000
	1 Amp	0.5 Amp	1,100,000
240 VAC	8 Amps	3 Amps	100,000
	6 Amps	2.5 Amps	150,000
	4 Amps	1.5 Amps	200,000
	1 Amp	0.5 Amp	800,000
24 VDC	8 Amps	3 Amps	100,000
	6 Amps	2.5 Amps	150,000
	4 Amps	1.5 Amps	200,000
	1 Amp	0.5 Amp	800,000
48 VDC	1.5 Amps	–	100,000
100 VDC	0.5 Amp	–	100,000
125 VDC	0.38 Amp	0.12 Amp	100,000
150 VDC	0.30 Amp	0.10 Amp	100,000

* For inductive loads

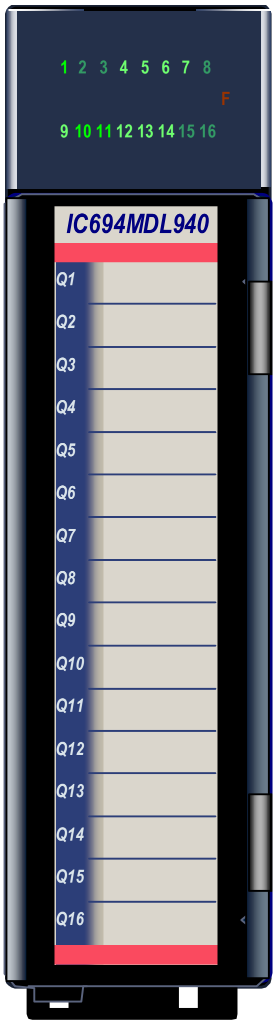
Relay contact life, when switching inductive loads, will approach resistive load contact life if suppression circuits are used. The examples below show typical suppression circuits for AC and DC loads. The 1A, 200V diode shown in the DC load typical suppression circuit is an industry standard 1N4935. The resistor and capacitor shown for AC load suppression are standard components.

Load Suppression Examples for Output Module IC694MDL931





Output Module, Relay Output, N.O., 2 Amp, 16 Point: IC694MDL940



The ***2 Amp Relay Output*** module, IC694MDL940, provides 16 normally–open relay circuits for controlling output loads. The output switching capacity of each output is 2 Amps. The output points are in four groups of four points each. Each group has a common power output terminal. The relay outputs can control a wide range of load devices, such as: motor starters, solenoids, and indicators. Power for the internal relay circuits is provided by the +24 volt DC bus on the backplane. The user must supply the AC or DC power to operate field devices.

Individual numbered LEDs show the ON/OFF status of each output point. There are no fuses on this module. The red bands on the label show that MDL940 is a high-voltage module.

This module can be installed in any I/O slot in an RX3i system.

Specifications: MDL940

Rated Voltage	24 volts DC, 120/240 volts AC (nominal - see the following table for exceptions)
Operating Voltage	5 to 30 volts DC 5 to 250 volts AC, 50/60 Hz
Outputs per Module	16 (four groups of four outputs each)
Isolation:	
Field to Backplane and to Frame Ground	250 VAC continuous; 1500 VAC for 1 minute
Point to Point	250 VAC continuous; 1500 VAC for 1 minute
Maximum Load	2 Amps pilot duty maximum per output 4 Amps maximum per common
Minimum Load	10mA
Maximum Inrush	5 Amps
On Response Time	15ms maximum*
Off Response Time	15ms maximum*
Power Consumption, all outputs on	7mA from 5 volt bus on backplane 135mA from relay 24V bus on backplane

Refer to Appendix A for product standards and general specifications.

* When this module is used with DC power supply IC695PSD040 or PSD140, special precautions should be taken because dropouts in the source voltage will be seen by this module and may cause relay dropouts.

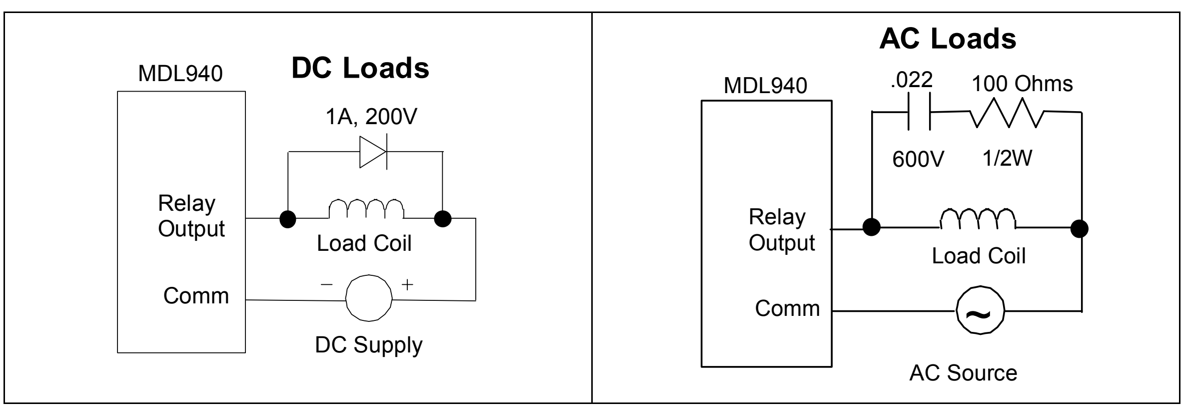
Load Current Limitations: MDL940

Operating Voltage	Maximum Current for Load Type		Typical Contact Life
	Resistive	Lamp or Solenoid *	(Number of Operations)
24 to 120 VAC	2 Amps	1 Amp	300,000
24 to 120 VAC	1 Amp	0.5 Amp	500,000
24 to 120 VAC	0.1 Amp	0.05 Amp	1,000,000
240 VAC	2 Amps	1 Amp	150,000
240 VAC	1 Amp	0.5 Amp	200,000
240 VAC	0.1 Amp	0.05 Amp	500,000
24 VDC	–	2 Amps	100,000
24 VDC	2 Amps	1 Amp	300,000
24 VDC	1 Amp	0.5 Amp	500,000
24 VDC	0.1 Amp	0.05 Amp	1,000,000
125 VDC	0.2 Amp	0.1 Amp	300,000

∗ Assumes a 7 ms time constant

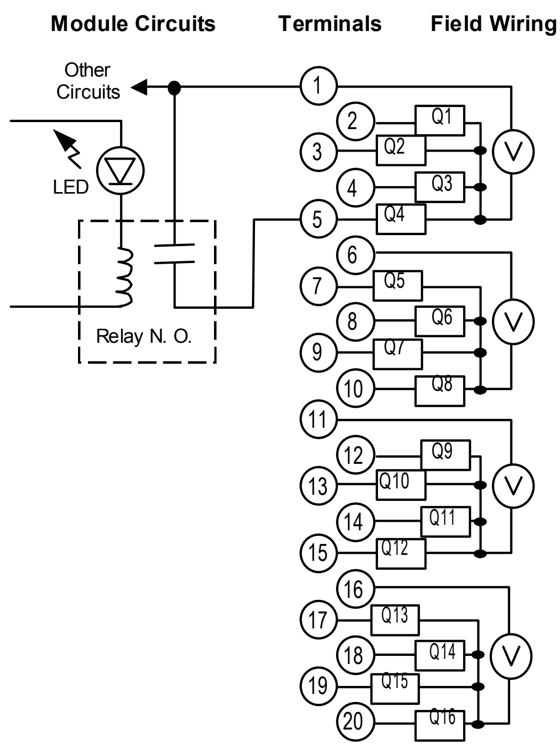
Relay contact life, when switching inductive loads, will approach resistive load contact life if suppression circuits are used. The following figures are examples of typical suppression circuits for AC and DC loads. The 1A, 200V diode shown in the DC load suppression circuit is an industry standard 1N4935. The resistor and capacitor shown for AC load suppression are standard components.

Load Suppression Examples for Output Module IC694MDL940



Field Wiring: MDL940

Terminal	*Connection*
1	Outputs 1 – 4 common (return)
2	Output 1
3	Output 2
4	Output 3
5	Output 4
6	Outputs 5 -8 common (return)
7	Output 5
8	Output 6
9	Output 7
10	Output 8
11	Outputs 9 - 12 common (return)
12	Output 9
13	Output 10
14	Output 11
15	Output 12
16	Outputs 13 – 16 common (return)
17	Output 13
18	Output 14
19	Output 15
20	Output 16

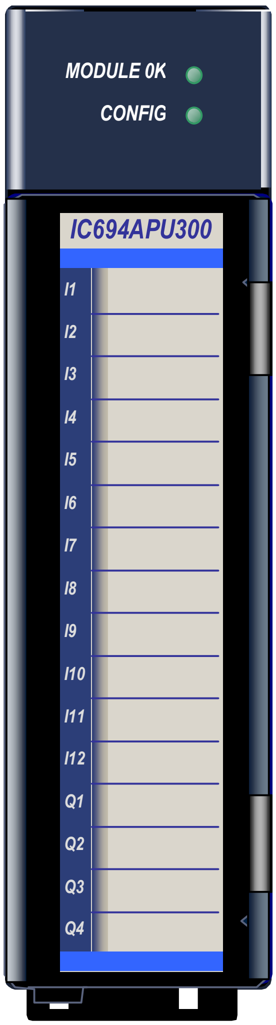


Chapter 8 Discrete Mixed Modules

This chapter describes the following discrete mixed input/output module for RX3i PACSystems:

Discrete Mixed Module	***Catalog Number***
High Speed Counter	IC694APU300

High-speed Counter Module: IC694APU300



The High-speed Counter module, IC694APU300, provides direct processing of rapid pulse signals up to 80 kHz. The module senses inputs, processes the input count information, and controls the outputs without needing to communicate with a CPU.

The High Speed Counter uses 16 bits of discrete input memory (%I), 15 words of analog input memory (%AI), and 16 bits of discrete output memory (%Q) in the CPU. The High-speed Counter can be configured to have:

- 4 identical, independent simple counters
- 2 identical, independent more complex counters
- 1 complex counter

Two green LEDs indicate the operating status of the module and the status of configuration parameters. Additional module features include:

- 12 positive logic (source) inputs with input voltage range selection of either 5 VDC or 10 to 30 VDC
- 4 positive logic (source) outputs
- Counts per timebase register for each counter
- Internal module diagnostics
- A removable terminal board for field wiring

Inputs can be used as count signals, direction, disable, edge-sensitive strobe, and preload inputs depending on the counter type selected by the user. Outputs can be used to drive indicating lights, solenoids, relays, and other devices.

Power for the module is drawn from the backplane's 5VDC bus. Power sources for input and output devices must be supplied by the user or by the +24 VDC Isolated output of the power supply. The module also provides a selectable threshold voltage to allow the inputs to respond to either 5VDC signal levels or 10 to 30VDC signal levels.

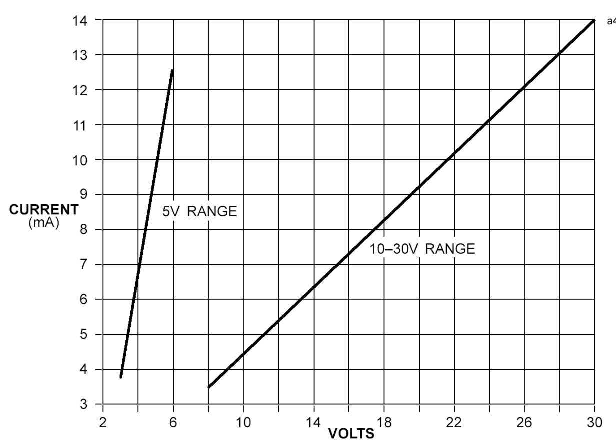
The blue bands on the label show that APU300 is a low-voltage module. This module can be installed in any I/O slot in an RX3i system.

Specifications: APU300

Inputs		
Voltage Range	5VDC (TSEL jumpered to INCOM) 10 to 30 VDC (TSEL open)	
Positive Logic Inputs	12	
Input Thresholds (I1 to I12)	***5VDC Range***	***10 to 30VDC Range***
Von	3.25V Range	8.0V minimum
Ion	3.2mA minimum	3.2mA minimum
Voff	1.5V maximum	2.4V maximum
Ioff	0.8mA maximum	0.8mA maximum
Survivable Peak Voltage	± 500V for 1mSec	
Transient Common Mode Noise Rejection	1000 volts per mSec minimum	
Input Impedance	See below	
Outputs		
Voltage Range	10 to 30VDC @ 500mA maximum	
Voltage Range	4.75 to 6VDC @ 20mA maximum	
Off State Leakage Current	10mA maximum per point	
Output Voltage Drop at 500 mA	0.5V maximum	
CMOS Load Drive Capability	Yes	
Positive Logic Outputs	4	
Output protection	Outputs are short circuit protected by a 3A pico fuse common to all 4 outputs	
Module		
Power Consumption	250mA from 5V bus on the backplane	
Isolation:		
Field to Backplane (optical) and to frame ground	250 VAC continuous, 1500 VAC for one minute	
Group to Group	250 VAC continuous, 1500 VAC for one minute	

Refer to Appendix A for product standards and general specifications.

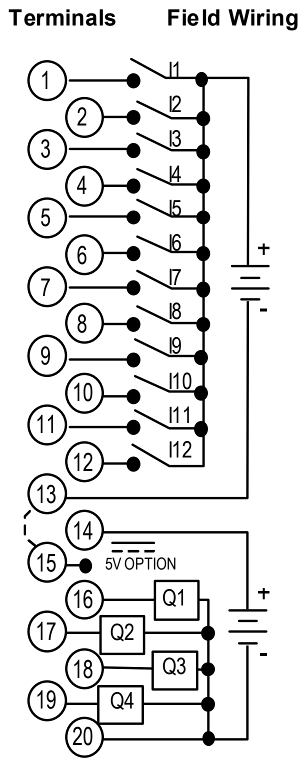
Input Impedance



Field Wiring: APU300

Wiring information for APU300 is shown below.

Shielded cable must be used for connecting to the High Speed Counter module. The shield for the cable must have a high frequency ground within 6 inches (15.24 cm) of the module to meet the IEC 1000-4-4 levels specified in Appendix A. The cable's length is limited to 30 meters.



All 12 High Speed Counter inputs are single-ended positive logic (source) type inputs. Transducers with CMOS buffer outputs (74HC04 equivalent) can directly drive the High-speed Counter inputs using the 5V input range. Transducers using TTL totem pole or open-collector outputs must include a 470 ohm pull-up resistor (to 5V) to guarantee compatibility with the High-speed Counter inputs. Transducers using high voltage open collector (sink) type outputs must have a 1K pull-up resistor to + 12V for compatibility with the High-speed Counter 10 to 30 volt input range.

The 5VDC threshold is selected by connecting a jumper between two terminals on the detachable terminal board connector. Leaving the threshold selection terminals unconnected places the inputs in the default 10 to 30 VDC voltage range.

Caution

Do not connect 10 to 30 VDC to the module inputs when the 5 VDC input range (pins 13 to 15 jumpered) is selected. Doing so will damage the module.

Terminal Assignments for Each Counter Type

The following table shows which terminals to use for the type of counter selected during module configuration.

Terminal	Signal Name	Pin Definition	Use in Counter Type		
			Type A	Type B (1)	Type C (2)
1	I1	Positive Logic Input	A1	A1	A1
2	I2	Positive Logic Input	A2	B1	B1
3	I3	Positive Logic Input	A3	A2	A2
4	I4	Positive Logic Input	A4	B2	B2
5	I5	Positive Logic Input	PRELD1	PRELD1	PRELD1.1 *
6	I6	Positive Logic Input	PRELD2	PRELD2	PRELD1.2
7	I7	Positive Logic Input	PRELD3	DISAB1	DISAB1
8	I8	Positive Logic Input	PRELD4	DISAB2	HOME
9	I9	Positive Logic Input	STRB1	STRB1.1 *	STRB1.1 *
10	I10	Positive Logic Input	STRB2	STRB1.2	STRB1.2
11	I11	Positive Logic Input	STRB3	STRB2.1	STRB1.3
12	I12	Positive Logic Input	STRB4	STRB2.2	MARKER
13	INCOM	Common for positive logic inputs	INCOM	INCOM	INCOM
14	OUTPWR (3) DC+	Power for positive logic outputs	OUTPWR	OUTPWR	OUTPWR
15	TSEL	Threshold select, 5V or 10 to 30V	TSEL	TSEL	TSEL
16	O1	Positive Logic Output	OUT1	OUT1.1 *	OUT1.1 *
17	O2	Positive Logic Output	OUT2	OUT1.2	OUT1.2
18	O3	Positive Logic Output	OUT3	OUT2.1	OUT1.3
19	O4	Positive Logic Output	OUT4	OUT2.2	OUT1.4
20	OUTCOM DC-	Common for positive logic outputs	OUTCOM	OUTCOM	OUTCOM

(1). Type B counter:

A1, B1 are the A and B inputs for counter 1.
A2, B2 are the A and B inputs for counter 2.

(2) Type C Counter:

A1, B1 are the A and B count inputs for (+) loop
A2, B2 are the A and B count inputs for (–) loop

(3) OUTPWR ***does not*** source power for user loads. Output power ***must be supplied*** from an external supply.

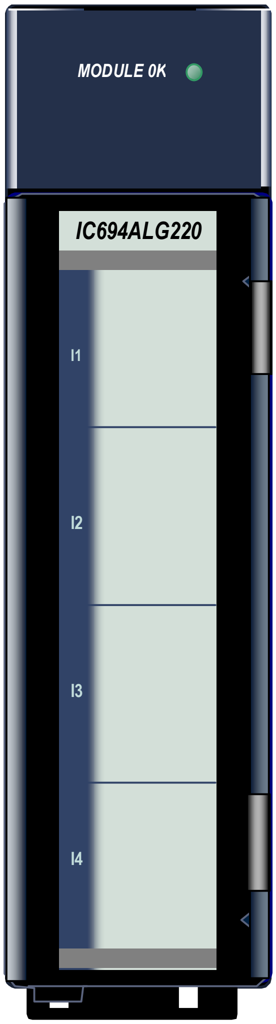
* Inputs and outputs identified by two numbers separated by a decimal point indicate the counter number to the left of the decimal point and the element number on the right. For example, STRB1.2 indicates Counter 1, Strobe 2 input.

Chapter 9 Analog Input Modules

This chapter describes Analog Input modules for PACSystems RX3i controllers.

Discrete Output Module	***Catalog Number***
Analog Input Module, 4 channel Voltage	IC694ALG220
Analog Input Module, 4 channel Current	IC694ALG221
Analog Input Module, 16/8 channel Voltage	IC694ALG222
Analog Input Module, 16 channel Current	IC694ALG223
Analog Input Module, 8 Channel Non-Isolated / 4 Channel Differential	IC695ALG608
Analog Input Module, 16 Channel Non-Isolated / 8 Channel Differential	IC695ALG616

Analog Input Module, 4 Channel Differential Voltage: IC694ALG220



The ***4–Channel Analog Voltage Input*** module, IC694ALG220, provides four analog input channels. This module accepts inputs in the range of -10 to +10 volts. Individual channels can be used with 4 to 20 mA inputs by jumpering the input terminals.

Conversion speed for each of the four channels is one millisecond. This provides an update rate of four milliseconds for any channel.

This module can be installed in any I/O slot of an RX3i PLC system.

Isolated +24 VDC Power

If the module is located in an RX3i Universal Backplane, an external source of Isolated +24 VDC is required to provide power for the module. The external source must be connected via the TB1 connector on the left side of the backplane.

If this module is located in an Expansion Backplane, the backplane's power supply provides the Isolated +24 VDC output for the module.

LEDs

The **Module OK** LED is ON when the module's power supply is operating.

Specifications: IC694ALG220

Voltage Range	-10 to +10 volts *
Calibration	Factory calibrated
Update Rate	4 milliseconds (all four channels)
Resolution	5 mV/20 µA, (1 LSB = 5 mV)
Absolute Accuracy **	+/-10 mV/40 µA (typical) over operating temperature +/-30 mV/160 µA (maximum) over operating temperature
Linearity	<1 Least Significant Bit
Isolation, Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for 1 minute
Cross–Channel Rejection	> 80dB
Input Impedance	> 9 Megohms (voltage mode)
	250 Ohms (current mode)
Input Filter Response	17 Hz
Internal Power Consumption	27 mA from +5 VDC bus on the backplane
	98 mA from the isolated +24 VDC backplane bus

Refer to Appendix A for product standards and general specifications.

∗ Both inputs must be within ± 11 volts of COM, including any noise present on the inputs.

** In the presence of severe RF interference (IEC 801–3, 10V/m), accuracy may be degraded to +/-100 mV/400 µA.

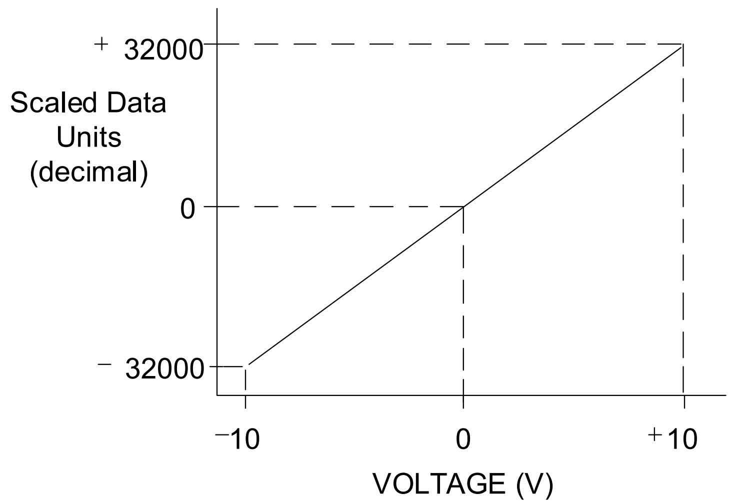
Data Format: IC694ALG220

Module data is stored in the PLC CPU in 16–bit 2's complement format as shown below.

MSB															LSB
+/-	10	9	8	7	6	5	4	3	2	1	0	X	X	X	X

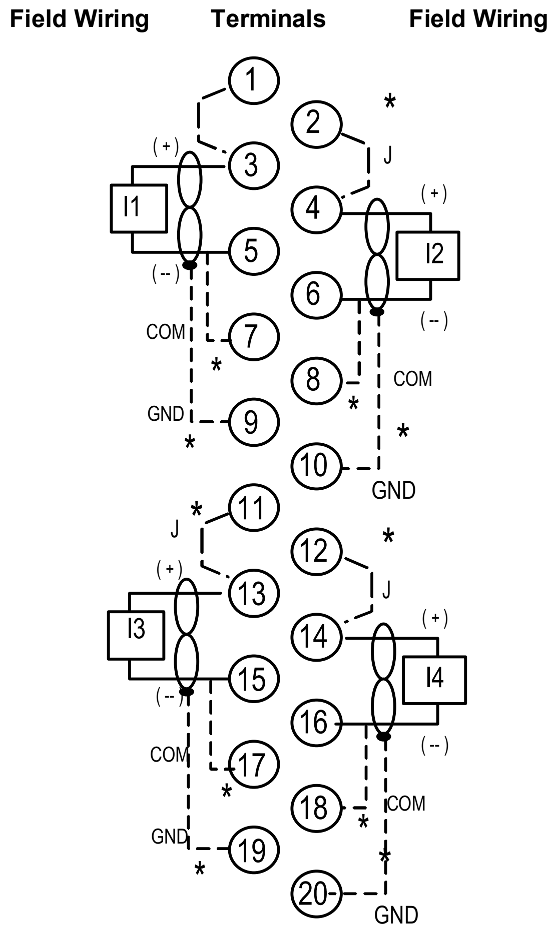
Scaling and Resolution

The module scales input data so that –10 V corresponds to –32000 and +10 V corresponds to +32000. Resolution per bit is 5 mV or 20 mA per bit.



A 4 to 20 mA input corresponds to a 1 to 5 Volt input to the module; therefore, the resolution of the 4 to 20 mA input signal is approximately 10 bits binary (1 part in 1024). The resolution can be increased to approximately 11 bits (1 part in 2048) by using a precision 250 Ohm resistor instead of the jumper. The resistor causes the voltage input module to see a 4 to 20 mA input as 2 to 10 volts.

Field Wiring: ALG220



*Optional Connection
J = Current Mode Input Jumpers

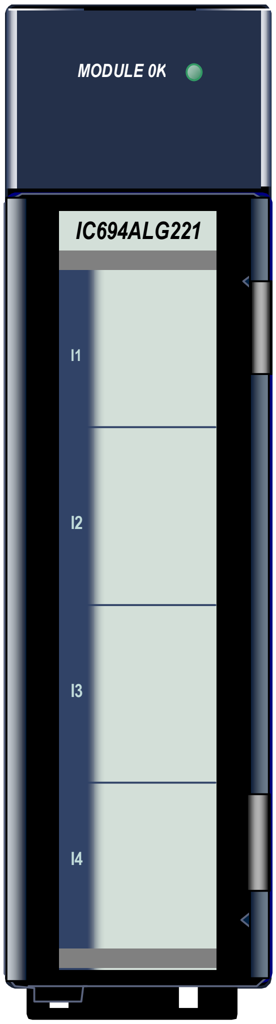
Terminal	Connection
1-3	Current mode input jumper for channel 1
2-4	Current mode input jumper for channel 2
3	Channel 1 +
4	Channel 2+
5	Channel 1-
6	Channel 2 -
7	Common
8	Common
9	Shield Termination Point for Channel 1
10	Shield Termination Point for Channel 2
11 - 13	Current mode input jumper for channel 3
12 - 14	Current mode input jumper for channel 4
13	Channel 3 +
14	Channel 4+
15	Channel 3-
16	Channel 4 -
17	Common
18	Common
19	Shield Termination Point for Channel 3
20	Shield Termination Point for Channel 4

To minimize the capacitive loading and noise, all field connections to the module should be wired using a good grade of twisted, shielded instrumentation cable. The shields can be connected to either COM or GND. The COM connection provides access to the common of the analog circuitry in the module. The GND connection provides access to the backplane (frame ground). The (-) side of the voltage source can also be tied to the COM terminal if the source is floating to limit common-mode voltages.

The optional jumpers shown can be used to configure a channel for use with 4 to 20 mA inputs. The resolution of 4 to 20 mA inputs can be increased from 10 bits to approximately 11 bits by installing a 250 Ohm resistor instead of the jumper

Connect the **+** and **-** terminals together for all unused inputs to minimize any fluctuations in the analog input table for the unused points.

Analog Input Module, 4 Channel Differential Current: IC694ALG221



The ***4–Channel Analog Current Input*** module, IC694ALG221, provides four analog input channels. This module has two possible input ranges:

- 4 to 20 mA
- 0 to 20 mA

Two range jumpers are provided with the module; one for channels one and two, and the other for channels three and four.

Conversion speed for each of the four channels is one–half millisecond. This provides an update rate of two milliseconds for any channel. Resolution of the converted signal is 12 bits binary (1 part in 4096) over either range.

Input protection for the module is sufficient for operation with reduced performance with up to 200 V common–mode. The module provides electrical isolation of externally generated noise between field wiring and the backplane through the use of optical isolation.

This module can be installed in any I/O slot of an RX3i system.

Isolated +24 VDC Power

If this module is located in an RX3i Universal Backplane, an external source of Isolated +24 VDC is required to provide power for the module. The external source must be connected via the TB1 connector on the left side of the backplane.

If the module is located in an Expansion Backplane, the backplane's power supply provides the Isolated +24 VDC output for the module.

LEDs

The **Module OK** LED is ON when the module's power supply is operating.

Specifications: IC694ALG221

Input Current Ranges	4 to 20 mA and 0 to 20 mA
Calibration	Factory calibrated to 4 μA per count
Update Rate	2 milliseconds (all four channels)
Resolution at 4–20 mA	4 μA (1 LSB = 4 μA)
Resolution at 0–20 mA	5 μA (1 LSB = 5 μA)
Absolute Accuracy *	0.1% full scale + 0.1% reading
Common Mode Voltage	200 volts
Linearity	< 1 Least Significant Bit
Isolation, Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for 1 minute
Common Mode Rejection	> 70dB at DC; >70dB at 60Hz
Cross–Channel Rejection	> 80dB from DC to 1kHz
Input Impedance	250 Ohms
Input Filter Response	325 Hz
Internal Power Consumption	100 mA from the isolated +24 VDC supply 25 mA from +5 VDC bus on the backplane

Refer to Appendix A for product standards and general specifications.

In the presence of severe RF interference (IEC 801–3, 10V/m), accuracy may be degraded to ±0.5% FS.

Data Format: IC694ALG221

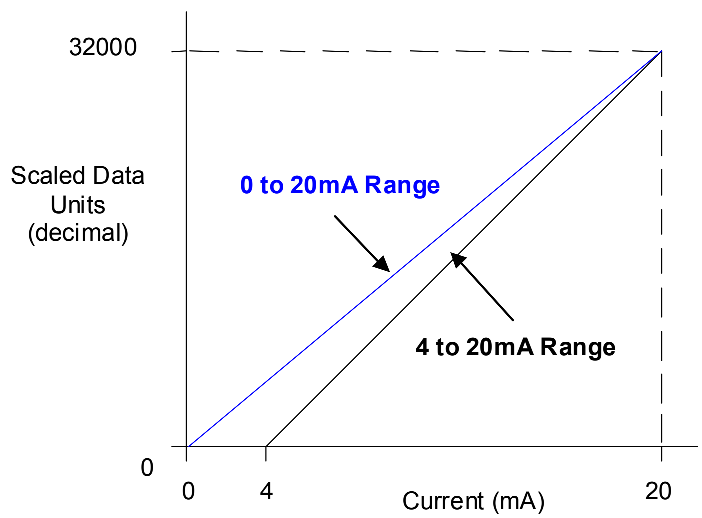
Module data is stored in the PLC CPU in 16–bit 2's complement format as shown below.

MSB															LSB
X	11	10	9	8	7	6	5	4	3	2	1	0	X	X	X

Current Inputs, A/D Data and Scaled Units

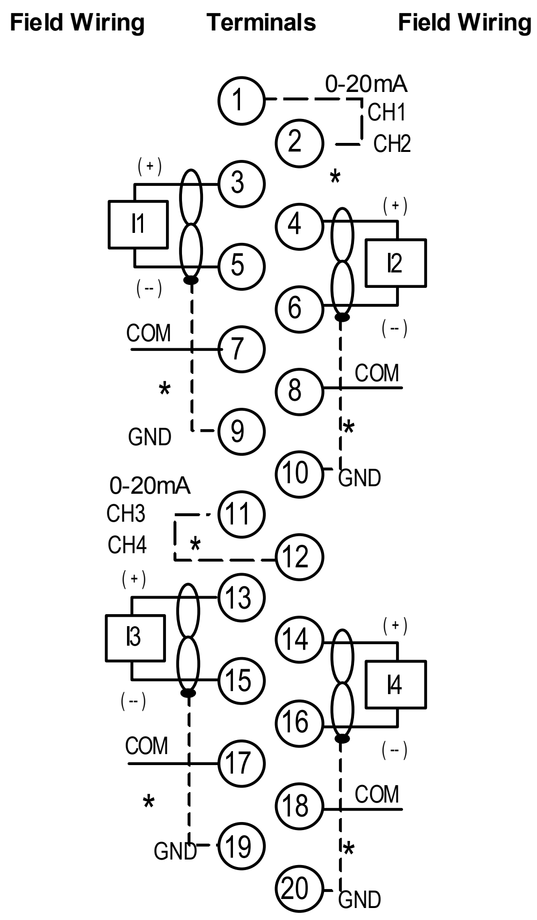
The default range for each input is 4 to 20 mA, scaled so that 4 mA corresponds to a count of 0 and 20 mA corresponds to a count of 32000 with each 1000 counts representing 0.5 mA.

When a jumper is added to the I/O terminal board, the input range for a PAIR of inputs is changed to 0 to 20 mA. In 0 to 20 mA range, 0 mA corresponds to a count of 0 and 20 mA corresponds to a count of 32000 with each 800 counts representing 0.5 mA.



If the current source is reversed into the input or is less than the low end of the current range, the module provides an input data word corresponding to the low end of the current range (0000H in PLC memory). If an input is greater than 20 mA, the module provides an input data value at full scale (7FF8H in PLC memory).

Field Wiring: IC694ALG221



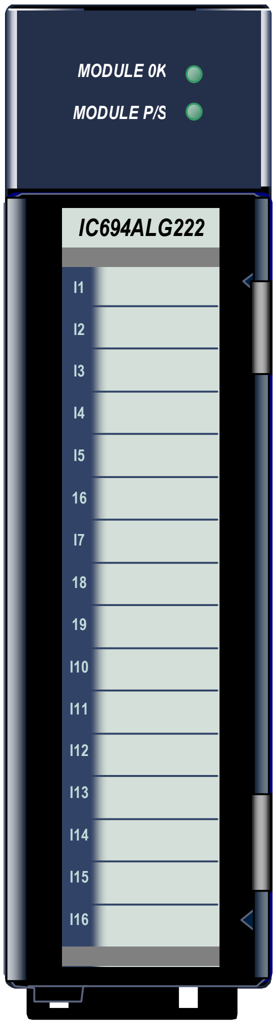
*Optional Connections

Terminal	Connection
1	0-20mA Jumper for channels 1 and 2
2	0-20mA Jumper for channels 1 and 2
3	Channel 1 +
4	Channel 2+
5	Channel 1-
6	Channel 2 -
7	Common
8	Common
9	Shield Termination Point for Channel 1
10	Shield Termination Point for Channel 2
11	0-20mA Jumper for channels 3 and 4
12	0-20mA Jumper for channels 3 and 4
13	Channel 3 +
14	Channel 4+
15	Channel 3-
16	Channel 4 -
17	Common
18	Common
19	Shield Termination Point for Channel 3
20	Shield Termination Point for Channel 4

To minimize the capacitive loading and noise, all field connections to the module should be wired using a good grade of twisted, shielded instrumentation cable. The shields can be connected to either COM or GND. The COM connection provides access to the common of the analog circuitry in the module. The GND connection provides access to the Backplane (frame ground).

To limit common–mode voltages, each current source common line may also be tied to its associated COM terminal if the source is floating. These optional connections are shown above.

Analog Input Module, 16 / 8 Channel Voltage: IC694ALG222



The ***16–Channel Analog Voltage Input*** module, IC694ALG222, provides 16 single-ended or eight differential input channels.

Each channel can be configured using the configuration software for either of two input ranges:

- 0 to 10 V (unipolar), default
- -10 to +10 V (bipolar)

High and Low alarm limits can be configured for both ranges.

This module can be installed in any I/O slot of an RX3i system.

Isolated +24 VDC Power

If the module is located in an RX3i Universal Backplane, an external source of Isolated +24 VDC is required to provide power for the module. The external source must be connected via the TB1 connector on the left side of the backplane.

If this module is located in an Expansion Backplane, the backplane's power supply provides the Isolated +24 VDC for the module.

LEDs

The **MODULE OK** LED provides module status information on powerup:

- *ON*: status is OK, module configured
- *OFF*: no backplane power or software not running (watchdog timer timed out)
- *Continuous rapid flashing*: configuration data not received from CPU
- *Slow flashes, then OFF*: failed power–up diagnostics or encountered code execution error

The **Module P/S** LED indicates that the module's internally-generated +5 VDC supply is above a minimum designated level.

Specifications: IC694ALG222

Number of Channels	1 to 16 selectable, single-ended 1 to 8 selectable, differential
Input Current Ranges	0 V to +10 V (unipolar) or -10 V to +10 V (bipolar); selectable each channel
Calibration	Factory calibrated to: 2.5 mV per count on 0 V to +10 V (unipolar) range 5 mV per count on -10 to +10 V (bipolar) range
Update Rate	6 milliseconds (all 16 single-ended channels) 3 milliseconds (all 8 differential channels)
Resolution at 0V to +10V	2.5 mV (1 LSB = 2.5 mV)
Resolution at -10V to +10V	5 mV (1 LSB = 5 mV)
Absolute Accuracy *	+/10.25% of full scale @ 25°C (77°F) +/-0.5% of full scale over specified operating temperature range
Linearity	< 1 LSB
Isolation, Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for 1 minute
Common Mode Voltage (Differential)	*/-11 V (bipolar range) **
Cross–Channel Rejection	> 80dB from DC to 1 kHz
Input Impedance	>500K Ohms (single-ended mode) >1 MegaOhms (differential mode)
Input Filter Response	41 Hz (single-ended mode) 82 Hz (differential mode)
Internal Power Consumption	112 mA (maximum) from the backplane +5 VDC bus 41 mA (maximum) from the backplane isolated +24 VDC supply

Refer to Appendix A for product standards and general specifications.

* In the presence of severe RF interference (IEC 801–3, 10V/m), accuracy may be degraded to +/-5% FS.

**The summation of the differential input, common–mode voltage, and noise must not exceed +/-11 volts when referenced to COM.

Configuration: IC694ALG222

Configurable parameters for module IC694ALG222 are described below.

Parameter	Choices	Description
Active Channels	1 to 16 for Single-ended mode, or 1 to 8 for Differential mode	The number of channels to be scanned. Channels are scanned in sequential, contiguous order.
Mode	Single-ended (default), or Differential	In Single-ended mode, there are 16 inputs referenced to a single common. In Differential mode, each of the 8 inputs has its own signal and common.
Reference Address for Input Data		The memory location for input data from the module. Each channel provides 16 bits of analog input data to the PLC CPU.
Reference Address for Status Data		The memory location for where status information from the module starts.
Length	8, 16, 24, 32, 40	The number of status bits reported to the PLC. Bits 1 – 8 provide basic module diagnostics. Bits 9 – 24 contain channel 1 – 8 high alarm and low alarm status. Bits 25 – 40 contain channel 9 – 16 high alarm and low alarm status. Data formats are shown in this section.
Range	0 to 10 V (default) or -10 to 10 V	In the 0 to 10 V default range, input voltage values from 0 to 10 V report 0 to 32,000 integer values to the CPU. In the -10 to 10 V range, input voltage values from -10 to 10 V report -32000 to 32,000 integer values to the CPU.
Alarm Low	0 to 10 V Range = 0 to 32760 -10 to 10 V Range = -32767 to 32752	Each channel can be assigned a low alarm limit alarm. Values entered without a sign are assumed to be positive. Be sure the alarm low values are appropriate for the selected range.
Alarm High	0 to 10 V Range = 0 to 32760 -10 to 10 V Range = -32767 to 32752	Each channel can also be assigned a high alarm limit. Values entered without a sign are assumed to be positive. Be sure the alarm high values are appropriate for the selected range.
I/O Scan Set	Default = 1	Assign the module to one of the I/O Scan Sets defined in the CPU configuration.

Data Format: IC694ALG222

The 12-bit resolution module analog input data is stored in the PLC CPU in 16–bit 2’s complement format in the unipolar range as shown below.

MSB LSB

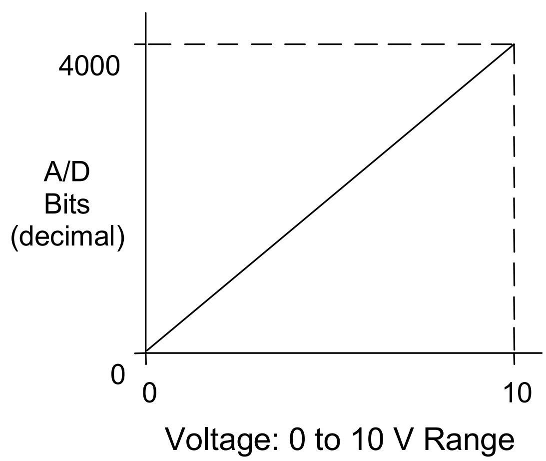
X	11	10	9	8	7	6	5	4	3	2	1	0	X	X	X

Input Scaling

The default input mode and range is single–ended, unipolar. In 0 to 10V mode, input data is scaled so that 0 volts corresponds to a count of 0 and 10 volts corresponds to a count of +32000.

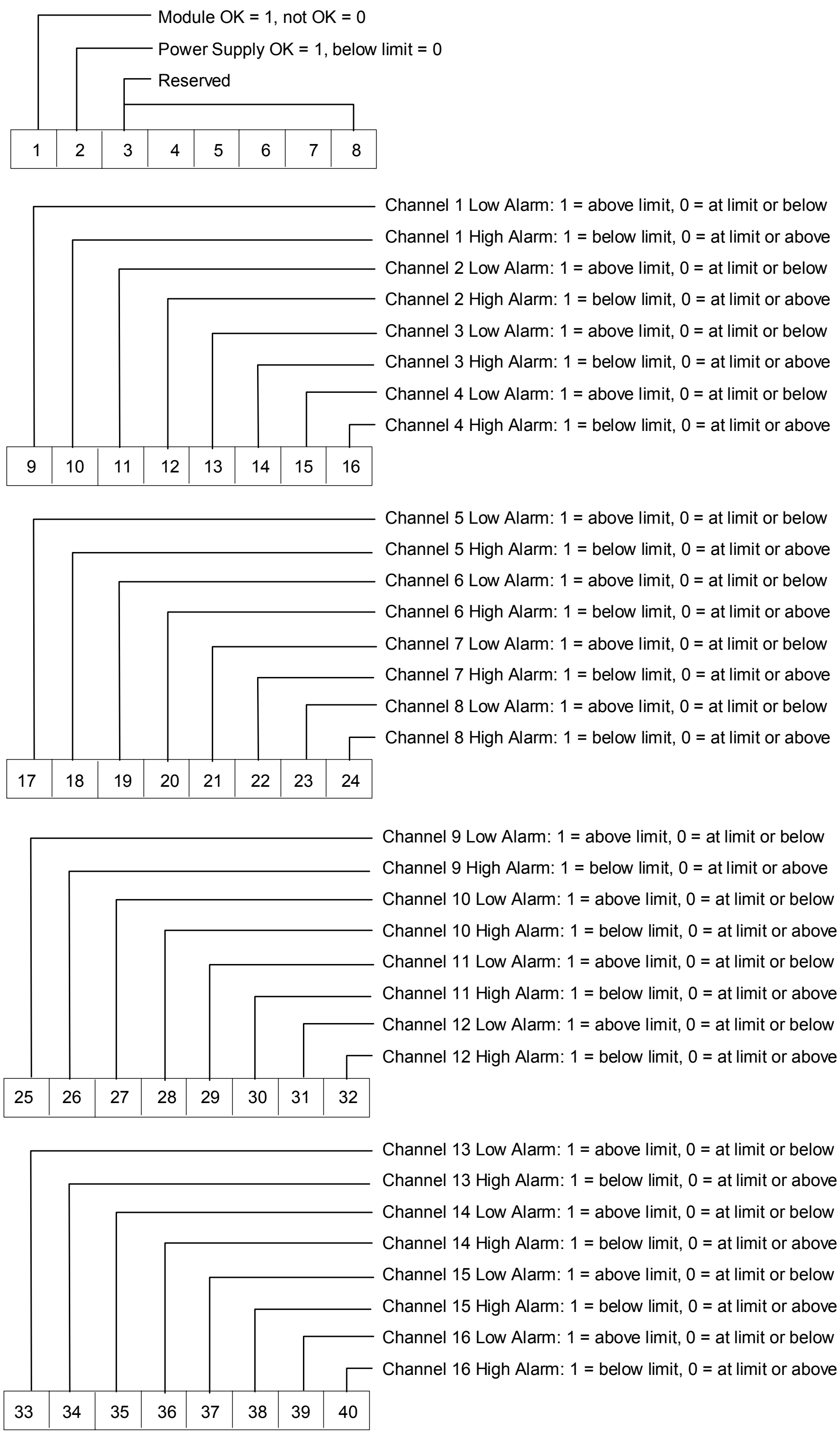
The bipolar range and mode can be selected by changing the module’s configuration parameters. In bipolar mode, -10 V corresponds to a count of -32000, 0 V corresponds to a count of 0, and +10 V corresponds to a count of +32000.

Factory calibration adjusts the analog value per bit (resolution) to a multiple of full scale (2.5 mV per bit for unipolar; 5 mV per bit for bipolar). The data is then scaled with the 4000 counts over the analog range. The data is scaled as shown below.



Status Data: IC694ALG222

Analog Module IC694ALG222 can be configured to return 8, 16, 24, 32, or 40 status bits to the PLC CPU. This status data provides the following information about module operation:

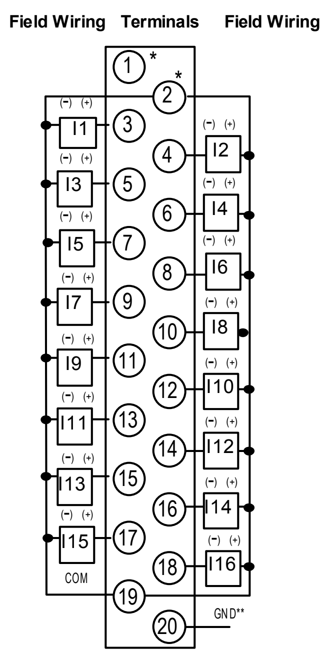


Field Wiring: IC694ALG222

Terminal	*Single-ended Mode*	*Differential Mode*
1, 2	not used	
3	Channel 1	Channel 1 +
4	Channel 2	Channel 1 -
5	Channel 3	Channel 2 +
6	Channel 4	Channel 2 -
7	Channel 5	Channel 3 +
8	Channel 6	Channel 3 -
9	Channel 7	Channel 4 +
10	Channel 8	Channel 4 -
11	Channel 9	Channel 5 +
12	Channel 10	Channel 5 -
13	Channel 11	Channel 6 +
14	Channel 12	Channel 6 -
15	Channel 13	Channel 7 +
16	Channel 14	Channel 7 -
17	Channel 15	Channel 8 +
18	Channel 16	Channel 8 -
19	Common	Common
20	Ground	Ground

Connections are shown below for 16-channel single-ended mode and 8-channel differential mode. Single-ended mode is the module's default operating mode. Differential mode must be set up by configuration.

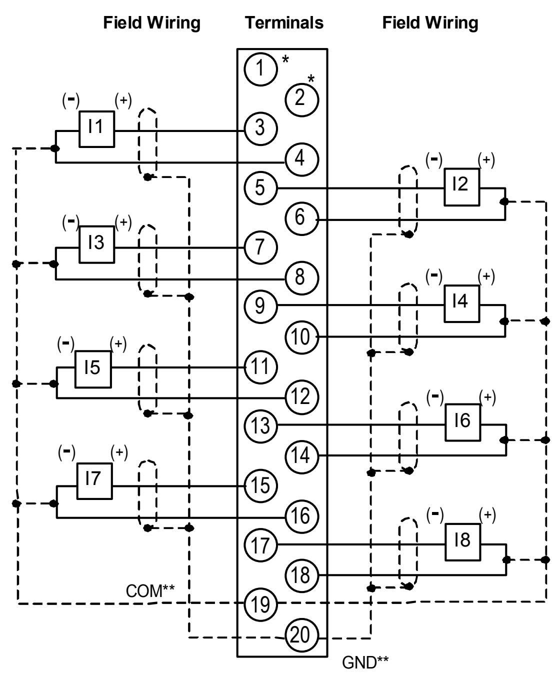
16 Single-ended Channels



* Not Connected

** Optional Shield Connection

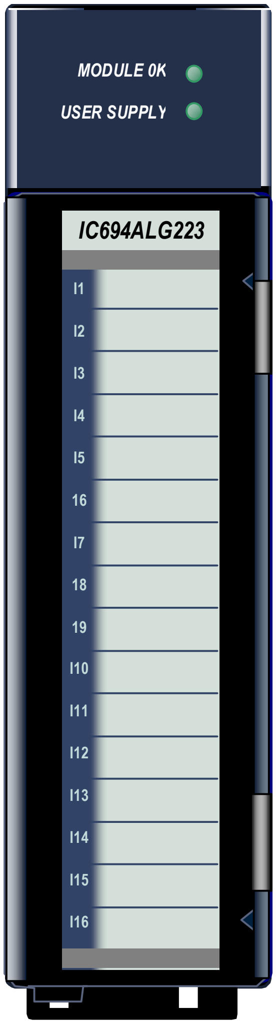
8 Differential Channels



* Not Connected

** Optional Connections

Analog Input Module, 16 Channel, Current: IC694ALG223



The ***16–Channel Analog Current Input*** module, IC694ALG223, provides 16 single–ended inputs. Each input can be configured using the configuration software for any of three input ranges:

- 4 to 20 mA
- 0 to 20 mA
- 4 to 20 mA Enhanced

High and Low alarm limits are available on all ranges. In the 4 to 20 mA Enhanced range, a low alarm limit can be set up to detect input current from 4 mA to 0 mA, providing open-wire fault detection in 4 to 20 mA applications.

The module also reports module status and external power supply status to the CPU using its assigned program reference addresses.

This module can be installed in any I/O slot in an RX3i system.

Module Power

This module consumes 120 mA from the 5 VDC bus on the PLC backplane. It also requires 65 mA plus current loop current(s) from a user-supplied +24 VDC supply.

LEDs

The **MODULE OK** LED provides module status information on power–up as follows:

- *ON*: status is OK, module configured;
- *OFF*: no backplane power or software not running (watchdog timer timed out);
- *Continuous rapid flashing*: configuration data not received from CPU;
- *Slow flashes, then OFF*: failed power–up diagnostics or encountered code execution error.

The **User Supply** LED indicates that the external 24 VDC supply is within specifications.

Specifications: IC694ALG223

Number of Channels	1 to 16 selectable; single-ended
Input Current Ranges	0 to 20 mA, 4 to 20 mA and 4 to 20 mA Enhanced (selectable per channel)
Calibration	Factory calibrated to: 4 µA per count on 4 to 20 mA range 5 µA per count on 0 to 20 mA and 4 to 20 mA Enhanced range
Update Rate	13 milliseconds (all 16 channels)
Resolution at 4–20 mA	4 µA (4 µA/bit)
Resolution at 0–20 mA	5 µA (5 µA/bit)
Resolution at 4–20 mA Enhanced	5 µA (5 µA/bit)
Absolute Accuracy *	+/-0.25% of full scale @ 25°C (77°F): +/- 0.5% of full scale over specified operating temperature range
Linearity	< 1 LSB from 4 to 20 mA (4 to 20 mA range) < 1 LSB from 100 µA to 20 mA (0 to 20 mA and 4 to 20 mA Enhanced ranges)
Isolation, Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for 1 minute
Common Mode Voltage	0 volts (single-ended channels)
Cross–Channel Rejection	> 80dB from DC to 1kHz
Input Impedance	250 Ohms
Input Low Pass Filter Response	19 Hz
External Supply Voltage Range	20 to 30 VDC
External Supply Voltage Ripple	10%
Internal Power Consumption	120 mA from the +5 VDC bus on the backplane 65 mA from 24 VDC external user power supply (in addition to current loop currents)

Refer to Appendix A for product standards and general specifications.

* In the presence of severe RF interference (IEC 801–3, 10V/m), accuracy may be degraded to +/-5% FS.

Configuration: IC694ALG223

Module IC694ALG223 is configured with the configuration software. Its configurable parameters are described below.

Parameter	Choices	Description
Active Channels	1 to 16	The number of channels to be scanned. Channels are scanned in sequential, contiguous order.
Reference Address for Input Data		The memory location for input data from the module. Each channel provides 16 bits of analog input data to the PLC CPU.
Reference Address for Status Data		The memory location for where status information from the module starts.
Length	8, 16, 24, 32, 40	The number of status bits reported to the PLC. Bits 1 – 8 provide basic module diagnostics. Bits 9 – 24 contain channel 1 – 8 high alarm and low alarm status. Bits 25 – 40 contain channel 9 – 16 high alarm and low alarm status. Data formats are shown in this section.
Range	4-20 mA (default), 0-20 mA, or 4-20 mA enhanced	In the 4-20 mA range, input currents from 4 to 20 mA are reported to the CPU as values from 0 to 32000 units. In the 0 to 20 mA range, input currents from 0 to 20 mA are reported to the CPU as values from 0 to 3200 units. In the 4 to 20 mA enhanced range, currents from 4 to 20 mA are reported to the CPU as values form 0 to 32000 units. Currents below 4 mA are reported as negative values with 0 represented as –8000 units.
Alarm Low	4-20 mA = 0 to 32759	Each channel can be assigned a low alarm limit alarm. Values entered without a sign are assumed to be positive. Be sure the alarm low values are appropriate for the selected range.
	0-20 mA = 0 to 32759	
	4-20 mA enhanced = -8000 to +32759	
Alarm High	4-20 mA = 1 to 32760	Each channel can also be assigned a high alarm limit. Values entered without a sign are assumed to be positive. Be sure the alarm high values are appropriate for the selected range.
	0-20 mA = 1 to 32760	
	4-20 mA enhanced = -7999 to +32760	
I/O Scan Set	Default = 1	Assign the module to one of the I/O Scan Sets defined in the CPU configuration.

Data Format: IC694ALG223

The 12-bit resolution module analog input data is stored in the PLC CPU in 16–bit 2's complement format as shown below.

MSB															LSB
X	11	10	9	8	7	6	5	4	3	2	1	0	X	X	X

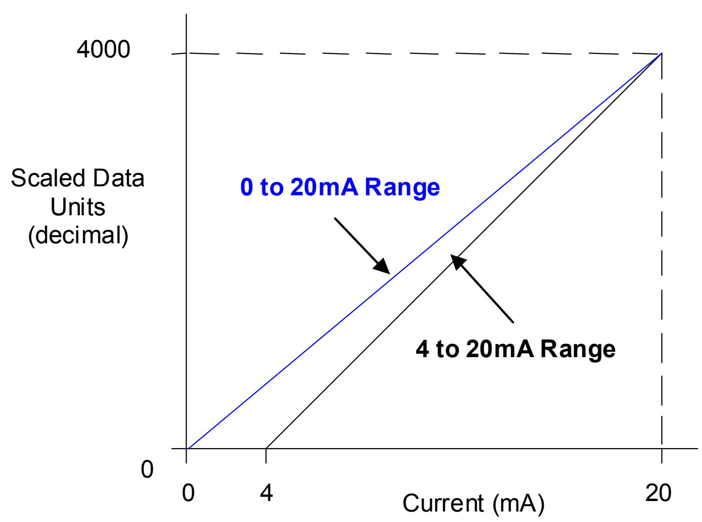
Input Scaling

In the 4 to 20 mA range, input data is scaled so that 4 mA corresponds to a count of 0 and 20 mA corresponds to a count of 32000.

In the 0 to 20 mA range, 0 mA corresponds to a count of 0 and 20 mA corresponds to a count of 32000. Full 12–bit resolution is available over the 4 to 20 mA and 0 to 20 mA ranges.

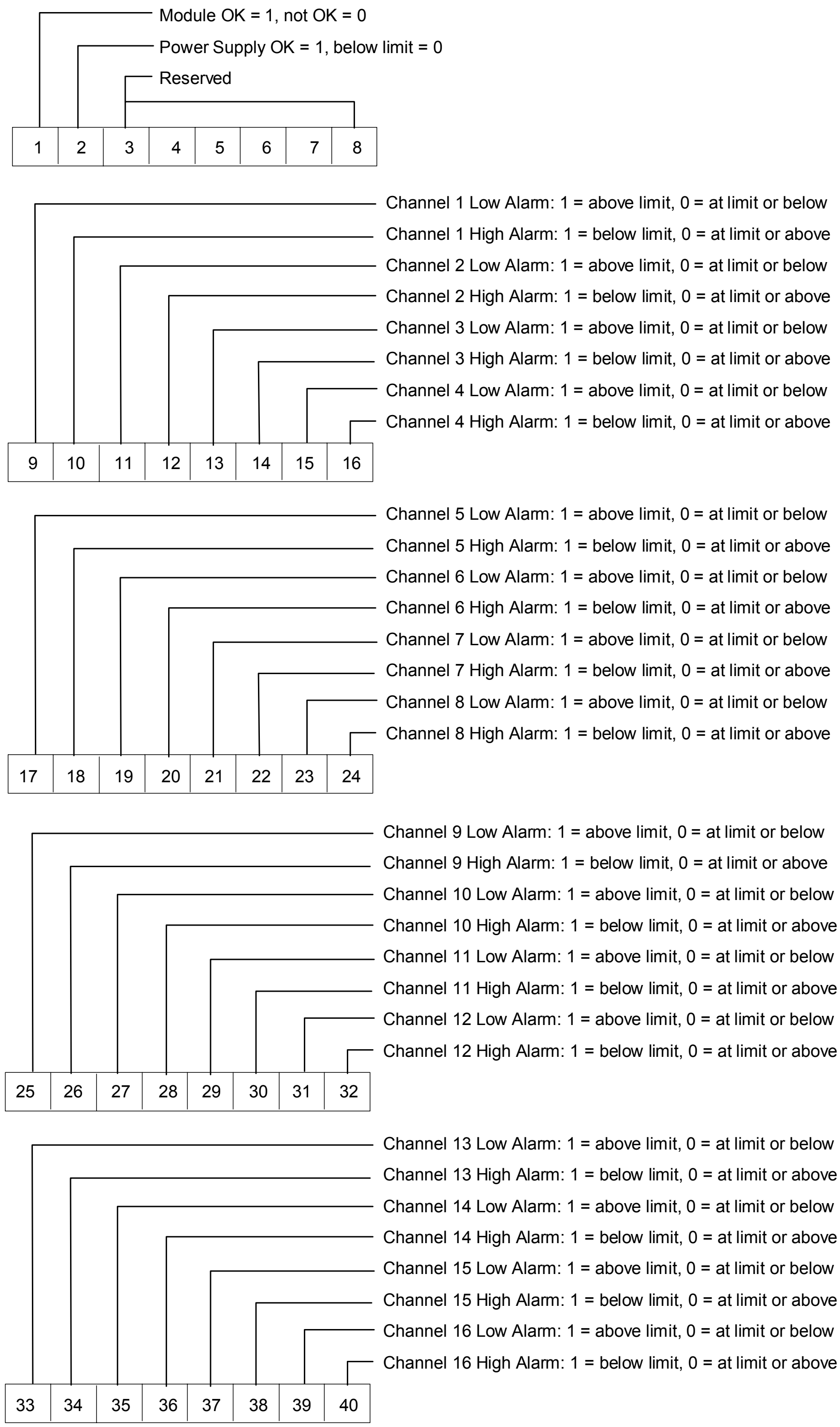
4 to 20 mA Enhanced range can also be configured. In that range, 0 mA corresponds to a count of -8000, 4 mA corresponds to a count of 0 (zero) and 20 mA corresponds to a count of +32000. A low alarm limit can be set up to detect input current from 4 mA to 0 mA, providing open-wire fault detection in 4 to 20 mA applications.

Analog values are scaled over the range of the converter. Factory calibration adjusts the analog value per bit (resolution) to a multiple of full scale (4 μA/bit). This calibration leaves a normal 12–bit converter with 4000 counts (normally 2^{12} = 4096 counts). The data is then scaled with the 4000 counts over the analog range. The data is scaled as shown below.



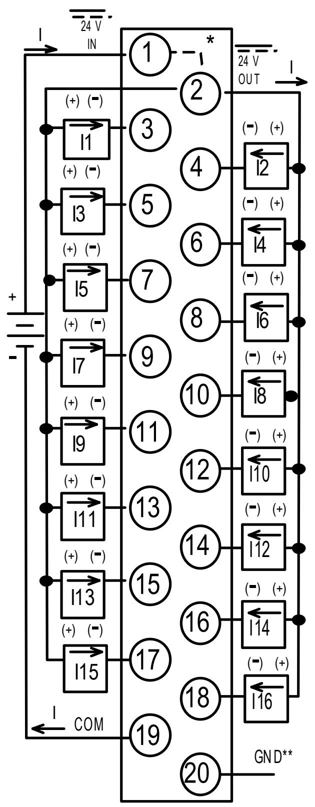
Status Data: IC694ALG223

Analog Module IC694ALG223 can be configured to return 8, 16, 24, 32, or 40 status bits to the PLC CPU. This status data provides the following information about module operation:



Field Wiring: IC694ALG223

Field Wiring Terminals   Field Wiring

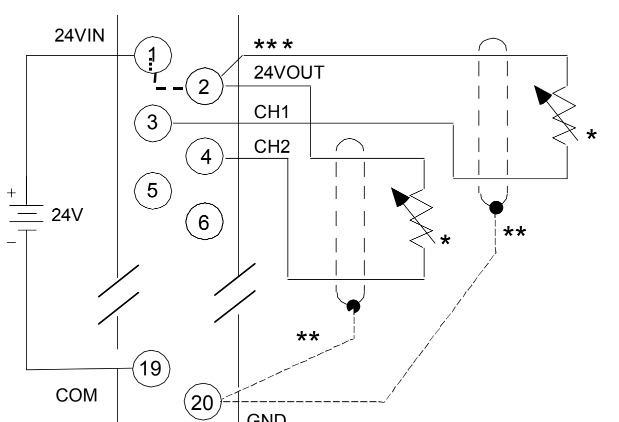


* Internally Connected

** Optional Shield Connection

Terminal	*Connection*
1	User supplied 24V Input; provides loop power via 24VOUT terminal (pin 2)
2	+24V loop power tie point
3	Current Input, Channel 1
4	Current Input, Channel 2
5	Current Input, Channel 3
6	Current Input, Channel 4
7	Current Input, Channel 5
8	Current Input, Channel 6
9	Current Input, Channel 7
10	Current Input, Channel 8
11	Current Input, Channel 9
12	Current Input, Channel 10
13	Current Input, Channel 11
14	Current Input, Channel 12
15	Current Input, Channel 13
16	Current Input, Channel 14
17	Current Input, Channel 15
18	Current Input, Channel 16
19	Common connection to input current sense resistors; user supplied 24V input return or 24VIN return
20	Frame ground connections for cable shields

Connection Example 1

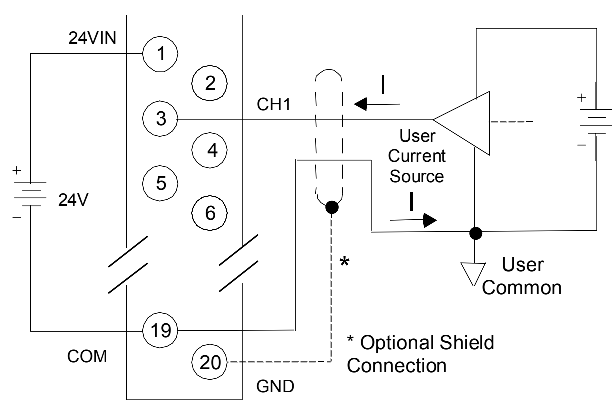


* User Current Loop Driver

** Optional Shield Connection

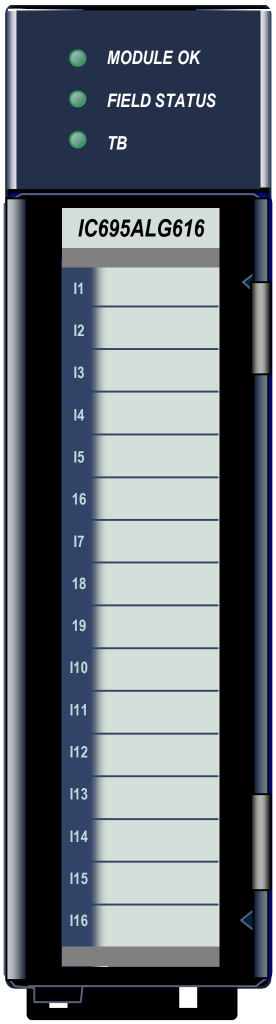
*** Pin 2 Connected to Pin 1 internally

Connection Example 2



To limit common-mode voltages, the current source can be tied to the COM terminal if the source is floating.

Analog Input Module, 8 / 4 Channel Voltage / Current: IC695ALG608
Analog Input Module,16 / 8 Channel Voltage / Current: IC695ALG616



Non-Isolated Differential Analog Voltage/Current Input module IC695ALG608 provides 8 single-ended or 4 differential input channels. ***Non-Isolated Differential Analog Voltage/Current Input*** module IC695ALG616, shown at left, provides 16 single-ended or 8 differential input channels. Analog input channels can be configured for these ranges:

- Current: 0 to 20mA, 4 to 20mA, +/- 20mA
- Voltage: +/- 10V, 0 to 10V, +/- 5V, 0 to 5V, 1 to 5V.

This module can be used with a Box-style (IC694TBB032), Extended Box-style (IC694TBB132), Spring-style (IC694TBS032), or Extended Spring-style (IC694TBS132) terminal Block. Extended terminal blocks provide the extra shroud depth needed for shielded wiring. See chapter 15 for more information about Terminal Blocks. Terminal Blocks are ordered separately.

These modules must be located in an RX3i Universal Backplane. They require an RX3i CPU with firmware version 3.0 or later. Machine Edition Version 5.0 SP3 Logic Developer-PLC or later must be used for configuration.

Module Features

- Completely software-configurable, no module jumpers to set
- Full autocalibration
- On-board error-checking
- Open-circuit detection for all voltage and 4-20mA inputs
- Configurable scaling and offsets per channel
- High alarm, low alarm, high-high alarm, low-low alarm detection and reporting selectable per channel
- Module fault reporting
- Supports diagnostic point fault contacts in the logic program
- Flash memory for future upgrades
- Positive and negative Rate of Change Alarms
- Autocalibration at startup
- Configurable interrupts for channel alarms and faults
- Terminal Block insertion or removal detection

Specifications: IC695ALG608 and IC695ALG616

Input Ranges	Current: 0 to 20mA, 4 to 20mA, +/- 20mA Voltage: +/- 10V, 0 to 10V, +/- 5V, 0 to 5V, 1 to 5V			
Backplane Power Requirements	ALG608: 330 mA maximum @ 5.0V +5% / -2.5%, 600 mA maximum @ 3.3V +5% / -3%			
	ALG616: 450 mA maximum @ 5.0V +5% / - 2.5%, 600 mA maximum @ 3.3V +5% / - 3%			
CPU Version	PACSustems RX3i CPU firmware version 3.0 and later			
Programmer Version	Machine Edition version 5.0 SP3 and later			
Power Dissipation within Module	IC695ALG608: 4.83 watts maximum IC695ALG616: 6.48 watts maximum			
Thermal Derating	None			
Resolution	24 bit ADC converted to Floating Point or Integer			
Input Data Format	Configurable as floating point IEEE 32 bit or 16-bit integer in a 32-bit field			
Filter Options	8Hz, 12Hz, 16Hz, 40Hz, 200Hz, 500Hz			
Module Scan Time (in milliseconds)	The module scan can consist of up to four acquisition cycles. Each cycle includes a specific set of channels, as described in the section “Channel Scanning”. Total Scan Time depends on the number of acquisition cycles in the scan, and the configured filter option.			
Configured Filter	***Number of Acquisition Cycles in the Scan***			
	1	***2***	***3***	***4***
8 Hz filter	121	241	362	482
12 Hz filter	81	161	242	322
16 Hz filter	61	121	182	242
40 Hz filter	21	41	62	82
200 Hz filter	5	9	14	18
500 Hz filter, filtering and rate detection disabled	3	5	7	9
500 Hz filter, all options enabled	3	6	9	12
Input Impedance	>100 Kohm voltage inputs			
Current Input Resistance	249 ohms +/- 1%			
Open Circuit Detection time	1 second maximum			

Continued ….

Specifications: IC695ALG608 and IC695ALG616, continued

Overvoltage	+/-60 VDC continuous, maximum		
Overcurrent	+/-28mA continuous, maximum		
Normal Mode Noise Rejection in dB		*At 50Hz*	*At 60Hz*
	8 Hz filter	103	97
	12 Hz filter	94	89
	16 Hz filter	39	65
	40 Hz filter	4	7
	200 Hz filter	0.1	0.2
	500 Hz	0.0	0.0
Common Mode Noise Rejection	120dB minimum @ 50/60 Hz with 8 Hz filter 110dB minimum @ 50/60 Hz with 12 Hz filter		
Channel-Channel DC Crosstalk	-80 dB minimum (single ended mode) -80 dB minimum (differential mode, grounded common) -60 dB minimum (differential mode, floating common)		
Calibrated Accuracy* @ 13°C – 33°C with 8 Hz, 12 Hz and 16 Hz filter	+/- 5V, + /- 10V, +/- 20 mA: 0.05% of range. 0 to 10V, 0 to 5V, 1 to 5V, 0 to 20 mA: 0.1% of range. 4 to 20 mA: 0.125% of range		
Calibrated Accuracy* @ 0°C – 60°C with 8 Hz, 12 Hz and 16 Hz filter	0 to 10V, 0 to 5V, 1 to 5V, 0.2% of range.0 to 20 mA: 0.25% of range. 4 to 20 mA: 0.3125% of range. +/- 5V, +/- 10V: 0.1% +/- 20 mA: 0.125% of range		
Calibration Interval	12 months typical to meet accuracy specifications over time. Offset can be applied as a periodic calibration adjustment.		
Isolation Voltage **terminal block to backplane/chassis**	Opto-isolated, transformer isolated 250 VAC continuous/1500 VAC for 1 minute		

* In the presence of severe RF interference (IC 801-3, 10V/M), accuracy may be degraded by +/- 1.5% of range.

Refer to Appendix A for product standards and general specifications.

LEDs

The **Module OK** LED indicates module status. The **Field Status** LED indicates the presence of a fault on at least one channel or a terminal block error. The TB (Terminal Block) LED indicates the presence or absence of the terminal block. LEDs are powered by the backplane power bus.

LED	*Indicates*
Module OK	ON Green: Module OK and configured. Slow Flashing Green or Amber: Module OK but not configured. Quick Flashing Green: Error. OFF: Module is defective or no backplane power present
Field Status	ON Green No faults on any enabled channel, and Terminal Block is present. ON Yellow: Fault on at least one channel. OFF: Terminal block not present or not fully seated.
TB	ON Red: Terminal block not present or not fully seated. ON Green: Terminal block is present. OFF: No backplane power to module.

Configuration Parameters: IC695ALG608 and IC695ALG616

Module Parameters		
Parameter	**Default**	**Description**
Channel Value Reference Address	%AIxxxxx	Starting address for the module's input data. This defaults to the next available %AI block.
Channel Value Reference Length	ALG608: 16 ALG616: 32	The number of words used for the module's input data. This parameter cannot be changed.
Diagnostic Reference Address	%Ixxxxx	Starting address for the channel diagnostics status data.
Diagnostic Reference Length	0	The number of bit reference bits required for the Channel Diagnostics data. When set to 0, Channel Diagnostics is disabled. To enable Channel Diagnostics mapping, change this to a non-zero value.
Module Status Reference Address	%Ixxxxx	Starting address for the module's status data.
Module Status Reference Length	0	The number of bits (0 to 32) required for the Module Status data. When set to 0, mapping of Module Status data is disabled. To enable Module Status data mapping, change this to a non-zero value.
I/O Scan Set	1	The scan set 1 – 32 to be assigned by the RX3i CPU.
Inputs Default	Force Off	In the event of module failure or removal, this parameter specifies the state of all Channel Value References for the module. Force Off = Channel Values clear to 0. Hold Last State = Channels hold their last state.
Inputs Default w/o Terminal Block	Enabled	Enabled / Disabled: Controls whether inputs will be set to their defaults if the Terminal Block is removed.
Channel Faults w/o Terminal Block	Disabled	Enabled / Disabled: Controls whether channel faults and configured alarm responses are generated after Terminal Block removal. If Disabled, channel faults and alarms are suppressed when the Terminal Block is removed. This setting does not affect module faults including the Terminal Block loss/add fault generation.
Analog Input Mode	Single-ended Input Mode	Single-ended / Differential: This selection must match the input wiring to the module.
A/D Filter Frequency	40Hz	Low pass A/D hardware filter setting for all inputs: 8, 12, 16, 40, 200, or 500Hz. Frequencies below the filter setting are not filtered by hardware.
Range Type	Disabled	Voltage/Current, Disabled
Range (Not for Range Type Disabled)	-10V to +10V	Voltage/current: -10V to +10V, 0V to +10V, 0 V to +5V, 1V to +5V, -5V to +5V, -20mA to +20mA, 4 to 20 mA, 0 to 20 mA

Continued …

Channel Parameters		
Parameter	***Default***	***Description***
Channel Value Format	32-bit Floating Point	16-bit integer or 32-bit floating point
High Scale Value (Eng Units)	The defaults for the 4 Scaling parameters depend on the configured Range Type and Range. Each Range and Range Type have a different set of defaults.	Note: Scaling is disabled if both High Scale Eng. Units equals High Scale A/D Units and Low Scale Eng. Units equals Low Scale A/D Units. Default is High A/D Limit of selected range type.
Low Scale Value (Eng Units)		Default is Low A/D Limit of selected range type. Must be lower than the high scaling value.
High Scale Value (A/D Units)		Default is High A/D Limit of selected range type. Must be greater than the low scaling value.
Low Scale Value (A/D Units)		Default is Low A/D Limit of selected range type.

Continued ….

Input Scaling

By default, the module converts a voltage or current input over the entire span of its configured Range into a floating point value for the CPU. For example, if the Range of a channel is 4 to 20mA, the module reports channel input values from 4.000 to 20.000. By modifying one or more of the four channel scaling parameters (Low/High Scale Value parameters) from their defaults, the scaled Engineering Unit range can be changed for a specific application. Scaling can provide inputs to the PLC that are already converted to their physical meaning, or convert input values into a range that is easier for the application to interpret. Scaling is always linear and inverse scaling is possible. All alarm values apply to the scaled Engineering Units value, not to the A/D input value.

The scaling parameters only set up the linear relationship between two sets of corresponding values. They do not have to be the limits of the input.

Example 1

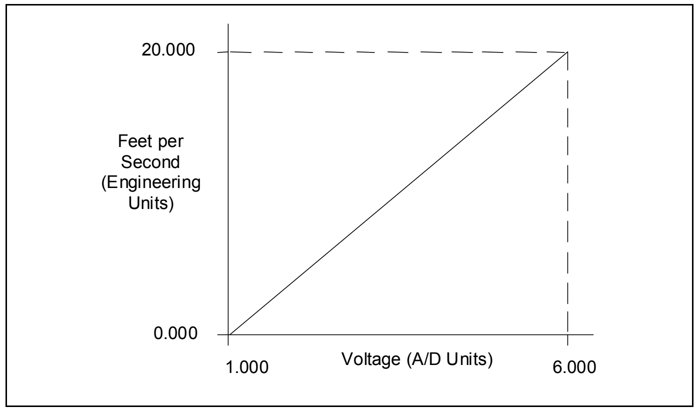
For a voltage input, 6.0 volts equals a speed of 20 feet per second, and 1.0 volt equals 0 feet per second. The relationship in this range is linear. For this example, the input values should represent speed rather than volts. The following channel configuration sets up this scaling:

High Scale Value (Eng Units) = 20.000

Low Scale Value (Eng Units) = 0.000

High Scale Value (A/D Units) = 6.000

Low Scale Value (A/D Units) = 1.000



For this example, 1.0V to 6.0V is the normal voltage range, but the module will attempt to scale the inputs for a voltage that lies outside the range. If a voltage of 10.0V were input to the channel, the module would return a scaled channel value of 36.000. The application should use alarms or take other precautions for scaled inputs that are outside the acceptable range or invalid.

Example 2

An existing application uses traditional analog to digital (A/D) count integer values. With scaling and the optional 16-bit integer input option, a channel can be configured to report integer count values. In this example, the application should interpret +10V as 32000 counts and -10V as -32000 counts. The following channel configuration will scale a +/-10V input channel to +/-32000 counts.

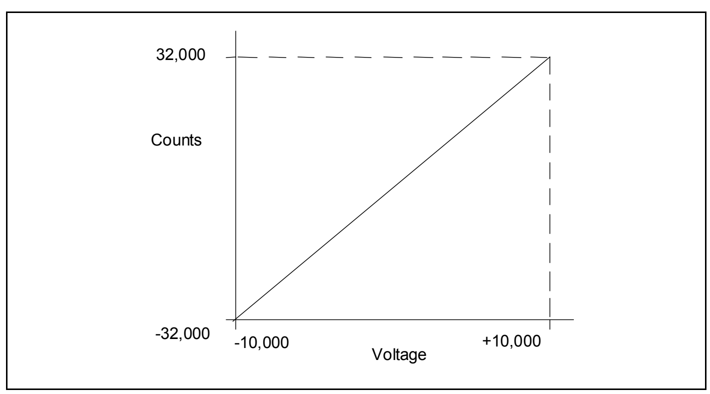
Channel Value Format = 16 Bit Integer

High Scale Value (Eng Units) = 32000.0

Low Scale Value (Eng Units) = -32000.0

High Scale Value (A/D Units) = 10.000

Low Scale Value (A/D Units) = -10.000



Channel Parameters continued		
Parameter	***Default***	***Description***
Positive Rate of Change Limit (Eng Units)	0.0	Rate of change in Engineering Units per Second that will trigger a Positive Rate of Change alarm. Default is disabled. Used with “Rate of Change Sampling Rate” parameter.
Negative Rate of Change Limit (Eng Units)	0.0	Rate of change in Engineering Units per Second that will trigger a Negative Rate of Change alarm. Default is disabled. Used with “Rate of Change Sampling Rate” parameter.
Rate of Change Sampling Rate	0.0	Time from 0 to 300 seconds to wait between comparisons. Default of 0.0 is to check after every input sample.

Continued ….

Rate of Change Alarms

Modules IC695ALG608 and IC695ALG616 can detect both Negative Rate of Change and Positive Rate of Change in Engineering Units per Second. When either of the Rate of Change parameters is configured to be non-zero, the module takes the difference in Engineering Units between the previous rate of change sample and the current sample, then divides by the elapsed time between samples.

If the Engineering Unit change from the previous sample to current sample is negative, the module compares the rate change with the Negative Rate of Change parameter.

If the Engineering Unit change between samples is positive, the module compares the results in comparing the rate change with the Positive Rate of Change parameter value.

In either case, if the rate of change is greater than the configured rate, a rate of change alarm occurs. The actions taken by the module following the alarm depend on the enabled rate of change actions that have been set up in the "Diagnostic Reporting Enable", "Fault Reporting Enable", and "Interrupts Enabled" parameters.

The Rate of Change Sampling Rate parameter determines how frequently the module compares the Rate of Change. If the Rate of Change Sampling Rate is 0 or any time period less than the channel update rate, the module compares the Rate of Change for every input sample of the channel.

Channel Parameters continued

Parameter	**Default**	**Description**
High-High Alarm (Eng Units) High Alarm (Eng Units) Low Alarm (Eng Units) Low-Low Alarm (Eng Units) High-High Alarm Deadband (Eng Units) High Alarm Deadband (Eng Units) Low Alarm Deadband (Eng Units) Low-Low Alarm Deadband (Eng Units)	The defaults for the High-High, High, Low, and Low-Low parameters depend on the configured Range Type and Range. Each Range and Range Type has a different set of default values.	***Alarms and Deadbands*** All of the alarm parameters are specified in Engineering Units. To use alarming, the A/D Alarm Mode must also be configured as enabled. *High-High Alarm and Low-Low Alarm:* When the configured value is reached or passed, a Low-Low Alarm or High-High Alarm is triggered. The configured values must be lower than/higher than the corresponding low/high alarm limits. *High Alarm and Low Alarm:* When the configured value is reached or below (above), a Low (High) Alarm is triggered. *High and Low Alarm Deadbands:* A range in Engineering Units above the alarm condition (low deadband) or below the alarm condition (high deadband) where the alarm status bit can remain set even after the alarm condition goes away. For the alarm status to clear, the channel input must fall outside the deadband range. Alarm Deadbands should not cause the alarm clear condition to be outside the Engineering Unit User Limits range. For example, if the engineering unit range for a channel is -1000.0 to +1000.0 and a High Alarm is set at +100.0, the High Alarm Deadband value range is 0.0 to less than 1100.0. A deadband of 1100.0 or more would put the High Alarm clear condition below –1000.0 units making the alarm impossible to clear within the limits.
User Offset	0.0	Engineering Units offset to change the base of the input channel. This value is added to the scaled value on the channel prior to alarm checking.
Software Filtering	Disabled	Disabled / Enabled. Controls whether software filtering will be performed on the inputs.
Integration Time in milliseconds.	0	Specifies the amount of time in milliseconds for the software filter to reach 63.2% of the input value. A value of 0 indicates software filter is disabled. A value of 100 indicates data will achieve 63.2% of its value in 100ms. Default is 0.

Continued ….

Using Alarming

The Diagnostic Reporting Enable, Fault Reporting Enable, and Interrupt Enable configuration parameters can be used to enable different types of responses for individual channel alarms. By default, all responses are disabled on every channel. Any combination of alarm enables can be configured for each channel.

- If Diagnostic Reporting is enabled, the module reports channel alarms in reference memory at the channel's Diagnostic Reference address.
- If Fault Reporting is enabled, the module logs a fault log in the I/O Fault table for each occurrence of a channel alarm.
- If Interrupts are enabled, an alarm can trigger execution of an Interrupt Block in the application program, as explained below.

Using Interrupts

To properly configure an I/O Interrupt, the Interrupt enable bit or bits must be set in the module's configuration. In addition, the program block that should be executed in response to the channel interrupt must be mapped to the corresponding channel's reference address.

Example:

In this example, the Channel Values Reference Address block is mapped to %AI0001-%AI0020. An I/O Interrupt block should be triggered if a High Alarm condition occurs on channel 2.

- Configure the High-Alarm condition.
- Set the High-Alarm Interrupt Enable flag for Channel 2 in the module configuration.

Channel 2's reference address corresponds to %AI00003 (2 Words per channel), so the interrupt program block Scheduling properties should be set for the "I/O Interrupt" Type and "%AI0003" as the Trigger.

Fault Reporting and Interrupts

These modules have separate enable/disable options for Diagnostic Reporting and Interrupts. Normally, disabling a diagnostic (such as Low/High Alarm or Over/Under range) in the configuration means that its diagnostic bit is never set. However, if interrupts are enabled for a condition and that interrupt occurs, the diagnostic bit for that condition is also set during the I/O Interrupt block logic execution. The next PLC input scan always clears this interrupt status bit back to 0, because Diagnostic Reporting has it disabled.

Module Data: IC695ALG608 and IC695ALG616

The module reports its input channel data in its configured input words, beginning at its assigned Channel Value Reference Address. Each channel occupies 2 words (whether the channel is used or not):

Channel Value Reference Address	***Contains this Input***
+0, 1	Channel 1
+2, 3	Channel 2
+4, 5	Channel 3
+6, 7	Channel 4
+8, 9	Channel 5
+10, 11	Channel 6
+12, 13	Channel 7
+14, 15	Channel 8
For Module IC695ALG616 Only:	
+16, 17	Channel 9
+18, 19	Channel 10
+20, 21	Channel 11
+22, 23	Channel 12
+24, 25	Channel 13
+26, 27	Channel 14
+28, 29	Channel 15
+30, 31	Channel 16

Depending on its configured Channel Value Format, each enabled channel reports a 32-bit floating point or 16-bit integer value to the CPU.

In the 16-bit integer mode, the low word of the 32-bit channel data area contains the 16-bit integer channel value. The high word (upper 16-bits) of the 32-bit value are set with the sign extension of the 16-bit integer. This sign-extended upper word allows the 16-bit integer to be read as a 32-bit integer type in logic without losing the sign of the integer. If the 16-bit integer result is negative, the upper word in the 32-bit channel data has the value 0xFFFF. If the 16-bit integer result is positive, the upper word is 0x0000.

Resolution and Range Type

The actual resolution for each input depends on the channel's configured Range Type and A/D Filter Frequency. At higher Filter Frequencies, input resolution decreases. The approximate resolution in bits for each Filter Frequency and Range Type are shown in the table below.

Filter Frequency	***Range Type***		
	+ / - 10V	***0 to 10V, + / - 5V, + / - 20V***	***0 to 5V, 1 to 5V, 0 to 20mA, 4 to 20mA***
8 Hz	18	17	16
12 Hz	17	16	15
16 Hz	17	16	15
40 Hz	16	15	14
200 Hz	15	14	13
500 Hz	14	13	12

Channel Scanning

These modules use 4 A/D converters to achieve the fastest possible channel scan times. The module has up to four acquisition cycles for each module scan. The acquisition cycles and channels acquired during each cycle are:

Acquisition Cycle	***Channels Acquired***	
	IC695ALG608	***IC695ALG616***
1	1, 5	1, 5, 9, 13
2	2, 6	2, 6, 10, 14
3	3, 7	3, 7, 11, 15
4	4, 8	4, 8, 12, 16

To bypass an acquisition cycle, all channels that would be acquired during that cycle must be disabled.

For fastest scan times, always wire by acquisition cycle. For example, if only eight channels were used on the 16-channel module, IC695ALG616, channels 1, 2, 5, 6, 9, 10, 13, and 14 should be used for optimum performance.

Channel Diagnostic Data

In addition to the input data from field devices, the module can be configured to report channel diagnostics status data to the CPU. The CPU stores this data at the module's configured *Diagnostic Reference Address*. Use of this feature is optional.

The diagnostics data for each channel occupies 2 words (whether the channel is used or not):

Diagnostic Reference Address	***Contains Diagnostics Data for:***
+0, 1	Channel 1
+2, 3	Channel 2
+4, 5	Channel 3
+6, 7	Channel 4
+8, 9	Channel 5
+10, 11	Channel 6
+12, 13	Channel 7
+14, 15	Channel 8
For Module IC695ALG616 Only:	
+16, 17	Channel 9
+18, 19	Channel 10
+20, 21	Channel 11
+22, 23	Channel 12
+24, 25	Channel 13
+26, 27	Channel 14
+28, 29	Channel 15
+30, 31	Channel 16

When a diagnostic bit equals 1, the alarm or fault condition is present on the channel. When a bit equals 0 the alarm or fault condition is either not present or detection is not enabled in the configuration for that channel.

For each channel, the format of this data is:

Bit	Description
1	Low Alarm
2	High Alarm
3	Underrange
4	Overrange
5	Open Wire
6 – 16	Reserved (set to 0).
17	Low-Low Alarm
18	High-High Alarm
19	Negative Rate of Change Alarm
20	Positive Rate of Change Alarm
21 - 32	Reserved (set to 0).

Module Status Data

The module can also optionally be configured to return 2 bits of module status data to the CPU. The CPU stores this data in the module's 32-bit configured Module Status Data reference area.

Bit	Description
1	Module OK (1 = OK, 0 = failure, or module is not present)
2	Terminal Block Present (1 = Present, 0 = Not present)
3 - 32	Reserved

Terminal Block Detection

The module automatically checks for the presence of a Terminal Block.

The module's TB LED indicates the state of the terminal block. It is green when the Terminal Block is present or red if it is not.

Faults are automatically logged in the CPU's I/O Fault table when the terminal block is inserted or removed from a configured module in the system. The fault type is Field Fault and the fault description indicates whether the fault is a "Loss of terminal block" or an "Addition of terminal block". If a Terminal Block is not present while a configuration is being stored, a "Loss of terminal block" fault is logged.

Bit 1 of the Module Status Reference indicates the status of the terminal block. To enable Module Status reporting, the Module Status Reference must be configured. During operation, the PLC must be in an I/O Enabled mode for the current Module Status to be scanned and updated in reference memory.

Field Wiring: IC695ALG608 and IC695ALG616, Single-Ended Mode

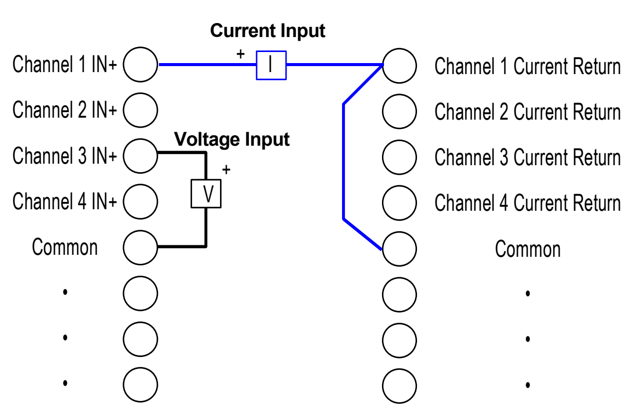
The table below lists wiring connections for Non-Isolated Analog Input Modules in Single-ended mode. Single-ended mode is the configured default operating mode.

Terminal	*IC695ALG608*	*IC695ALG616*	*IC695ALG608*	*IC695ALG616*	*Terminal*
1	Channel 1 IN+		Channel 1 Current Return (IRTN1)		19
2	Channel 2 IN+		Channel 2 Current Return (IRTN2)		20
3	Channel 3 IN+		Channel 3 Current Return (IRTN3)		21
4	Channel 4 IN+		Channel 4 Current Return (IRTN4)		22
5	Common		Common		23
6	Channel 5 IN+		Channel 5 Current Return (IRTN5)		24
7	Channel 6 IN+		Channel 6 Current Return (IRTN6)		25
8	Channel 7 IN+		Channel 7 Current Return (IRTN7)		26
9	Channel 8 IN+		Channel 8 Current Return (IRTN8)		27
10	No Connection	Channel 9 IN+	No Connection	Channel 9 Current Return (IRTN9)	28
11	No Connection	Channel 10 IN+	No Connection	Channel 10 Current Return (IRTN10)	29
12	No Connection	Channel 11 IN+	No Connection	Channel 11 Current Return (IRTN11)	30
13	No Connection	Channel 12 IN+	No Connection	Channel 12 Current Return (IRTN12)	31
14	Common		Common		32
15	No Connection	Channel 13 IN+	No Connection	Channel 13 Current Return (IRTN13)	33
16	No Connection	Channel 14 IN+	No Connection	Channel 14 Current Return (IRTN14)	34
17	No Connection	Channel 15 IN+	No Connection	Channel 15 Current Return (IRTN15)	35
18	No Connection	Channel 16 IN+	No Connection	Channel 16 Current Return (IRTN16)	36

There are no shield terminals on these modules. For shielding, tie the cable shields to the ground bar along the bottom of the backplane. M3 tapped holes are provided for this purpose.

All the common terminals are connected together internally, so any common terminal can be used for the negative lead of the external power supply.

Single-Ended Mode



For single-ended mode, a voltage input should be connected between its Channel IN+ terminal and a Common (CM) return terminal.

A current input should be connected between its Channel IN+ terminal and its Channel Current Return Terminal. In addition, a jumper wire should be connected between the Channel Current Return terminal and a Common (COM) return.

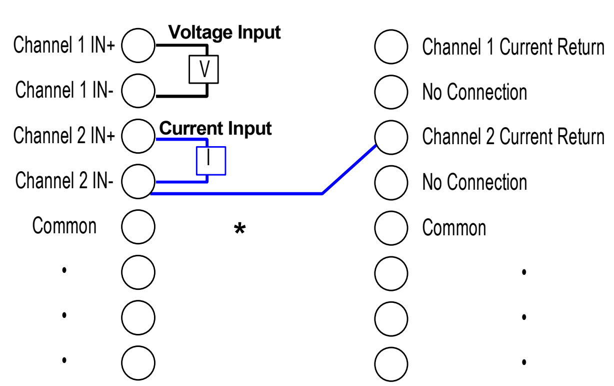
Field Wiring: IC695ALG608 and IC695ALG616, Differential Mode

The table below lists wiring connections for Non-Isolated Analog Input Modules configured for Differential mode.

Terminal	IC695ALG608	IC695ALG616	IC695ALG608	IC695ALG616	Terminal
1	Channel 1 IN+		Channel 1 Current Return (IRTN1)		19
2	Channel 1 IN -		No Connection		20
3	Channel 2 IN+		Channel 2 Current Return (IRTN3)		21
4	Channel 2 IN -		No Connection		22
5	Common		Common		23
6	Channel 3 IN+		Channel 3 Current Return (IRTN5)		24
7	Channel 3 IN-		No Connection		25
8	Channel 4 IN+		Channel 4 Current Return (IRTN7)		26
9	Channel 4 IN-		No Connection		27
10	No Connection	Channel 5 IN+	No Connection	Channel 5 Current Return (IRTN9)	28
11	No Connection	Channel 5 IN-	No Connection		29
12	No Connection	Channel 6 IN+	No Connection	Channel 6 Current Return (IRTN11)	30
13	No Connection	Channel 6 IN-	No Connection		31
14	Common		Common		32
15	No Connection	Channel 7 IN+	No Connection	Channel 7 Current Return (IRTN13)	33
16	No Connection	Channel 7 IN-	No Connection		34
17	No Connection	Channel 8 IN+	No Connection	Channel 8 Current Return (IRTN15)	35
18	No Connection	Channel 8 IN-	No Connection		36

There are no shield terminals on these modules. For shielding, tie the cable shields to the ground bar along the bottom of the backplane. M3 tapped holes are provided for this purpose. All the common terminals are connected together internally, so any common terminal can be used for the negative lead of the external power supply.

Differential Input Mode Connections



* Keep this jumper as short as possible to minimize error due to the added resistance of the wire. This resistance should be 25mΩ or less.

For differential inputs, two adjacent terminals are connected as one channel. The lower-numbered terminal acts as the high side.

A voltage input is connected between the two adjacent Channel IN terminals as shown at left.

A current input is connected between the channel's Channel IN+ and Current Return terminals. In addition, a jumper wire must be connected between the Channel IN - terminal and the corresponding Channel Current Return terminal.

Tie common to signal ground for improved channel-to-channel Crosstalk immunity.

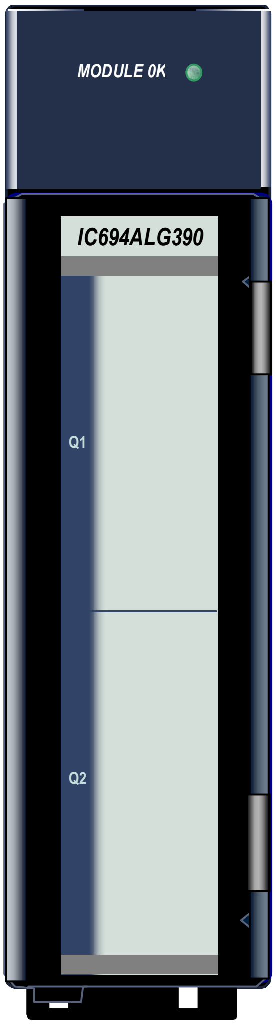
Two door cards are provided with the module: one shows connections for single-ended mode and the other shows connections for differential mode. Insert the card that matches the wiring that will be used.

Chapter 10 Analog Output Modules

This chapter describes Analog Output modules for PACSystems RX3i controllers.

Analog Output Module	***Catalog Number***
Output Analog 2 Channels, Voltage	IC694ALG390
Output Analog 2 Channels, Current	IC694ALG391
Output Analog Current/Voltage 8 Channels	IC694ALG392
Output Analog Current/Voltage 4 Channels	IC695ALG704
Output Analog Current/Voltage 8 Channels	IC695ALG708

Analog Output Module, 2 Channel Voltage: IC694ALG390



The ***2–Channel Analog Voltage Output*** module, IC694ALG390, has two output channels, each capable of converting 13 bits of binary (digital) data to an analog output signal for field devices. The Analog Voltage Output module provides outputs in the range of -10 volts to +10 volts. Both channels are updated on every scan.

The module's outputs can be set up to either *Default to 0 volts* or *Hold–Last–State* if the CPU goes to the Stop mode or Reset. Selection of the output default state is made by a jumper on the module. If the jumper is not installed, the outputs Hold Last State.

This module can be installed in any I/O slot in an RX3i system.

Isolated +24 VDC Power

If the module is located in an RX3i Universal Backplane, an external source of Isolated +24 VDC is required to provide power for the module. The external source can be connected via the TB1 connector on the left side of the backplane or directly on the module's terminal block.

If this module is located in an Expansion Backplane, its primary power source can be either the Isolated +24 VDC from the backplane power supply or an external Isolated +24 VDC power supply connected to the module's terminal block. If the external source is set between 27.5-30 VDC, it takes over the module's load from the Isolated 24 VDC system supply. Note that an external source should be used if it is desired to maintain hold last state operation during a loss of backplane power.

LED

The **Module OK** LED is ON when the module's power supply is operating.

Specifications: ALG390

Voltage Range	-10 to +10 volts
Calibration	Factory calibrated to 2.5 mV per count
Supply Voltage (nominal)	+24 VDC, from isolated +24 VDC on backplane or user-supplied voltage source, and +5 VDC from backplane
External Supply Voltage Range	18 VDC to 30 VDC
External Supply Voltage Ripple	10%
Update Rate	Approximately 5 milliseconds (both channels) Update rate is application dependent.
Resolution	2.5 mV (1 LSB = 2.5 mV)
Absolute Accuracy *	+/-5 mV at 25°C (77°F)
Offset	1 mV maximum, 0 to 60°C (32° to 140°F)
Output Loading (maximum)	5 mA (2 K ohms minimum resistance)
Output Load Capacitance	2000 pico farads, maximum
Isolation, Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for 1 minute
Internal Power Consumption	32 mA from +5 VDC supply 120 mA from +24 VDC supply (isolated backplane or user supply)

Refer to Appendix A for product standards and general specifications.

* In the presence of severe RF interference (IEC 801–3, 10 V/m), accuracy may be degraded to ±50 mV.

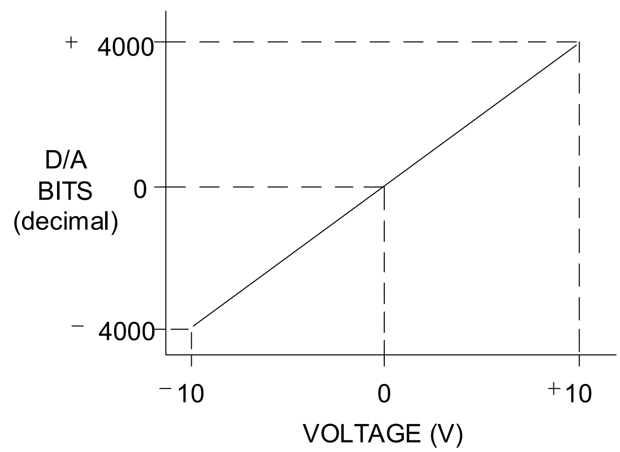
Data Format: ALG390

Module data is stored by the PLC CPU in 16–bit 2's complement format:

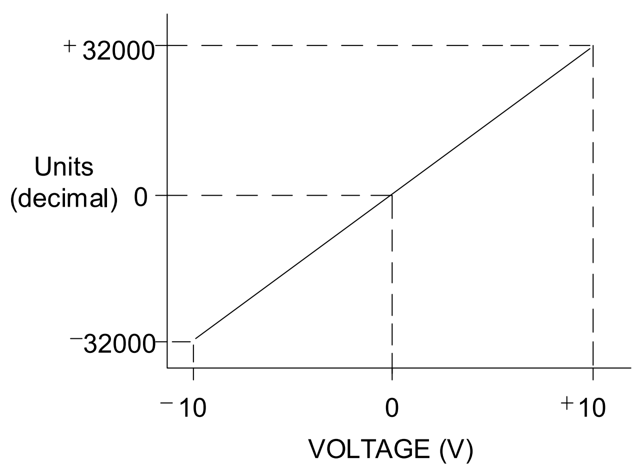
MSB															LSB
+/-	10	9	8	7	6	5	4	3	2	1	0	X	X	X	X

Resolution of the converted signal is 12 bits binary plus sign, which is effectively 13 bits (1 part in 8192). The module scales the digital data to create an output voltage for the output:

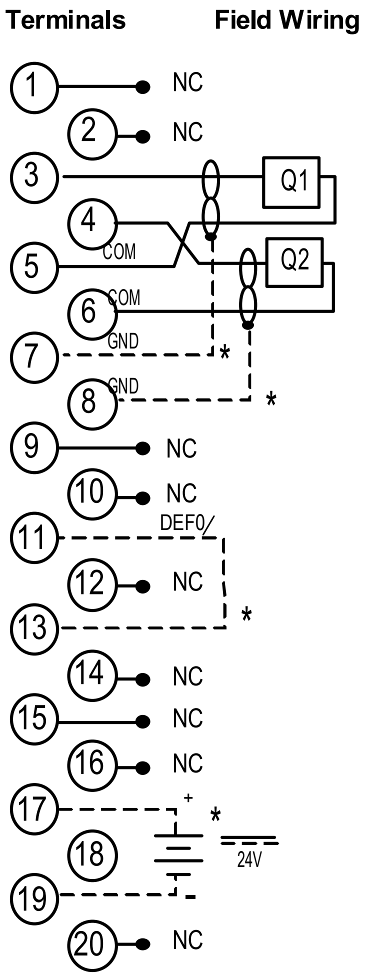
D/A Bits versus Voltage Outputs



Scaling of the output is shown below.



Field Wiring: ALG390



*Optional Connections

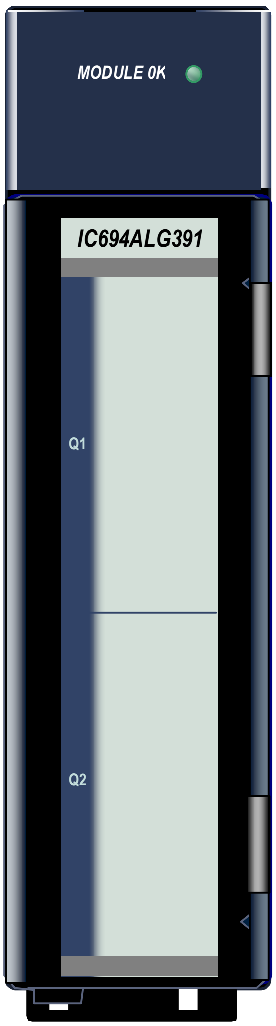
Terminal	*Connection*
1	No connection
2	No connection
3	Output 1
4	Output 2
5	Output 1 Common
6	Output 2 Common
7	Shield termination point for output 1
8	Shield termination point for output 2
9	No connection
10	No connection
11 - 13	Output default selection jumper
12	No connection
13	Output default selection jumper
14	No connection
15	No connection
16	No connection
17	External +24 VDC Power Supply +
18	No connection
19	External +24 VDC Power Supply -
20	No connection

To minimize capacitive loading and noise, all field connections should be wired using a good grade of twisted, shielded instrumentation cable. The shields should be connected to GND on the user terminal connector block. The GND connection provides access to the backplane (frame ground) resulting in superior rejection of noise caused by any shield drain currents.

DEF0 is the optional Output Default Jumper. It determines the operation of both outputs when the CPU is in Stop or Reset mode. The jumper should be installed if outputs should default to 0. The jumper should not be installed if outputs should hold their last state (the last valid commanded value received from the CPU).

An optional external +24 VDC supply can be installed as shown.

Analog Output Module, Current, 2 Channel: IC694ALG391



The ***2–Channel Analog Current Output*** module, IC694ALG391, has two output channels, each capable of converting 12 bits of binary (digital) data to an analog output signal for field devices. Each output can be set using a jumper on the module to produce output signals in one of two ranges:

- 0 to 20 mA
- 4 to 20 mA.

Each output may also be set up as a less accurate voltage source. The selection of current or voltage output is made with a jumper or resistor on the module terminals. Both channels are updated on every scan.

The module's outputs can be set up to either *Default to 0/4 mA* or *Hold–Last–State* if the CPU goes to the Stop mode or Reset. Selection of the output default state is made by a jumper on the module's terminal board. See Output Defaults in this section for more information.

LED

The **Module OK** LED is ON when the module's power supply is operating.

Isolated +24 VDC Power

If the module is located in an RX3i Universal Backplane, an external source of Isolated +24 VDC is required to provide power for the module. The external source can be connected via the TB1 connector on the left side of the backplane or directly on the module's terminal block.

If this module is located in an Expansion Backplane, its primary power source can be either the Isolated +24 VDC from the backplane power supply or an external Isolated +24 VDC power supply connected to the module's terminal block. If the external source is set between 27.5-30 VDC, it takes over the module's load from the Isolated 24 VDC system supply. Note that an external source should be used if it is desired to maintain hold last state operation during a loss of backplane power.

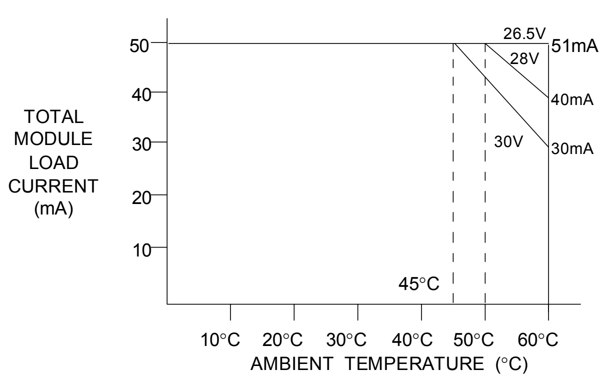
Specifications: ALG391

Output Current Range	4 to 20 mA and 0 to 20 mA
Output Voltage Range	1 to 5 volts and 0 to 5 volts
Calibration	Factory calibrated to 4 µA per count
External Supply Voltage Range	20 VDC to 30 VDC. Depends on the current load and the ambient temperature as shown below.
External Supply Voltage Ripple	10%
Update Rate	5 milliseconds (approximate, both channels) Application dependent.
Resolution:	
4 to 20mA	4 µA (1 LSB = 4 µA)
0 to 20mA	5 µA (1 LSB = 5 µA)
1 to 5V	1 mV (1 LSB = 1 mV)
0 to 5V	1.25 mV (1 LSB = 1.25 mV)
Absolute Accuracy: *	
4 to 20mA	+/-8 µA at 25°C (77°F)
0 to 20mA	+/-10 µA at 25°C (77°F)
1 to 5V	+/-50 mV at 25°C (77°F)
0 to 5V	+/-50 mV at 25°C (77°F)
Maximum Compliance Voltage	25 VDC
User Load (current mode)	0 to 850 Ohms
Output Load Capacitance (current mode)	2000 pF
Output Load Inductance (current mode)	1 H
Maximum Output Loading (voltage mode)	5 mA (2 K Ohms minimum resistance) (2000 pF maximum capacitance)
Isolation, Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for 1 minute
Internal Power Consumption	30 mA from +5 VDC supply 215 mA from Isolated +24 VDC supply

Refer to Appendix A for product standards and general specifications.

* In the presence of severe RF interference (IEC 801–3, 10 V/m), accuracy may be degraded to ±80 µA (4 to 20 mA range), ±100µA (0 to 20 mA range).

Load Current Derating



NOTE
WHEN IN VOLTAGE MODE, ASSUME 20.5 mA PER CHANNEL IN ADDITION TO V_{OUT} LOAD CURRENT PER CHANNEL.

EXAMPLE: BOTH CHANNELS IN 0 TO +10V MODE WITH 2K LOADS = 51 mA

Data Format: ALG391

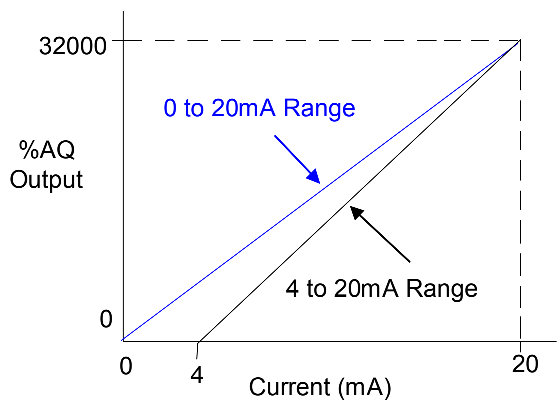
Module data is stored by the PLC CPU in 16–bit 2's complement format as shown below.

MSB															LSB
X	11	10	9	8	7	6	5	4	3	2	1	0	X	X	X

The 13 most significant bits from the %AQ register are converted to sign magnitude by the PLC and sent to the module.

D/A Bits versus Current Outputs

The module scales the output data received from the CPU according to the range selected for the channel.



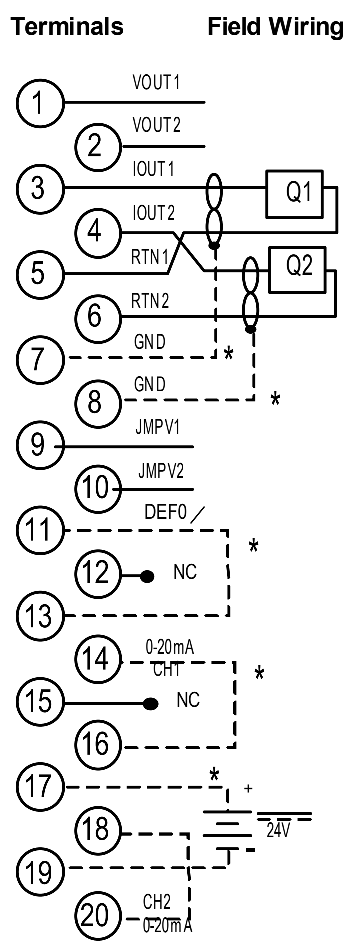
In the 4 to 20 mA range, the module scales output data with each 1000 counts representing 0.5 mA. In this range a count of 0 corresponds to 4 mA and a count of 32000 corresponds to 20 mA.

In 0 to 20 mA range, the module scales output data so that each 800 counts represents 0.5 mA. In this range, a count of 0 corresponds to 0 mA and a count of 32000 corresponds to 20 mA with each 800 counts representing 0.5 mA.

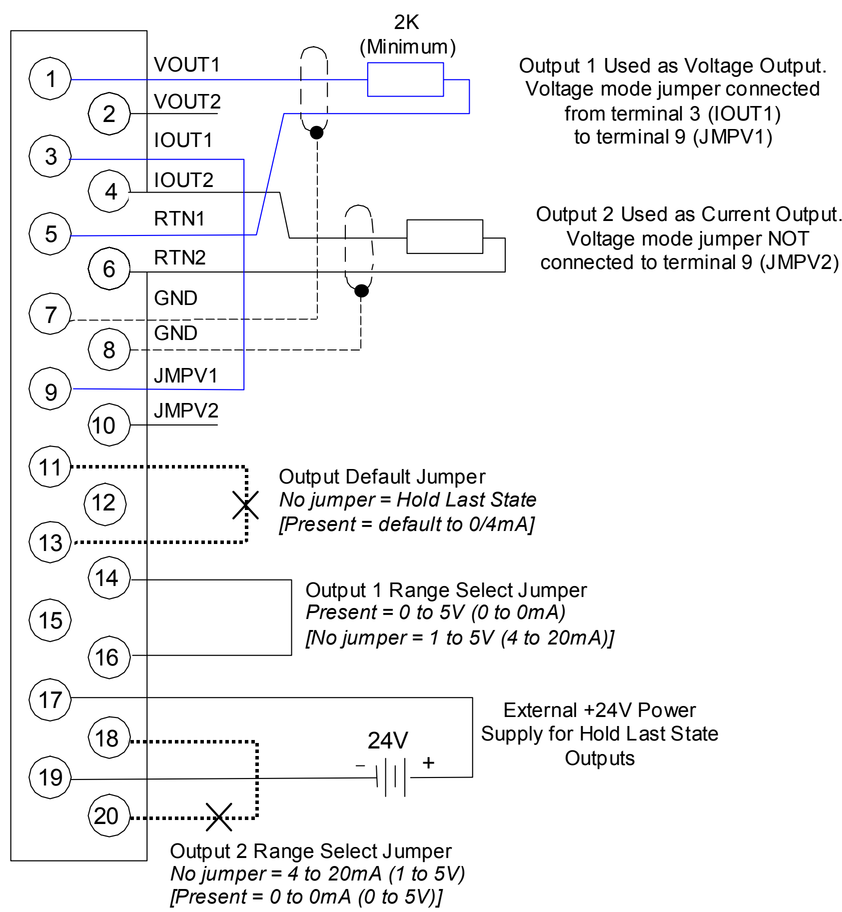
If the module receives negative data from the CPU, it outputs the low end of the range (either 0 mA or 4 mA). If a value greater than 32767 is received, it is not accepted.

Field Wiring: ALG391

To minimize the capacitive loading and noise, all field connections to the module should be wired using a good grade of twisted, shielded instrumentation cable. The shields should be connected to GND on the user terminal connector block. The GND connection provides access to the backplane (frame ground) resulting in superior rejection of noise caused by any shield drain currents. If no jumper is installed, the module performs as a current source. If the jumper is present, the module performs as a voltage source.

<table>
<tr><th>Module Wiring</th><th>Example Connections</th></tr>
<tr><td>


*Optional Connections
</td><td>
In this example, Output 1 is used as a voltage output (JMPV1 connected to IOUT1) in the 0 to 5 V range (RANGE 1 jumper installed) Output 2 is used as a current output (JMPV2 not connected) in the 4 to 20 mA mode (RANGE2 jumper not installed). Both outputs will Hold Last State (no Output Default jumper installed, external +24 VDC power supply connected).



</td></tr>
</table>

Current or Voltage Outputs

Each channel's range and its operation in current or voltage mode are set with jumpers on the module terminals. For voltage operation, a 250 Ohm resistor can be used instead of a voltage jumper to increase the voltage range. The table below lists the output ranges that can be set up for each output, and the jumper or resistor settings for each range.

Range of the Output	Range Jumper Installed	Voltage Jumper or Resistor Installed
4 mA to 20 mA	No	No
0 mA to 20 mA	Yes	No
0 V to 5 V	Yes	jumper
0 V to 10 V	Yes	250 Ohm resistor
1 V to 5 V	No	jumper
2 V to 10 V	No	250 Ohm resistor

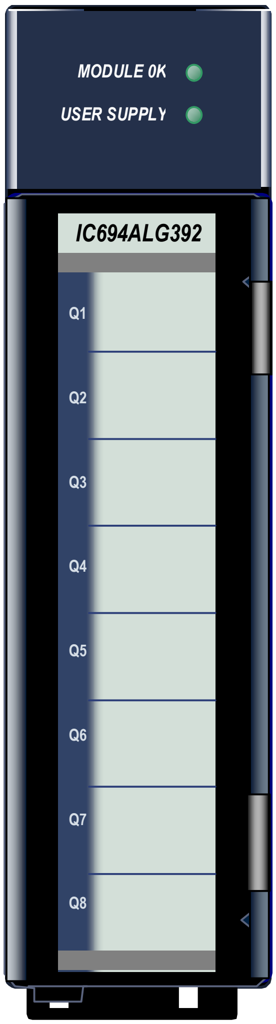
Output Defaults

Both module outputs can be set to either Default to 0 or 4 mA or Hold Last State if the CPU goes to Stop mode or is Reset. The module's Output Default operation is set using another jumper on the terminal block.

If the Output Default (DEF0/4) jumper is installed on module terminals 11 and 13, both outputs default to the low end of their ranges.

If the Output Default jumper is not installed, both outputs hold the last valid output value received from the PLC CPU. This option requires an external +24 VDC power supply to maintain output power when the system power goes down.

Analog Output Module, Current/Voltage, 8 Channel: IC694ALG392



The ***8–Channel Analog Current/Voltage Output*** module; IC694ALG392, provides up to eight single-ended output channels with current loop outputs and/or voltage outputs. Each output channel can be set up using the configuration software for any of these ranges:

- 0 to +10 volts (unipolar)
- 10 to +10 volts (bipolar)
- 0 to 20 milliamps
- 4 to 20 milliamps

Each channel is capable of converting 15 to 16 bits (depending on the range selected) of binary data to an analog output. All eight channels are updated every 12 milliseconds.

In current modes, the module reports an Open Wire fault to the CPU for each channel. The module can go to a known last state when system power is interrupted. As long as external power is applied to the module, each output will maintain its last value or reset to zero, as configured.

This module can be installed in any I/O slot of an RX3i system.

Isolated +24 VDC Power

The module must receive its 24 VDC power from an external source.

If the module is located in an RX3i Universal Backplane, the external source can be connected via the TB1 connector on the left side of the backplane or directly on the module's terminal block.

If this module is located in an Expansion Backplane, the external source must be connected to the module's terminal block.

LEDs

The **Module OK** LED indicates module status. The **User Supply** LED indicates whether the external +24 VDC power supply is present and is above the minimum level. Both LEDs are powered from the +5 VDC backplane power bus.

LED	Indicates
OK	ON: Module OK and configured Flashing: Module OK but not configured OFF: Module is defective or no +5V backplane power present
USER OK	ON: External power supply present OFF: No user power

Specifications: ALG392

Number of Output Channels	1 to 8 selectable, single–ended
Output Current Range	4 to 20 mA and 0 to 20 mA
Output Voltage Range	0 to 10 V and –10 V to +10 V
Calibration	Factory calibrated to .625 µA for 0 to 20 mA; 0.5 µA for 4 to 20 mA; and .3125 mV for voltage (per count)
User Supply Voltage (nominal)	+24 VDC, from user supplied voltage source
External Supply Voltage Range	20 VDC to 30 VDC
Power Supply Rejection Ratio (PSRR)	
Current	5 µA/V (typical), 10 µA/V (maximum)
Voltage	25 mV/V (typical), 50 mV/V (maximum)
External Power Supply Voltage Ripple	10% (maximum)
Internal Supply Voltage	+5 VDC from PLC backplane
Update Rate	8 milliseconds (approximate, all eight channels) Determined by I/O scan time, application dependent.
Resolution:	**4 to 20mA:** 0.5 µA (1 LSB = 0.5 µA)
	0 to 20mA: 0.625 µA (1 LSB = 0.625 µA)
	0 to 10V: 0.3125 mV (1 LSB = 0.3125 mV)
	-10 to +10V: 0.3125 mV (1 LSB = 0.3125 mV)
Absolute Accuracy: *	
Current Mode	+/-0.1% of full scale @ 25°C (77°F), typical +/-0.25% of full scale @ 25°C (77°F), maximum +/-0.5% of full scale over operating temperature range (maximum)
Voltage Mode	+/-0.25% of full scale @ 25°C (77°F), typical +/-0.5% of full scale @ 25°C (77°F), maximum +/-1.0% of full scale over operating temperature range (maximum)
Maximum Compliance Voltage	V_{USER} –3 V (minimum) to V_{USER} (maximum)
User Load (current mode)	0 to 850 Ω (minimum at V_{USER} = 20 V, maximum 1350 Ω at V_{USER} = 30 V) (Load less than 800 Ω is temperature dependent.)
Output Load Capacitance (current mode)	2000 pF (maximum)
Output Load Inductance (current mode)	1 H
Output Loading (voltage mode) **Output load Capacitance**	5 mA (2 K Ohms minimum resistance) (1 µF maximum capacitance)
Isolation, Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for 1 minute
Power Consumption	110 mA from +5 VDC PLC backplane supply 315 mA from +24 VDC user supply

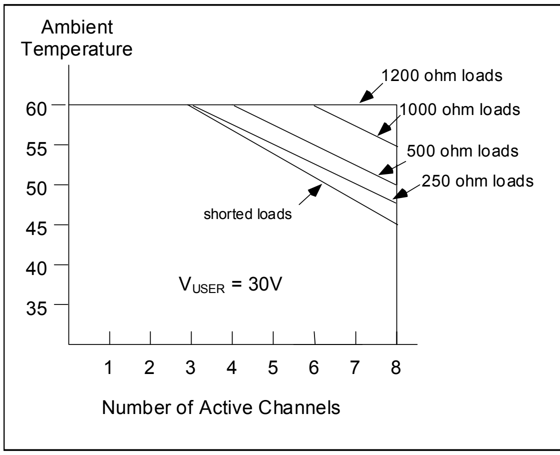
Refer to Appendix A for product standards and general specifications. In order to meet the IEC 1000-4-3 levels for RF Susceptibility specified in Appendix A, when this module is present, the system must be mounted in a metal enclosure.

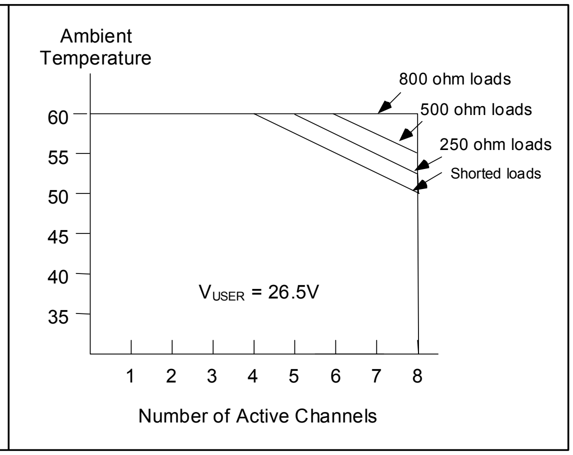
- In the presence of severe RF interference (IEC 801–3, 10V/m), accuracy may be degraded to ±1% FS for current outputs and ±3% FS for voltage outputs.

Derating Curves: ALG392

For maximum performance and module life, the module should be operated at maximum load resistance to offload heat. Module thermal deratings depend on the voltage level and the use of current and voltage outputs. The first two charts below show the maximum ambient temperature for current-only modules at 30 VDC and at 26.5 VDC.

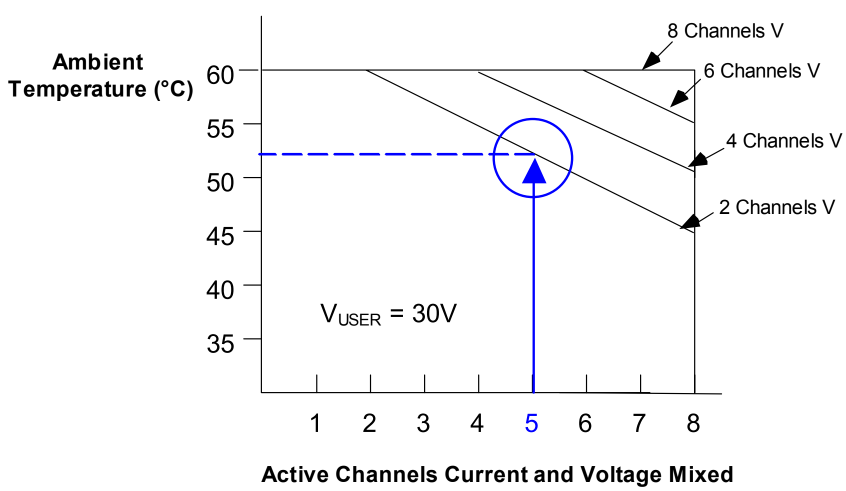
Current Outputs Only





Mixed Current and Voltage Outputs

In the deratings shown below, voltage channels have 2 K Ohm loads and current channels have shorted loads. To determine the maximum operating temperature for mixed current and voltage outputs, select the line in the chart below that corresponds to the number of voltage channels being used. For example, a module uses 2 voltage channels and 3 current channels. The total channels are 5, and the maximum operating temperature is approximately 52.5°C:



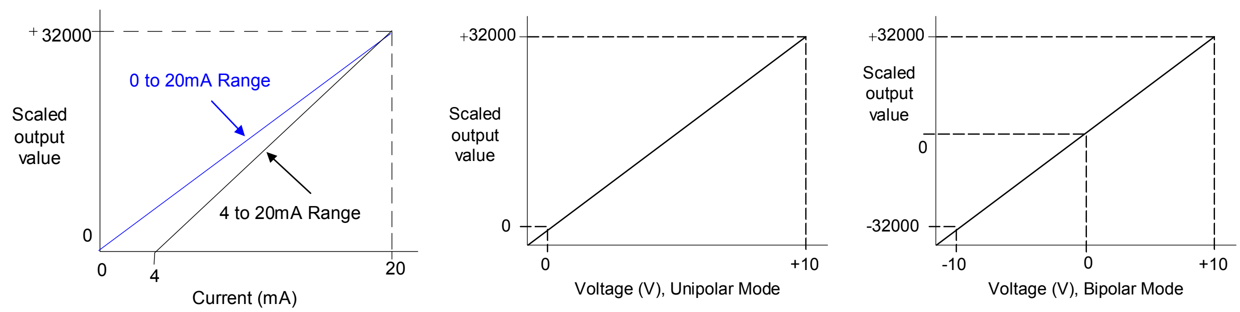
Current and Voltage Ranges and Resolution

In the 4 to 20 mA range the module scans output data from the PLC so that 4 mA corresponds to a count of 0, and 20 mA corresponds to a count of 32000. In the 0 to 20 mA range, user data is scaled so that 0 mA corresponds to a count of 0 and 20 mA corresponds to 32000. In 0 to 20 mA mode, a value up to 32767 provides a maximum output of approximately 20.5 mA. In current mode, the module also reports an open loop fault to the PLC.

For voltage operation in the default unipolar mode (0 to +10 volts), data is scaled so that 0 volts corresponds to a count of 0 and +10 volts corresponds to a count of 32000. In this mode, a value up to 32767 creates an overrange output of approximately 10.24 volts.

In the -10 to +10 volt range, data is scaled so that -10 volts corresponds to a count of -32000 and +10 volts corresponds to a count of +32000. In this range, output values from -32767 to +32767 result in an overrange of approximately -10.24 volts to +10.24 volts.

Scaling for both current and voltage ranges is shown below.



The resolution per bit depends on the channel's configured range:

4 to 20 mA:	0.5 μA
0 to 20 mA:	0.625 μA
0 to 10 V:	0.3125 mV
-10 to +10 V:	0.3125 mV

Module Data

Module ALG392 uses up to 8 output reference words. Each channel provides 16 bits of analog output data as an integer value. Output resolution is 15 bits except for the bipolar voltage mode, which has 16-bit resolution. The 16th bit is the sign bit.

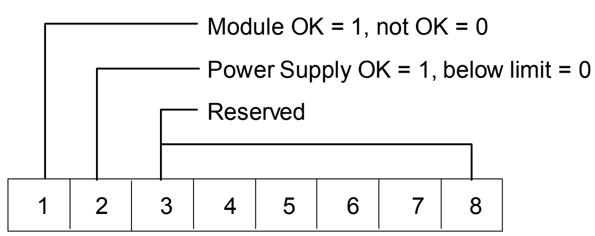
Range	Resolution	Range Limits
0 to 20 mA	15 bits	0 to 32767
4 to 20 mA	15 bits	0 to 32767*
0 to 10 V	15 bits	0 to 32767
-10 to 10 V	16 bits	- 32768 to 32767

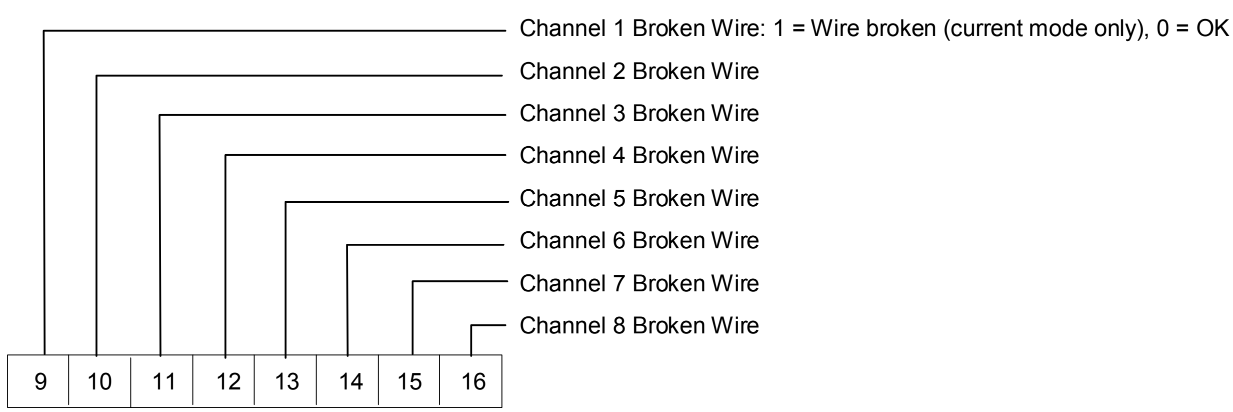
* In 4-20 mA mode, if the PLC CPU sends a channel a value that is greater than 32000, the module uses the value 32000 instead.

Status Data: ALG292

This module uses either 8 or 16 discrete input bits, as configured. The first 8 bits are used for module status information as shown below.

In current mode, individual channels can also report Broken Wire diagnostics. Those diagnostics are reported in bits 9-16:

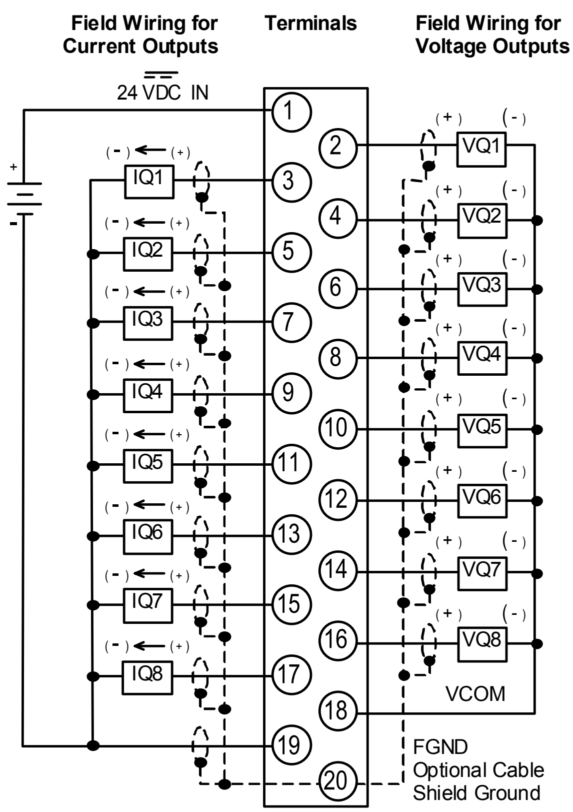




Field Wiring: ALG392

Terminal	Signal Name	Signal Definition
1	24VIN	User Supplied +24 VDC Input
2	V CH 1	Channel 1 Voltage Output
3	I CH 1	Channel 1 Current Output
4	V CH 2	Channel 2 Voltage Output
5	I CH 2	Channel 2 Current output
6	V CH 3	Channel 3 Voltage Output
7	I CH 3	Channel 3 Current output
8	V CH 4	Channel 4 Voltage Output
9	I CH 4	Channel 4 Current output
10	V CH 5	Channel 5 Voltage Output
11	I CH 5	Channel 5 Current output
12	V CH 6	Channel 6 Voltage Output
13	I CH 6	Channel 6 Current output
14	V CH 7	Channel 7 Voltage Output
15	I CH 7	Channel 7 Current output
16	V CH 8	Channel 8 Voltage Output
17	I CH 8	Channel 8 Current output
18	V COM	Voltage Common
19	I COM	Current Common/User +24 VDC Return
20	GND	Frame ground connection for cable shields

The diagram below shows connections for current and voltage outputs. Each channel can be configured to operate as a voltage output or a current output - not both simultaneously.



Configuration: ALG392

Parameter	Description	Values	Default Values
Active Channels	Number of channels scanned	1 through 8	1
Reference Address for Module Output Data	Starting address for %AQ reference type	standard range	%AQ0001, or next highest available address
Reference Address for Channel Status Data	Starting address for %I reference type	standard range	%I00001, or next highest available address
Length	Number of %I status locations	8 or 16	8
Stop Mode	Output state when module toggled from RUN to STOP mode	Hold Last State or Default to Zero	Hold Last State
Output Channel Range	Type of Output Range	0, +10V -10, +10V 4, 20 mA 0, 20 mA	0, 10V

Active Channels indicates the number of channels that will be scanned by the PLC CPU.

The choice made for Stop Mode determines whether the module's outputs will hold their last states or default to zero when the goes from Run to Stop mode.

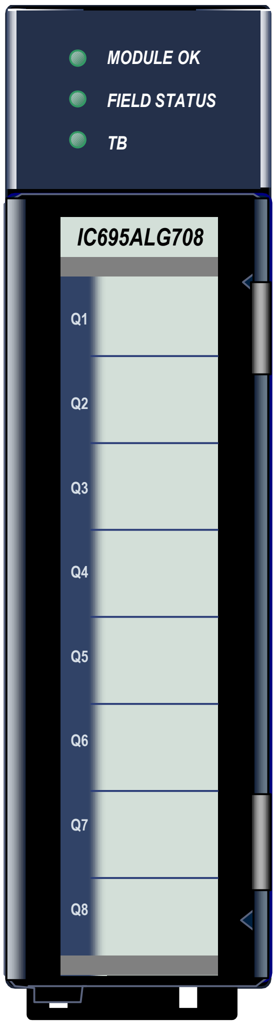
The %AQ Reference Address parameter selects the start of the area in the %AQ memory where the output data to the module will begin.

The %I Reference Address selects the start of the area in %I memory for the module's status data. If the length is set to 8, then only module status will be reported. If the length is set to 16, channel status will also be reported for channels that are operating as current outputs.

Each channel can be set up to operate on one of four output ranges:

- 0 to 10 V (default
- -10 to +10 V range
- 4 to 20 mA, and 0 to 20 mA
- 0 to 20 mA

Analog Output Module, 4 Channel Voltage / Current: IC695ALG704
Analog Output Module,8 Channel Voltage / Current: IC695ALG708



Non-Isolated Analog Voltage/Current Output module IC695ALG704 provides 4 configurable voltage or current output channels. ***Non-Isolated Analog Voltage/Current Output*** module IC695ALG708, shown at left, provides 8 configurable voltage or current output channels. Analog channels can be configured for these output ranges:

- Current: 0 to 20mA, 4 to 20mA
- Voltage: +/- 10V, 0 to 10V

These modules can be used with a Box-style (IC694TBB032), Extended Box-style (IC694TBB132), Spring-style (IC694TBS032), or Extended Spring-style (IC694TBS132) Terminal Block. Extended terminal blocks provide the extra shroud depth needed for shielded wiring. See chapter 15 for more information about Terminal Blocks. Terminal Blocks are ordered separately.

These modules must be located in an RX3i Universal Backplane. They require an RX3i CPU with firmware version 3.0 or later. Machine Edition Version 5.0 SP3 Logic Developer-PLC or later must be used for configuration.

Isolated +24 VDC Power

The module must receive its 24 VDC power from an external source. The external source must be connected directly to the module's terminal block. It cannot be connected via the TB1 connector on the RX3i Universal Backplane. ***Module Features***

- Completely software-configurable, no module jumpers to set
- Individually enable or disable channels
- Clamping and Alarm Limits
- Latching of Alarms
- Configurable output bias
- Rapid channel acquisition times based on filter frequency
- Full autocalibration
- On-board error-checking
- Configurable scaling and offsets per channel
- High alarm, low alarm, high-high alarm, low-low alarm detection and reporting selectable per channel
- Module fault reporting
- Configurable Hold Last State or Output Defaults

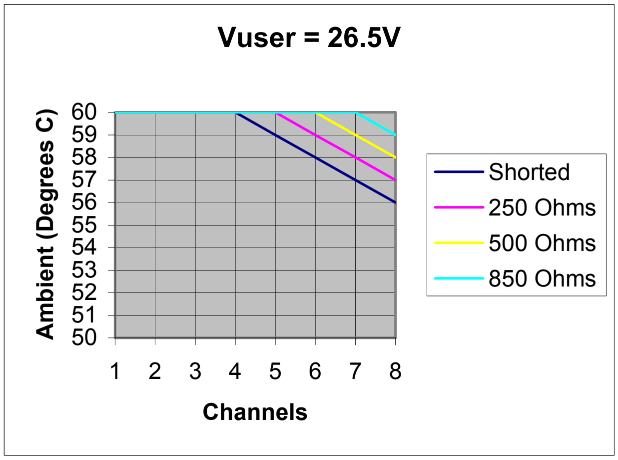
Specifications: IC695ALG704 and IC695ALG708

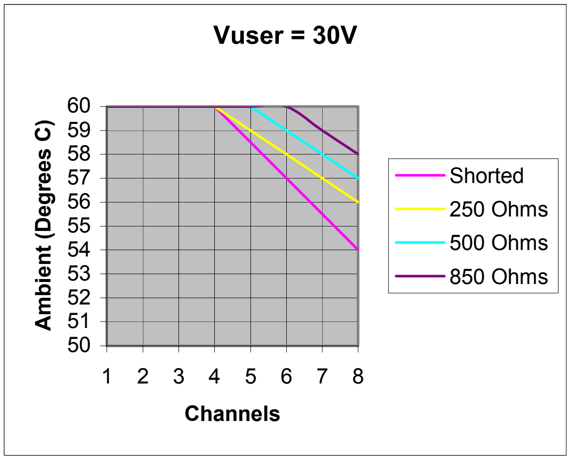
Output Ranges	Current: 0 to 20mA, 4 to 20mA Voltage: +/- 10V, 0 to 10V
Backplane Power Requirements	375 mA maximum at 3.3V
Power Dissipation within Module (Vuser=24V)	IC695ALG704: 4.8 Watts maximum IC695ALG708: 7.25Watts maximum
Thermal Derating	IC695ALG704: None IC695ALG708: Voltage mode: none Current mode: See next page.
External Power Supply V_{user}	Voltage Range: +19.2V to +30VDC Current required for ALG704: 150mA maximum Current required for ALG708: 250mA maximum
Resolution	+/-10V: 15.9 bits, 0 to 10V: 14.9 bits, 0 to 20mA: 15.9 bits, 4 to 20mA : 15.6 bits
Output Data Format	Configurable as floating point IEEE 32 bit or 16-bit integer in a 32-bit field
Update Rate (Determined by I/O scan time, application dependent.)	8 milliseconds (approximate, all eight channels)
Output Overvoltage Protection	Current outputs only: -30V for 60 seconds, +30V for one hour
Calibrated Accuracy	Accurate to within 0.15% of full scale at 25°C Accurate to within 0.30% of full scale at 60°C In the presence of severe RF interference (IC 801-3, 10V/M), accuracy may be degraded to +/-1% FS.
Output Load Reactance	Current: 10µH maximum, Voltage: 1µF maximum
Maximum Output Load	Current: 850 Ohms maximum at V_{user} = 20V Voltage: 2 Kohms minimum
Output Gain Drift	Voltage output: 20ppm per degree C typical Current output: 35ppm per degree C typical
Output Settling Time	Voltage or current output: 2ms, 0 to 95%.
Isolation, Field to Backplane	2550VDC for one second
Maximum Compliance Voltage	V_{user} – 3V (minimum) to V_{user} (maximum)

Refer to Appendix A for product standards and general specifications.

Output Points vs. Temperature, Current Mode

Module IC695ALG704 has no thermal derating. Module IC695ALG708 has no thermal derating in voltage mode. Thermal deratings for module IC695ALG708 In current mode are shown below.





LEDs

The **Module OK** LED indicates module status. The **Field Status** LED indicates whether the external +24 VDC power supply is present and is above the minimum level and whether or not faults are present. All LEDs are powered from the backplane power bus.

LED	*Indicates*
Module OK	ON Green: Module OK and configured. Quick Flashing Green: Module performing powerup sequence. Slow Flashing Green or Amber: Module OK but not configured. OFF: Module is defective or no backplane power present
Field Status	ON Green No faults on any enabled channel, Terminal Block is present, and field power is present. ON Amber and TB Green: Terminal Block is installed, fault on at least one channel, or field power is not present. ON Amber and TB Red: Terminal Block not fully removed, field power still detected. OFF and TB Red: Terminal block not present and no field power is detected.
TB	ON Red: Terminal block not present or not fully seated. See above. ON Green: Terminal block is present. See above. OFF: No backplane power to module.

Configuration Parameters: IC695ALG704 and IC695ALG708

Module Parameters		
Parameter	***Default***	***Description***
Outputs Reference Address	%AQxxxxx	Starting address for the module's output data. This defaults to the next available %AQ block.
Outputs Reference Length	ALG704: 8 ALG7088: 16	The number of words used for the module's output data. This parameter cannot be changed.
Output Command Feedback Reference Address	%AIxxxxx	Stating address for the module's command feedback data. This defaults to the next available %AI address after a non-zero length is configured.
Output Command Feedback Length	0	The number of words used for the module's command feedback data. Length defaults to 0. It can be set to 8 or 16, depending on the module type being configured.
Diagnostic Reference Address	%Ixxxxx	Starting address for the channel diagnostics status data. This defaults to the next available %I block.
Diagnostic Reference Length	0	Read Only. The number of bit reference bits required for the Channel Diagnostics data. Default is 0, which means mapping of Channel Diagnostics is disabled. Change this to a non-zero value to enable Channel Diagnostics mapping. Maximum length is 128 bits for module IC695ALG704 or 256 bits for module IC695ALG708.
Module Status Reference Address	%Ixxxxx	Starting address for the module's status data. This defaults to the next available %I block.
Module Status Reference Length	0	Read Only. The number of bits (0 or 32) required for the Module Status data. Default is 0, which means mapping of Module Status data is disabled. Change this to a non-zero value to enable Module Status data mapping.

Continued…

Analog Output Commanded Feedback

The module returns a copy of the analog output data received from CPU in its corresponding channel analog input shared memory. Output Feedback can be monitored to check the values being sent to the channels. The data is in the same scaled format as the output data for each channel. During normal operation this feedback data should match the actual output data after one or more PLC scans of module inputs. During faults, ramping, overrange, and clamping conditions, the analog output data may differ from the commanded output.

OverTemperature

If OverTemperature is enabled, the module generates an OverTemperature alarm if the module's internal temperature is too great for the number of outputs that are on at the same time. In addition to the configurable options for OverTemperature fault reporting and interrupts, an over temperature condition is also indicated by the OverTemperature bit in the module's Status Reference data. Detection of the OverTemperature status bit is always enabled.

Module Parameters		
Parameter	**Default**	**Description**
I/O Scan Set	1	The scan set 1 – 32 to be assigned to the module by the RX3i CPU.
Channel Faults w/o Terminal Block	Disabled	Enabled / Disabled: Controls whether channel faults and configured alarm responses will be generated after a Terminal Block removal. The default setting of Disabled means channel faults and alarms are suppressed when the Terminal Block is removed. This parameter does not affect module faults including the Terminal Block loss/add fault generation.
Module Fault Reporting Enabled	Enabled	Enabled / Disabled. Controls whether the module will report faults resulting from either loss of field power or overtemperature conditions.
Field Power Removed Enabled	Enabled	Enabled / Disabled. With Module Fault Reporting enabled, this parameter controls reporting of Field Power Removed module faults.
Over Temp Enabled	Enabled	Enabled / Disabled. With Module Fault Reporting enabled, this parameter controls reporting of Overtemperature module faults.
Module Interrupt Reporting Enabled	Disabled	Enabled / Disabled.
Field Power Removed Enabled	Disabled	Enabled / Disabled. With Module Interrupt Reporting enabled, this parameter controls interrupts for Field Power Removed module faults.
Over Temp Enabled	Disabled	Enabled / Disabled. With Module Interrupt Reporting enabled, this parameter controls interrupts for Overtemperature module faults.
Range Type	Disabled Current	Sets up the type of output to be used for each channel. Choices are: Disabled Voltage, Disabled Current, Voltage/Current.
Range (Only for Range Type Voltage/Current)	-10V to +10V	For voltage/current: -10V to +10V, 0V to +10V, 4mA to 20 mA, 0mA to 20 mA.
Channel Value Format	32-bit Floating Point	16-bit integer or 32-bit floating point
Outputs Default	Force to Default Value	Controls the state the output will be set to in Outputs Disabled mode (stop), if a fault occurs, if power is lost, or if the configuration is cleared. Choices are Hold Last State, or default to a specific configured default value.

Continued …

Range Type

Each channel on the module that will be used should be configured for Voltage/Current. Its voltage or current range and other parameters can then be configured as needed. If the channel output will not be used and is not wired, select either "Disabled" option. If a channel is disabled, it is not necessary to configure any of its other parameters.

If the channel is wired to a current output, but will not presently be used, select "Disabled Current". This will set the channel's current output to 0mA (the channel's voltage output will be non-zero).

If the channel is wired to a voltage output, but will not presently be used, select "Disabled Voltage". This will set the channel's voltage output to 0V (the channel's current output will be non-zero).

Output Defaults

If Hold Last State is enabled, an output will hold its last commanded value when the CPU indicates Outputs Not Enabled, or if one of the fault conditions listed below occurs. If Hold Last State is disabled, the output is commanded to go to the Default Value. The Default Value must be set within the selected output range. If both Default Value and Ramp Rate are enabled, the channel will ramp to the default value. Fault conditions are:

- CPU outputs are not enabled
- Backplane power is not ok. In that case, there is no ramping, even if ramping has been enabled.
- Loss of communications from CPU.
- Loss of I/O communications.
- Loss of field power.

Outputs Default Notes

- Hot Removal of the module in an I/O Enabled mode will cause all outputs to Hold Last State (even channels configured for Force to Default Value). If that operation is not desirable, the outputs can be forced to default by first turning off field power and removing the module's Terminal Block before hot-removing the module.
- Resetting the module using SVC_REQ 24 causes all channels to Hold Last State even if Default Value is configured. The application program must handle output defaulting before execution of the Service Request.
- Default Ramp Rate configuration is ignored if backplane power from the power supply is lost. Channels configured for Default Value go to the default value immediately.
- The first time a configuration is stored following a return of backplane power, the Default Ramp rate is not used. Any channel configured for Default Value goes to its default value immediately. If analog power was not lost and the same configuration is restored on the next powerup, the channel state is unchanged from the time the power was lost. The Default Ramp Rate is used for any subsequent reconfiguration.

Output Default Conditions and Actions

Condition	***Hold Last State or Default Value***	***Default Ramp Rate Enabled***	***Outputs Enabled and Ramp Rate Enabled***	***Channel Output Setting*** (Except where indicated, field power is assumed to be present).
Outputs Enabled and No Faults	N/A	N/A	No	Output goes to its commanded value from reference memory; defaults don't apply.
	N/A	N/A	Yes	Output is ramped to the commanded output from reference memory at the Outputs Enabled ramp rate. Defaults don't apply.
Outputs Disabled, Fault Mode, or Reconfiguration	Default Value	No	N/A	Output is set to the Default Value
	Default Value	Yes	N/A	Output is ramped to the Default Value at the Default ramp rate, starting at the last commanded value before entering mode.
	Hold Last State	N/A	N/A	Output is held at the last commanded value
Loss of Backplane Power or First Configuration Store after Powerup	Default Value	N/A	N/A	Output is set to the Default Value.
	Hold Last State	N/A	N/A	Output is held at last commanded value.
Hot Removal, Reset with SVCREQ 24 or Cleared Configuration	N/A	N/A	N/A	Output is held at last commanded value.
Loss of Field Power	N/A	N/A	N/A	All outputs go to 0V and 0mA.

Channel Parameters, *continued*

Parameter	***Default***	***Description***
High Scale Value (Eng Units)	The defaults for the 4 Scaling parameters depend on the configured Range Type and Range. Each Range and Range Type have a different set of defaults.	Note: Scaling is disabled if both High Scale Eng. Units equals High Scale A/D Units and Low Scale Eng. Units equals Low Scale A/D Units. Default = High A/D Limit of selected range type.
Low Scale Value (Eng Units)		Default is Low A/D Limit of selected range type. Must be lower than the high scaling value.
High Scale Value (A/D Units)		Default is High A/D Limit of selected range type. Must be greater than the low scaling value.
Low Scale Value (A/D Units)		Default is Low A/D Limit of selected range type.

Continued …

Output Scaling

By default, the module converts a floating point value from the CPU into a voltage or current output over the entire span of its configured Range. For example, if the Range of a channel is 4 to 20mA, the module accepts channel output values from 4.000 to 20.000. By modifying one or more of the four channel scaling parameters (Low/High Scale Value parameters) from their defaults, the scaled Engineering Unit range can be changed for a specific application. Scaling is always linear and inverse scaling is possible. All alarm values apply to the scaled Engineering Units value, not to the A/D units value.

The scaling parameters only set up the linear relationship between two sets of corresponding values. They do not have to be the limits of the output.

Example

In this example, the application should interpret 32000 counts as +10V and –32000 counts as -10V . The following channel configuration will scale a +/-10V output channel to +/-32000 counts.

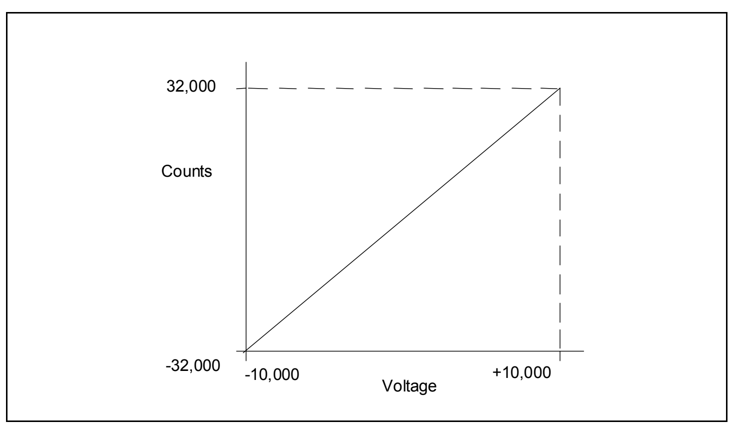
Channel Value Format = 16 Bit Integer

High Scale Value (Eng Units) = 32000.0

Low Scale Value (Eng Units) = -32000.0

High Scale Value (A/D Units) = 10.000

Low Scale Value (A/D Units) = -10.000



Channel Parameters, continued		
Parameter	***Default***	***Description***
High Alarm (Eng Units)	The defaults depend on the configured Range.	All of the alarm parameters are specified in Engineering Units. When the configured value is reached or below (above), a Low (High) Alarm is triggered.
Low Alarm (Eng Units)		
Outputs Enabled Ramp Rate (Eng Units)	0.0	The rate in Engineering Units at which the output will change during normal operation.
Default Ramp Rate (Eng Units)	0.0	The rate in Engineering Units at which the output will change if a fault condition occurs or if outputs are not enabled.
Output Clamping Enabled	Disabled	Enabled / Disabled. See description below.
Upper Clamp Limit (Eng Units)	The defaults depend on the configured Range.	The Upper Clamp Limit must be greater than the Lower Clamp Limit. This parameter can be used to restrict the output to a range that is narrower than its configured Range Type. For example, a channel configured for –10V to +10V could be restricted to -8V to +7.5V.
Lower Clamp Limit (Eng Units)		
Default Value (Eng Units)	0.0	If Hold Last State is disabled, the output is commanded to go to the Default Vale when the CPU is not in Outputs Enabled mode or under certain fault conditions.
User Offset (Eng Units)	0.0	A configurable value that can be used to change the base of the channel. This value is added to the scaled value of the channel before alarm-checking.

Continued …

Lower, Upper Clamp and Alarms

Alarms can be used to indicate when the module has been commanded to meet or exceed the configured high or low limits for each channel. These are set at six configurable alarm trigger points:

- High Alarm and Low Alarm
- Upper Clamp and Lower Clamp
- Overrange and Underrange Alarm

Each alarm is individually configurable per channel to generate diagnostics bit status, fault alarms, or interrupt alarms.

If a channel is commanded higher than the Upper Clamp value, the output is set to the Upper Clamp value and an Upper Clamp condition is indicated. If a channel is commanded lower than the Lower Clamp value, the output is set to the Lower Clamp value and a Lower Clamp condition is indicated.

The High and Low Alarm checks are performed on the engineering units output value after possibly being adjusted by ramping, clamping, and fault conditions.

Channel Parameters, *continued*		
Parameter	***Default***	***Description***
Diagnostic Reporting Enable *If Diagnostic Reporting is enabled, the additional parameters listed below can be used to enable specific types of alarms.*	Disabled	*Diagnostic Reporting Enable options* are used to enable reference memory reporting of alarms into the Diagnostic Reference area. *Fault Reporting Enable option*s enable fault logging of alarms into the I/O Fault Table. These parameters enable or disable the individual diagnostics features of a channel. When any of these parameters is enabled, the module uses associated parameters to perform the enabled feature. For example, if Over Range is enabled in the “Diagnostic Reporting Enable” menu, the module will set the Over Range bit in the Diagnostic Reference for the channel. If any of these parameters is disabled, the module does not react to the associated alarm conditions. *For example, if Low Alarm Enable is set to Disabled in the “Fault Reporting Enable” menu, the Low Alarm fault is not logged in the I/O Fault Table when Low Alarm is detected on the channel.*
Fault Reporting Enable *If Fault Reporting is enabled, the additional parameters listed below can be used to enable specific types of Faults.*	Disabled	
Interrupts Enable	Disabled	
Low Alarm Enable	Disabled	
High Alarm Enable	Disabled	
Under Range Enable	Disabled	
Over Range Enable	Disabled	
Lower Clamp Alarm Enable	Disabled	
Upper Clamp Alarm Enable	Disabled	

Alarming and Fault Reporting

The Diagnostic Reporting Enable, Fault Reporting Enable, and Interrupt Enable configuration parameters can be used to enable different types of responses for individual channel alarms. By default, all responses are disabled on every channel. Any combination of alarm enables can be configured for each channel.

- If Diagnostic Reporting is enabled, the module reports channel alarms in reference memory at the channel's Diagnostic Reference address.
- If Fault Reporting is enabled, the module logs a fault log in the I/O Fault table for each occurrence of a channel alarm.
- If Interrupts are enabled, an alarm can trigger execution of an Interrupt Block in the application program, as explained below.

Using Interrupts

To properly configure an I/O Interrupt, the Interrupt enable bit or bits must be set in the module's configuration. In addition, the program block that should be executed in response to the channel interrupt must be mapped to the corresponding channel's reference address.

Example:

In this example, the Channel Values Reference Address block is mapped to %AQ0001-%AQ0008. An I/O Interrupt block should be triggered if a High Alarm condition occurs on channel 2.

- Configure the High-Alarm condition.
- Set the High-Alarm Interrupt Enable flag for Channel 2 in the module configuration.

Channel 2's reference address corresponds to %AQ00003 (2 Words per channel), so the interrupt program block Scheduling properties should be set for the "I/O Interrupt" Type and "%AQ0003" as the Trigger.

Fault Reporting and Interrupts

These modules have separate enable/disable options for Diagnostic Reporting and Interrupts. Normally, disabling a diagnostic (such as Low/High Alarm or Over/Under range) in the configuration means that its diagnostic bit is never set. However, if interrupts are enabled for a condition and that interrupt occurs, the diagnostic bit for that condition is also set during the I/O Interrupt block logic execution. The next PLC input scan always clears this interrupt status bit back to 0, because Diagnostic Reporting has it disabled.

Module Data: IC695ALG704 and IC695ALG708

The module receives its channel data from its configured output words, beginning at its assigned Channel Value Reference Address. Each channel occupies 2 words (whether the channel is used or not):

Channel Value Reference Address	***Contains this Input***
+0, 1	Channel 1
+2, 3	Channel 2
+4, 5	Channel 3
+6, 7	Channel 4
For Module IC695ALG708 Only:	
+8, 9	Channel 5
+10, 11	Channel 6
+12, 13	Channel 7
+14, 15	Channel 8

Depending on its configured Channel Value Format, each enabled channel output reference location is read as a 32-bit floating point or 16-bit integer value.

In the 16-bit integer mode, low word of the 32-bit channel data area contains the 16-bit integer channel value. The high word (upper 16-bits) of the 32-bits is ignored. The full range of the 16-bit integer is a signed decimal value from +32767 to –32768.

Because the channel reference location is 32 bits, it is possible for the application program to write 32-bit signed decimal values to the output reference. However, the program logic must restrict the magnitude of the value to the range +32767 to –32768. Exceeding this range will result in misinterpretation of the sign bit, and incorrect output channel operation.

Channel Diagnostic Data

In addition to the input data from field devices, the module can be configured to report channel diagnostics status data to the CPU. The CPU stores this data at the module's configured *Diagnostic Reference Address*. Use of this feature is optional.

The diagnostics data each channel occupies 2 words (whether the channel is used or not):

Diagnostic Reference Address	***Contains Diagnostics Data for:***
+0, 1	Channel 1
+2, 3	Channel 2
+4, 5	Channel 3
+6, 7	Channel 4
For Module IC695ALG708 Only:	
+8, 9	Channel 5
+10, 11	Channel 6
+12, 13	Channel 7
+14, 15	Channel 8

When a diagnostic bit equals 1, the alarm or fault condition is present on the channel. When a bit equals 0 the alarm or fault condition is either not present or detection is not enabled in the configuration for that channel.

For each channel, the format of this data is:

Bit	***Description***
1	Low Alarm Exceeded = 1
2	High Alarm Exceeded = 1
3	Underrange = 1
4	Overrange = 1
5 – 20	Reserved (set to 0).
21	Lower Clamp Active = 1
22	Upper Clamp Active = 1
23 - 32	Reserved (set to 0).

Module Status Data

The module can also optionally be configured to return 4 bits of module status data to the CPU. The CPU stores this data in the module's 32-bit configured Module Status Data reference area.

Bit	***Description***
1	Module OK (1 = OK, 0 = failure, or module is not present)
2	Terminal Block Present (1 = Present, 0 = Not present)
3	Field Power (0 = Present, 1 = Not present)
4	Module Overtemperature (0 = Not overtemperature, 1 = Approaching or exceeding overtemperature)
5 - 32	Reserved

Terminal Block Detection

The module automatically checks for the presence of a Terminal Block.

The module's TB LED indicates the state of the terminal block. It is green when the Terminal Block is present or red if it is not.

Faults are automatically logged in the CPU's I/O Fault table when the terminal block is inserted or removed from a configured module in the system. The fault type is Field Fault and the fault description indicates whether the fault is a "Loss of terminal block" or an "Addition of terminal block". If a Terminal Block is not present while a configuration is being stored, a "Loss of terminal block" fault is logged.

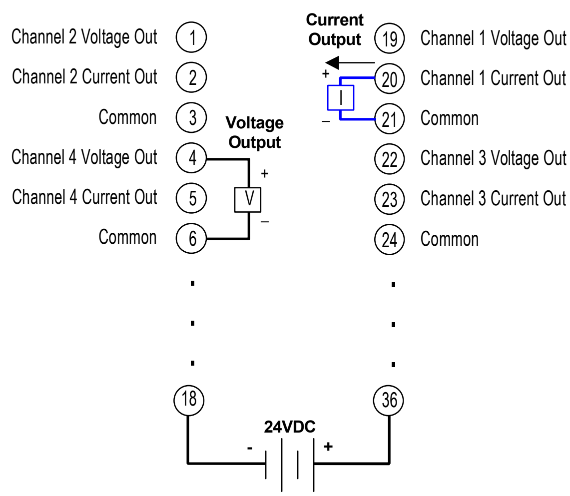
Bit 2 of the Module Status Reference indicates the status of the terminal block. To enable Module Status reporting, the Module Status Reference must be configured. During operation, the PLC must be in an I/O Enabled mode for the current Module Status to be scanned and updated in reference memory.

Field Wiring: IC695ALG704 and IC695ALG708

The table below lists wiring connections for the Non-Isolated Analog Output Modules. There are no shield terminals. For shielding, tie cable shields to the ground bar along the bottom of the backplane. M3 tapped holes are provide in the ground bar for this purpose.

Terminal	IC695ALG704	IC695ALG708	IC695ALG704	IC695ALG708	Terminal
1	Channel 2 Voltage Out		Channel 1 Voltage Out		19
2	Channel 2 Current Out		Channel 1 Current Out		20
3	Common (COM)		Common (COM)		21
4	Channel 4 Voltage Out		Channel 3 Voltage Out		22
5	Channel 4 Current Out		Channel 3 Current Out		23
6	Common (COM)		Common (COM)		24
7	No Connection	Channel 6 Voltage Out	No Connection	Channel 5 Voltage Out	25
8	No Connection	Channel 6 Current Out	No Connection	Channel 5 Current Out	26
9	Common (COM)		Common (COM)		27
10	No Connection	Channel 8 Voltage Out	No Connection	Channel 7 Voltage Out	28
11	No Connection	Channel 8 Current Out	No Connection	Channel 7 Current Out	29
12	Common (COM)		Common (COM)		30
13	Common (COM)		Common (COM)		31
14	Common (COM)		Common (COM)		32
15	Common (COM)		Common (COM)		33
16	Common (COM)		Common (COM)		34
17	Common (COM)		Common (COM)		35
18	Common (COM)		+24V In		36

Each channel can be individually-configured to operate as a voltage output or a current output, not both simultaneously. All the common terminals are connected together internally. so any common terminal can be used for the negative lead of the external power supply.



Chapter 11 Analog Modules with HART Communications

This chapter describes Non-isolated Analog modules that provide HART communications for PACSystems RX3i controllers.

- Overview of HART Communications for PACSystems RX3i
- Module Descriptions, specifications, configuration parameters, and wiring information for:
    - Analog Input Module, 16/ 8 Channel Voltage / Current, HART: IC695ALG626
    - Analog Input Module, 8/4 Channel Voltage / Current, HART: IC695ALG628
    - Analog Output Module, 8 Channel Voltage/Current with HART: IC695ALG728
- COMMREQs for HART Modules
- HART Function Blocks for the Application Program
- Converting HART Data to / from RX3i Format

Overview of HART Communications for PACSystems RX3i

HART® (highway addressable remote transducer) protocol is an open standard owned by the members of the HART Communication Foundation. HART combines simultaneous 4-20mA current loop operation with digital communications using the same signal. It imposes a frequency-shifted AC signal on the normal 4 to 20mA current loop signal. Both analog and digital communications signals utilize the same set of wires without signal disruptions. For more information about HART, refer to the HART Application Guide, published by the HART Communication Foundation (www.hartcomm.org).

For PACSystems RX3i, point-to-point HART communications are provided by the three analog modules described in this chapter. Each channel on modules IC695ALG626, ALG628, and ALG728 can utilize HART 5.0 protocol to communicate with HART field devices. The HART devices must be revision 5.0 or later; earlier HART versions use a different messaging format that is not supported by the RX3i analog HART modules.

To utilize HART communications, a channel must be configured for HART operation as described in this chapter, and for 4-20mA current range. During module operation, the 4-20mA channel signal communicates one process variable. Additional process variables, configuration data, and device data are transferred digitally using the HART protocol. The 4-20mA signal is not affected by the HART signal.

RX3i HART Module Operation

HART is a master-slave communications protocol. An RX3i analog module with HART communications act as the Primary Master for a single HART field device and a Secondary Master , which is usually an optional handheld device. RX3i analog HART modules do not support multi-drop communications consisting of multiple field devices on a channel, or Burst Mode transmissions. However, they do support the HART concept of multiple “slots” on a field device.

The HART module automatically issues HART commands to any HART device that is present and enabled in configuration. The response data from these commands is maintained within the HART module's internal memory and is optionally available for input scanning of HART Data, or for response to the Get Device Information COMMREQ (command 1). During start-up or after a device configuration changes (HART device "configuration changed" bit is set), the HART module executes HART commands 0, 3, 12, 13, 15, 16, 33, 48, and 50 (All Data). In addition, the module periodically re-issues command #3 and also command #33 if HART Slot Variables are enabled (Dynamic Data). The period with which the Dynamic Data commands are issued depends on the configuration for HART Pass-Thru Service Options and the number of HART devices enabled in a modem group. HART command #59 is issued each time a HART device initializes to set the number of preambles to 5.

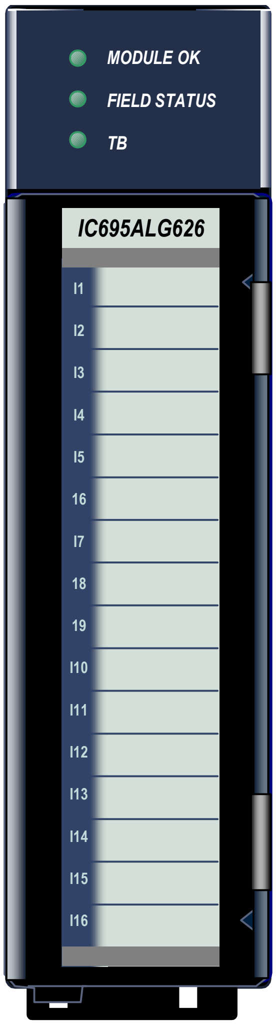
An RX3i HART module can be configured to make HART device data available for input scanning by using the HART Data Scan Control. With this option as part of normal input scanning from the module, the automatic HART command response data from each device is formatted and written to reference memory at the HART Data Reference Address. In addition to the disabled option, there are two other configuration options for the HART Data Scan Control. Dynamic Only periodically updates inputs with data from HART command #3 and provides the resulting PV, SV, TV, and FV variables to input reference memory. If HART Slot Variables are enabled, the command #33 slot variable values are also updated automatically. Dynamic Only data also includes the most current Communication and Device Status. The All Data option provides the same information as the Dynamic Only option, plus additional data from HART commands 0, 12, 13, 15, 16, 48, and 50.

In many applications, the Dynamic Only option should provide all of the needed HART variables. The variable data updates automatically in the HART module's input scan data (no COMMREQ trigger is needed). If the Dynamic Only data is not sufficient, additional HART data may be accessed automatically using the All Data option. Enabling either the Dynamic Only or All Data option affects the PLC I/O sweep time because of increased input scan data from the module. If neither scan option provides all the necessary inputs or if additional control of HART devices is needed, COMMREQs are available that provide additional functionality or replace the automatic input scanning. Two COMMREQs are available. The Get Device Information COMMREQ (Command 1) returns the same data for a HART device as the All Data scan option; however, this COMMREQ must be reissued in logic to get updates of the variable data. The HART Pass-Thru COMMREQ is capable of executing any HART command including manufacturer-specific commands; however, care must be used to correctly format HART command request and response data which must be byte packed and big-endian formatted. Instructions are given in this chapter.

Using DO I/O with HART Modules

The HART modules fully support the DOIO function block if only analog channel values and analog diagnostics are scanned. However, DOIO will not function under certain conditions when HART devices are enabled and the HART Data Scan Control is set to either All Data or Dynamic Only. Because of CPU limitations, only modules with input scan sizes of 256 bytes or less can use the DOIO function block. HART modules will function normally with DOIO unless the input scan size becomes greater than 256 bytes (this input size limitation may be increased or eliminated in future releases). When this input scan size is exceeded, any attempt to use DOIO for HART module inputs or outputs will fail, and the DOIO function will not pass power flow. The exact number of devices that can be enabled and DOIO continue to operate depends on the module. For ALG628 and ALG728, the number of devices that can be enabled with All Data selected is only 1, and the number of devices with Dynamic Only selected is 5. For ALG626, the number devices enabled with Dynamic Only selected is 3, and DOIO will not function at all for ALG626 if any HART devices are enabled with All Data selected.

Analog Input Module,16/ 8 Ch. Voltage / Current, HART: IC695ALG626
Analog Input Module, 8/4 Ch. Voltage / Current, HART: IC695ALG628



Non-Isolated Differential Analog Voltage/Current Input module IC695ALG628 provides 8 single-ended or 4 differential input channels. ***Non-Isolated Differential Analog Voltage/Current Input*** module IC695ALG626 provides 16 single-ended or 8 differential input channels. Both modules feature HART version 5.0 communications capability on each channel. Module IC695ALG626 has four internal HART modems. Module IC695ALG628 has two internal HART modems. In single-ended mode, four single-ended channels are multiplexed into each HART modem. In differential mode, two differential channels are multiplexed into each HART modem. Analog input channels can be configured for these ranges:

- Current: 0 to 20mA, 4 to 20mA, +/- 20mA
- Voltage: +/- 10V, 0 to 10V, +/- 5V, 0 to 5V, 1 to 5V.

Channels that will use HART communications must be configured for the 4-20mA range.

Module Features

- Completely software-configurable, no module jumpers to set
- Full autocalibration
- On-board error-checking
- Open-circuit detection for all voltage and 4-20mA inputs
- Configurable scaling and offsets per channel
- High alarm, low alarm, high-high alarm, low-low alarm detection and reporting selectable per channel
- Module fault reporting
- Supports diagnostic point fault contacts in the logic program
- Flash memory for future upgrades
- Positive and negative Rate of Change Alarms
- Autocalibration at startup
- Configurable interrupts for channel alarms and faults
- Terminal Block insertion or removal detection
- Version 5.0 HART communications

These modules must be located in an RX3i Universal Backplane. They require an RX3i CPU with firmware version 3.5 or later. Machine Edition Version 5.5 or later must be used for configuration. The modules can be used with a Box-style (IC694TBB032), Extended Box-style (IC694TBB132), Spring-style (IC694TBS032), or Extended Spring-style (IC694TBS132) Terminal Block. Extended terminal blocks provide the extra shroud depth needed for shielded wiring. Terminal Blocks are ordered separately.

Specifications: IC695ALG626 and IC695ALG628

Input Ranges	Current: 0 to 20mA, 4 to 20mA, +/- 20mA Voltage: +/- 10V, 0 to 10V, +/- 5V, 0 to 5V, 1 to 5V							
Backplane Power Requirements	ALG626 600 mA maximum @ 5.0V +5% / - 2.5%, 625 mA maximum @ 3.3V +5% / - 3%							
	ALG628: 450 mA maximum @ 5.0V +5% / - 2.5%, 625 mA maximum @ 3.3V +5% / - 3%							
Programmer	Machine Edition version 5.5 and later							
Power Dissipation within Module	IC695ALG626: 7.35 watts maximum IC695ALG628: 5.55 watts maximum							
Thermal Derating	Module IC695ALG628 has no thermal derating. Module IC695ALG626 has no thermal derating in voltage mode. Thermal derating for module IC695ALG626 in current mode is shown on the next page.							
Resolution	24 bit ADC converted to Floating Point or Integer							
Input Data Format	Configurable as floating point IEEE 32 bit or 16-bit integer in a 32-bit field							
Filter Options	8Hz, 12Hz, 16Hz, 40Hz, 200Hz, 500Hz							
Analog Module Scan Time (in milliseconds)	The module scan can consist of up to four acquisition cycles. Each cycle includes a specific set of channels, as described in the section "Channel Scanning". Total Scan Time depends on the number of acquisition cycles in the scan, the configured filter option, and whether the channels are analog or HART.							
Configured Filter	***Number of Acquisition Cycles in the Scan***							
	1		***2***		***3***		***4***	
	Analog	*HART*	*Analog*	*HART*	*Analog*	*HART*	*Analog*	*HART*
8 Hz filter	121	128	241	254	362	380	482	506
12 Hz filter	81	88	161	174	242	260	322	346
16 Hz filter	61	68	121	134	182	200	242	266
40 Hz filter	21	28	41	54	62	80	82	106
200 Hz filter	5	12	9	22	14	32	18	42
500 Hz filter *[with filtering and rate detection enabled]*	3	N/A	5 *[6]*	N/A	7 *[9]*	N/A	9 *[12]*	N/A

HART Data Scan Time (in seconds)	The HART data scan can consist of up to four acquisition cycles (similar but asynchronous to the analog scan time). Each cycle includes a specific set of channels: For ALG626 single ended: channels 1-4, 5-8, 9-12, 13-16 are separate channel groups. For ALG626 differential: channels 1-2, 3-4, 5-6, 7-8 are separate channel groups. For ALG628 single ended: channels 1-4, 5-8 are separate channel groups. For ALG628 differential: channels 1-2, 3-4 are separate channel groups. Note: If you have only 4 Hart Devices on an ALG626 module, to minimize update times it is best to connect them to channels 1, 5, 9, and 13 so you only have 1 Hart enabled channel per channel group. Total HART scan time depends on the number of acquisition cycles in the scan, number of retries, enabling/disabling of slot variables, and use of pass-thru commands. If slot variables are enabled, update times are doubled.	
	HART Devices in Group	**Each HART Data Channel Updates Every:**
	1	0.7 second (typical)
	2	1.9 seconds (typical)
	3	3.0 seconds (typical)
	4	4.0 seconds (typical)

Continued ….

Specifications: IC695ALG608 and IC695ALG616, continued

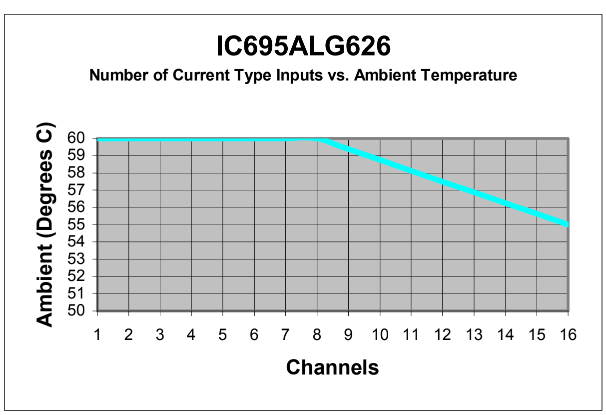
Input Impedance	>100 Kohm voltage inputs		
Current Input Resistance	249 ohms +/- 1%		
Open Circuit Detection time	1 second maximum		
Overvoltage	+/-60 VDC continuous, maximum		
Overcurrent	+/-28mA continuous, maximum		
Normal Mode Noise Rejection in dB		*At 50Hz*	*At 60Hz*
	8 Hz filter	103	97
	12 Hz filter	94	89
	16 Hz filter	39	65
	40 Hz filter	4	7
	200 Hz filter	0.1	0.2
	500 Hz	0.0	0.0
Common Mode Noise Rejection	120dB minimum @ 50/60 Hz with 8 Hz filter 110dB minimum @ 50/60 Hz with 12 Hz filter		
Channel-Channel DC Crosstalk	-80 dB minimum (single ended mode) -80 dB minimum (differential mode, grounded common) -60 dB minimum (differential mode, floating common)		
Calibrated Accuracy* @ 13°C – 33°C with 8 Hz, 12 Hz and 16 Hz filter	+/- 5V, + /- 10V, +/- 20 mA: 0.05% of range. 0 to 10V, 0 to 5V, 1 to 5V, 0 to 20 mA: 0.1% of range. 4 to 20 mA: 0.125% of range		
Calibrated Accuracy* @ 0°C – 60°C with 8 Hz, 12 Hz and 16 Hz filter	0 to 10V, 0 to 5V, 1 to 5V, 0.2% of range.0 to 20 mA: 0.25% of range. 4 to 20 mA: 0.3125% of range. +/- 5V, +/- 10V: 0.1% +/- 20 mA: 0.125% of range		
Calibration Interval	12 months typical to meet accuracy specifications over time. Offset can be applied as a periodic calibration adjustment.		
Isolation Voltage **terminal block to backplane/chassis**	Opto-isolated, transformer isolated 250 VAC continuous/1500 VAC for 1 minute		

* In the presence of severe RF interference (IC 801-3, 10V/M), accuracy may be degraded by +/- 1% of range.

Refer to Appendix A for product standards and general specifications.

Thermal Derating

For module IC695ALG626 in current mode, the number of inputs that can be on at the same time depends on the ambient temperature as shown below.



LEDs

The **Module OK** LED indicates module status. The **Field Status** LED indicates the presence of a fault on at least one channel or a terminal block error. The TB (Terminal Block) LED indicates the presence or absence of the terminal block. LEDs are powered from the backplane power bus.

LED	***Indicates***
Module OK	ON Green: Module OK and configured. Slow Flashing Green or Amber: Module OK but not configured. Quick Flashing Green: Error. OFF: Module is defective or no backplane power present
Field Status	ON Green No faults on any enabled channel, and Terminal Block is present. ON Yellow: Fault on at least one channel. OFF: Terminal block not present or not fully seated.
TB	ON Red: Terminal block not present or not fully seated. ON Green: Terminal block is present. OFF: No backplane power to module.

Configuration Parameters: IC695ALG626 and IC695ALG628

Module Parameters		
Parameter	***Default***	***Description***
Channel Value Reference Address	%AIxxxxx	Starting address for the module's input data. This defaults to the next available %AI block. The format of this data is shown on page 11-14.
Channel Value Reference Length	ALG628: 16 ALG626: 32	The number of words used for the module's input data. This parameter cannot be changed.
Diagnostic Reference Address	%Ixxxxx	Starting address for the channel diagnostics status data. The format of this data is shown on page 11-16.
Diagnostic Reference Length	0	The number of bit reference bits required for the Channel Diagnostics data. When set to 0, Channel Diagnostics is disabled. To enable Channel Diagnostics mapping, change this to a non-zero value.
Module Status Reference Address	%Ixxxxx	Starting address for the module's status data. The format of this data is shown on page 11-17.
Module Status Reference Length	0	The number of bits (0 to 32) required for the Module Status data. When set to 0, mapping of Module Status data is disabled. To enable Module Status data mapping, change this to a non-zero value.
HART Data Scan Control	No data	Selects whether the CPU will automatically scan from the HART module: no data, changed data only, or all data for each HART-enabled channel. See the below for details of memory usage. Dynamic Data Only: the first 18 words or 288 bits of HART data per input device. All Data: all of the HART data (88 words or 1408 bits for each HART input device.
HART Pass-thru Service Options	Once per two channel scans	Selects whether the module will automatically service a HART pass-through command i each 1, 2, or 4 channel scans or only upon change of the HART device configuration or if data hasn't been read for 10 seconds (Pass-Thru Only). If Pass-Thru Only is selected, scan data is not automatically available to the application program. However, it can be read using COMMREQ 1.
HART Status Reference Address		Starting address for the HART Status data. The format of this data is shown on page 11-41.
HART Status Reference Length		Length of the HART Status data; 4 words or 64 bits.

Continued ….

<table>
<tr><th colspan="4">Module Parameters, continued</th></tr>
<tr><th>Parameter</th><th>Default</th><th colspan="2">Description</th></tr>
<tr><td>HART Data Reference Address</td><td></td><td colspan="2">Starting address for the HART data for the module in %I, %Q, %AI, %AQ, %R, %W, %G, %M, or %T memory. Format of this data is shown on page 11-42.</td></tr>
<tr><td rowspan="5">HART Data Reference Length</td><td rowspan="5">0</td><td colspan="2">Length of the HART data. If Data Scan Control is set to no data, the length is 0. The length is automatically set according to the selection made for HART Data Scan Control</td></tr>
<tr><td>HART Data Scan Control</td><td>HART Data Reference Length</td></tr>
<tr><td>No Data</td><td>0</td></tr>
<tr><td>Dynamic Data Only</td><td>Highest HART-enabled Channel Number X (18 words or 288 bits)</td></tr>
<tr><td>All Data</td><td>Highest HART-enabled Channel Number X (88 words or 1408 bits)</td></tr>
<tr><td>I/O Scan Set</td><td>1</td><td colspan="2">The scan set 1 – 32 to be assigned to the module by the RX3i CPU</td></tr>
<tr><td>Inputs Default</td><td>Force Off</td><td colspan="2">In the event of module failure or removal, this parameter specifies the state of all Channel Value References for the module.
Force Off = Channel Values clear to 0.
Hold Last State = Channel Values hold their last state.</td></tr>
<tr><td>Inputs Default w/o Terminal Block</td><td>Enabled</td><td colspan="2">Enabled / Disabled: Controls whether inputs will be set to their defaults if the Terminal Block is removed.</td></tr>
<tr><td>Channel Faults w/o Terminal Block</td><td>Disabled</td><td colspan="2">Enabled / Disabled: Controls whether channel faults and configured alarm responses will be generated after a Terminal Block removal. The default setting of Disabled means channel faults and alarms are suppressed when the Terminal Block is removed. This parameter does not affect module faults including the Terminal Block loss/add fault generation.</td></tr>
<tr><td>Analog Input Mode</td><td>Single-ended Input Mode</td><td colspan="2">Single-ended / Differential: This selection must match the input wiring to the module.</td></tr>
<tr><td>A/D Filter Frequency</td><td>40Hz</td><td colspan="2">Low pass A/D hardware filter setting for all inputs on the module: 8, 12, 16, 40, 200, or 500Hz. Default is 40Hz. Frequencies below the filter setting are not filtered by hardware.</td></tr>
</table>

Continued …

<table>
<tr><td colspan="3">Channel Parameters</td></tr>
<tr><td>Parameter</td><td>Default</td><td>Description</td></tr>
<tr><td>Range Type</td><td>Disabled</td><td>Voltage/Current, Disabled</td></tr>
<tr><td>Range (Not for Range Type Disabled)</td><td>-10V to +10V</td><td>For voltage/current: -10V to +10V, 0V to +10V, 0 V to +5V, 1V to +5V, -5V to +5V, -20mA to +20mA, 4 to 20 mA, 0 to 20 mA</td></tr>
<tr><td>Channel Value Format</td><td>32-bit Floating Point</td><td>16-bit integer or 32-bit floating point</td></tr>
<tr><td>High Scale Value (Eng Units)</td><td rowspan="4">The defaults for the 4 Scaling parameters depend on the configured Range Type and Range. Each Range and Range Type have a different set of defaults.</td><td>Note: Scaling is disabled if both High Scale Eng. Units equals High Scale A/D Units and Low Scale Eng. Units equals Low Scale A/D Units.
Default is High A/D Limit of selected range type.</td></tr>
<tr><td>Low Scale Value (Eng Units)</td><td>Default is Low A/D Limit of selected range type. Must be lower than the high scaling value.</td></tr>
<tr><td>High Scale Value (A/D Units)</td><td>Default is High A/D Limit of selected range type. Must be greater than the low scaling value.</td></tr>
<tr><td>Low Scale Value (A/D Units)</td><td>Default is Low A/D Limit of selected range type.</td></tr>
</table>

Continued ….

Input Scaling

By default, the module converts a voltage or current input over the entire span of its configured Range into a floating point value for the CPU. For example, if the Range of a channel is 4 to 20mA, the module reports channel input values from 4.000 to 20.000. By modifying one or more of the four channel scaling parameters (Low/High Scale Value parameters) from their defaults, the scaled Engineering Unit range can be changed for a specific application. Scaling can provide inputs to the PLC that are already converted to their physical meaning, or convert input values into a range that is easier for the application to interpret. Scaling is always linear and inverse scaling is possible. All alarm values apply to the scaled Engineering Units value, not to the A/D input value.

The scaling parameters only set up the linear relationship between two sets of corresponding values. They do not have to be the limits of the input.

Example 1

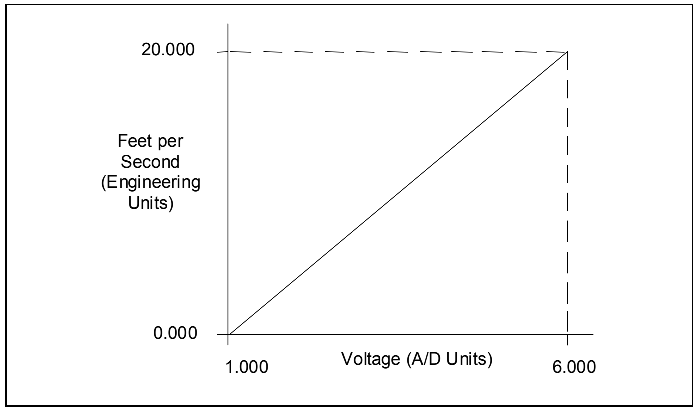
For a voltage input, 6.0 volts equals a speed of 20 feet per second, and 1.0 volt equals 0 feet per second. The relationship in this range is linear. For this example, the input values should represent speed rather than volts. The following channel configuration sets up this scaling:

High Scale Value (Eng Units) = 20.000

Low Scale Value (Eng Units) = 0.000

High Scale Value (A/D Units) = 6.000

Low Scale Value (A/D Units) = 1.000



For this example, 1.0V to 6.0V is the normal voltage range, but the module will attempt to scale the inputs for a voltage that lies outside the range. If a voltage of 10.0V were input to the channel, the module would return a scaled channel value of 36.000. The application should use alarms or take other precautions for scaled inputs that are outside the acceptable range or invalid.

Example 2

An existing application uses traditional analog to digital (A/D) count integer values. With scaling and the optional 16-bit integer input option, a channel can be configured to report integer count values. In this example, the application should interpret +10V as 32000 counts and -10V as -32000 counts. The following channel configuration will scale a +/-10V input channel to +/- 32000 counts.

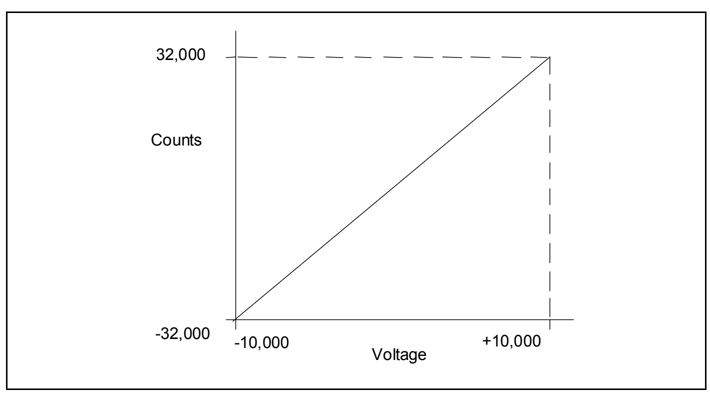
Channel Value Format = 16 Bit Integer

High Scale Value (Eng Units) = 32000.0

Low Scale Value (Eng Units) = -32000.0

High Scale Value (A/D Units) = 10.000

Low Scale Value (A/D Units) = -10.000



Channel Parameters continued		
Parameter	***Default***	***Description***
Positive Rate of Change Limit (Eng Units)	0.0	Rate of change in Engineering Units per Second that will trigger a Positive Rate of Change alarm. Default is disabled. Used with “Rate of Change Sampling Rate” parameter.
Negative Rate of Change Limit (Eng Units)	0.0	Rate of change in Engineering Units per Second that will trigger a Negative Rate of Change alarm. Default is disabled. Used with “Rate of Change Sampling Rate” parameter.
Rate of Change Sampling Rate	0.0	Time from 0 to 300 seconds to wait between comparisons. Default of 0.0 is to check after every input sample.

Continued ….

Rate of Change Alarms

These modules can detect both Negative Rate of Change and Positive Rate of Change in Engineering Units per Second. When either Rate of Change parameter is configured to be non-zero, the module takes the difference in Engineering Units between the previous rate of change sample and the current sample, then divides by the elapsed time between samples.

If the Engineering Units change from the previous sample to current sample is negative, the module compares the rate change with the Negative Rate of Change parameter.

If the Engineering Units change between samples is positive, the module compares the results in comparing the rate change with the Positive Rate of Change parameter value.

In either case, if the rate of change is greater than the configured rate, a rate of change alarm occurs. The actions taken by the module following the alarm depend on the enabled rate of change actions that have been set up in the "Diagnostic Reporting Enable", "Fault Reporting Enable", and "Interrupts Enabled" parameters.

The Rate of Change Sampling Rate parameter determines how frequently the module compares the Rate of Change. If the Rate of Change Sampling Rate is 0 or any time period less than the channel update rate, the module compares the Rate of Change for every input sample of the channel.

<table>
<tr><th colspan="3">Channel Parameters continued</th></tr>
<tr><th>Parameter</th><th>Default</th><th>Description</th></tr>
<tr><td>High-High Alarm (Eng Units)</td><td rowspan="8">The defaults for the High-High, High, Low, and Low-Low parameters depend on the configured Range Type and Range. Each Range and Range Type has a different set of default values.</td><td rowspan="8">Alarms and Deadbands
All of the alarm parameters are specified in Engineering Units. To use alarming, the A/D Alarm Mode must also be configured as enabled.
High-High Alarm and Low-Low Alarm: When the configured value is reached or passed, a Low-Low Alarm or High-High Alarm is triggered. The configured values must be lower than/higher than the corresponding low/high alarm limits.
High Alarm and Low Alarm: When the configured value is reached or below (above), a Low (High) Alarm is triggered.
High and Low Alarm Deadbands: A range in Engineering Units above the alarm condition (low deadband) or below the alarm condition (high deadband) where the alarm status bit can remain set even after the alarm condition goes away. For the alarm status to clear, the channel input must fall outside the deadband range.
Alarm Deadbands should not cause the alarm clear condition to be outside the Engineering Unit User Limits range. For example, if the engineering unit range for a channel is -1000.0 to +1000.0 and a High Alarm is set at +100.0, the High Alarm Deadband value range is 0.0 to less than 1100.0. A deadband of 1100.0 or more would put the High Alarm clear condition below –1000.0 units making the alarm impossible to clear within the limits.</td></tr>
<tr><td>High Alarm (Eng Units)</td></tr>
<tr><td>Low Alarm (Eng Units)</td></tr>
<tr><td>Low-Low Alarm (Eng Units)</td></tr>
<tr><td>High-High Alarm Deadband (Eng Units)</td></tr>
<tr><td>High Alarm Deadband (Eng Units)</td></tr>
<tr><td>Low Alarm Deadband (Eng Units)</td></tr>
<tr><td>Low-Low Alarm Deadband (Eng Units)</td></tr>
<tr><td>User Offset</td><td>0.0</td><td>Engineering Units offset to change the base of the input channel. This value is added to the scaled value on the channel prior to alarm checking.</td></tr>
<tr><td>Software Filtering</td><td>Disabled</td><td>Disabled / Enabled. Controls whether software filtering will be performed on the inputs.</td></tr>
<tr><td>Integration Time in milliseconds.</td><td>0</td><td>Specifies the amount of time in milliseconds for the software filter to reach 63.2% of the input value.
A value of 0 indicates software filter is disabled. A value of 100 indicates data will achieve 63.2% of its value in 100ms. Default is 0.</td></tr>
</table>

Continued ….

Using Alarming

The Diagnostic Reporting Enable, Fault Reporting Enable, and Interrupt Enable configuration parameters can be used to enable different types of responses for individual channel alarms. By default, all responses are disabled on every channel. Any combination of alarm enables can be configured for each channel.

- If Diagnostic Reporting is enabled, the module reports channel alarms in reference memory at the channel's Diagnostic Reference address.
- If Fault Reporting is enabled, the module logs a fault log in the I/O Fault table for each occurrence of a channel alarm.
- If Interrupts are enabled, an alarm can trigger execution of an Interrupt Block in the application program, as explained below.

Using Interrupts

To properly configure an I/O Interrupt, the Interrupt enable bit or bits must be set in the module's configuration. In addition, the program block that should be executed in response to the channel interrupt must be mapped to the corresponding channel's reference address.

Example:

In this example, the Channel Values Reference Address block is mapped to %AI0001-%AI0020. An I/O Interrupt block should be triggered if a High Alarm condition occurs on channel 2.

- Configure the High-Alarm condition.
- Set the High-Alarm Interrupt Enable flag for Channel 2 in the module configuration.

Channel 2's reference address corresponds to %AI00003 (2 Words per channel), so the interrupt program block Scheduling properties should be set for the "I/O Interrupt" Type and "%AI0003" as the Trigger.

Fault Reporting and Interrupts

These modules have separate enable/disable options for Diagnostic Reporting and Interrupts. Normally, disabling a diagnostic (such as Low/High Alarm or Over/Under range) in the configuration means that its diagnostic bit is never set. However, if interrupts are enabled for a condition and that interrupt occurs, the diagnostic bit for that condition is also set during the I/O Interrupt block logic execution. The next PLC input scan always clears this interrupt status bit back to 0, because Diagnostic Reporting has it disabled.

Channel Parameters continued		
Parameter	***Default***	***Description***
HART Communications	Disabled	Enabled/disabled. Set this to enabled if the channel will use HART communications. Enabling HART communications on a channel forces the channel to 4-20mA operation.
HART Slot Variables	Disabled	Enabled/disabled. If HART Slot Variables is enabled, the module will periodically send HART command #33 to request data. Channel variables will be read and placed in the HART scan block channel data. For each slot, the variable assignment code can be set between 0 and 255.
Slot Code 0, 1, 2, 3	1	The slot transmitter variable assignment code that will be used to retrieve data from the connected HART device. This is used with HART Pass-Thru command 33, byte 0. These values are used in the request data for HART command #33.

Input Module Data Formats

This section explains how the module uses separate reference areas that can be assigned during module configuration:

- *Channel Value Reference Data*, required memory for the analog input channel values.
- *Input Channel Diagnostic Reference Data*, optional memory for channel faults and alarms.
- *Module Status Reference Data,* optional memory for general module status data.

In addition, during configuration, optional *HART Reference Data,* memory can be assigned. See the section “HART Reference Data” later in this chapter for details.

Channel Value Reference Data

The module reports its input channel data in its configured *Channel Value Reference* input words, beginning at its assigned Channel Value Reference Address. Each channel value occupies 2 words, whether the channel is used or not:

Channel Value Reference Address	***Contains this Input***
+0, 1	Channel 1
+2, 3	Channel 2
+4, 5	Channel 3
+6, 7	Channel 4
+8, 9	Channel 5
+10, 11	Channel 6
+12, 13	Channel 7
+14, 15	Channel 8
For Module IC695ALG626 Only:	
+16, 17	Channel 9
+18, 19	Channel 10
+20, 21	Channel 11
+22, 23	Channel 12
+24, 25	Channel 13
+26, 27	Channel 14
+28, 29	Channel 15
+30, 31	Channel 16

Depending on its configured Channel Value Format, each enabled channel reports a 32-bit floating point or 16-bit integer value to the CPU.

In the 16-bit integer mode, the low word of the 32-bit channel data area contains the 16-bit integer channel value. The high word (upper 16-bits) of the 32-bit value are set with the sign extension of the 16-bit integer. This sign-extended upper word allows the 16-bit integer to be read as a 32-bit integer type in logic without losing the sign of the integer. If the 16-bit integer result is negative, the upper word in the 32-bit channel data has the value 0xFFFF. If the 16-bit integer result is positive, the upper word is 0x0000.

Resolution and Range Type

The actual resolution for each input depends on the channel's configured Range Type and A/D Filter Frequency. At higher Filter Frequencies, input resolution decreases. The approximate resolution in bits for each Filter Frequency and Range Type are shown in the table below.

Filter Frequency	***Range Type***		
	+ / - 10V	***0 to 10V, + / - 5V, + / - 20V***	***0 to 5V, 1 to 5V, 0 to 20mA, 4 to 20mA***
8 Hz	18	17	16
12 Hz	17	16	15
16 Hz	17	16	15
40 Hz	16	15	14
200 Hz	15	14	13
500 Hz	14	13	12

Channel Scanning

These modules use 4 A/D converters to achieve the fastest possible channel scan times. The module has up to four acquisition cycles for each module scan. The acquisition cycles and channels acquired during each cycle are:

Acquisition Cycle	***Channels Acquired***	
	IC695ALG628	***IC695ALG626***
1	1, 5	1, 5, 9, 13
2	2, 6	2, 6, 10, 14
3	3, 7	3, 7, 11, 15
4	4, 8	4, 8, 12, 16

To bypass an acquisition cycle, all channels that would be acquired during that cycle must be disabled.

For fastest scan times, always wire by acquisition cycle. For example, if only eight channels were used on the 16-channel module, IC695ALG626, channels 1, 2, 5, 6, 9, 10, 13, and 14 should be used for optimum performance.

Input Channel Diagnostic Reference Data

If the module is configured to use a *Diagnostic Reference Address*, it reports channel diagnostics status data to the CPU. The CPU stores this data at the module's configured *Diagnostic Reference Address*. Use of this feature is optional.

The diagnostics data for each channel occupies 2 words (whether the channel is used or not):

Diagnostic Reference Address	***Contains Diagnostics Data for:***
+0, 1	Channel 1
+2, 3	Channel 2
+4, 5	Channel 3
+6, 7	Channel 4
+8, 9	Channel 5
+10, 11	Channel 6
+12, 13	Channel 7
+14, 15	Channel 8
For Module IC695ALG626 Only:	
+16, 17	Channel 9
+18, 19	Channel 10
+20, 21	Channel 11
+22, 23	Channel 12
+24, 25	Channel 13
+26, 27	Channel 14
+28, 29	Channel 15
+30, 31	Channel 16

When a diagnostic bit equals 1, the alarm or fault condition is present on the channel. When a bit equals 0 the alarm or fault condition is either not present or detection is not enabled in the configuration for that channel. For each channel, the format of this data is:

Bit	***Description***
1	Low Alarm
2	High Alarm
3	Underrange
4	Overrange
5	Open Wire
6 – 16	Reserved (set to 0).
17	Low-Low Alarm
18	High-High Alarm
19	Negative Rate of Change Alarm
20	Positive Rate of Change Alarm
21 - 32	Reserved (set to 0).

Module Status Reference Data

The module can optionally be configured to return 2 bits of module status data to the CPU. The CPU stores this data in the module's 32-bit configured *Module Status Reference* area.

Bit	*Description*
1	Module OK (1 = OK, 0 = failure, or module is not present)
2	Terminal Block Present (1 = Present, 0 = Not present)
3 - 32	Reserved

During operation, the PLC must be in an I/O Enabled mode for the current Module Status to be scanned and updated in reference memory.

Terminal Block Detection

The module automatically checks for the presence of a Terminal Block. The module's TB LED indicates the state of the terminal block. It is green when the Terminal Block is present or red if it is not.

Faults are automatically logged in the CPU's I/O Fault table when the terminal block is inserted or removed from a configured module in the system. The fault type is Field Fault and the fault description indicates whether the fault is a "Loss of terminal block" or an "Addition of terminal block". If a Terminal Block is not present while a configuration is being stored, a "Loss of terminal block" fault is logged.

Bit 2 of the Module Status Reference indicates the status of the terminal block.

Field Wiring: IC695ALG626 and ALG628, Single-Ended Mode

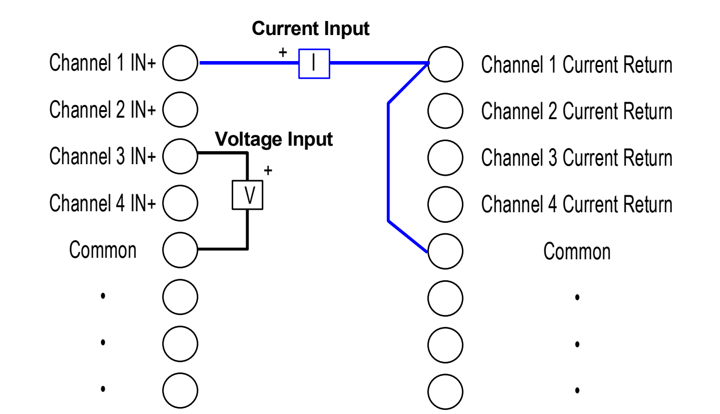
The table below lists wiring connections for Single-ended mode.

Terminal	ALG628	ALG628	ALG626	ALG628	Terminal
1	Channel 1 IN+		Channel 1 Current Return (IRTN1)		19
2	Channel 2 IN+		Channel 2 Current Return (IRTN2)		20
3	Channel 3 IN+		Channel 3 Current Return (IRTN3)		21
4	Channel 4 IN+		Channel 4 Current Return (IRTN4)		22
5	Common		Common		23
6	Channel 5 IN+		Channel 5 Current Return (IRTN5)		24
7	Channel 6 IN+		Channel 6 Current Return (IRTN6)		25
8	Channel 7 IN+		Channel 7 Current Return (IRTN7)		26
9	Channel 8 IN+		Channel 8 Current Return (IRTN8)		27
10	No Connection	Channel 9 IN+	No Connection	Channel 9 Current Return (IRTN9)	28
11	No Connection	Channel 10 IN+	No Connection	Channel 10 Current Return (IRTN10)	29
12	No Connection	Channel 11 IN+	No Connection	Channel 11 Current Return (IRTN11)	30
13	No Connection	Channel 12 IN+	No Connection	Channel 12 Current Return (IRTN12)	31
14	Common		Common		32
15	No Connection	Channel 13 IN+	No Connection	Channel 13 Current Return (IRTN13)	33
16	No Connection	Channel 14 IN+	No Connection	Channel 14 Current Return (IRTN14)	34
17	No Connection	Channel 15 IN+	No Connection	Channel 15 Current Return (IRTN15)	35
18	No Connection	Channel 16 IN+	No Connection	Channel 16 Current Return (IRTN16)	36

There are no shield terminals on these modules. For shielding, tie the cable shields to the ground bar along the bottom of the backplane. M3 tapped holes are provided for this purpose.

All the common terminals are connected together internally, so any common terminal can be used for the negative lead of the external power supply.

Single-Ended Mode



For single-ended mode, a voltage input should be connected between its Channel IN+ terminal and a Common (COM) return terminal.

A current input should be connected between its Channel IN+ terminal and its Channel Current Return Terminal. In addition, a jumper wire should be connected between the Channel Current Return terminal and a Common (COM) return.

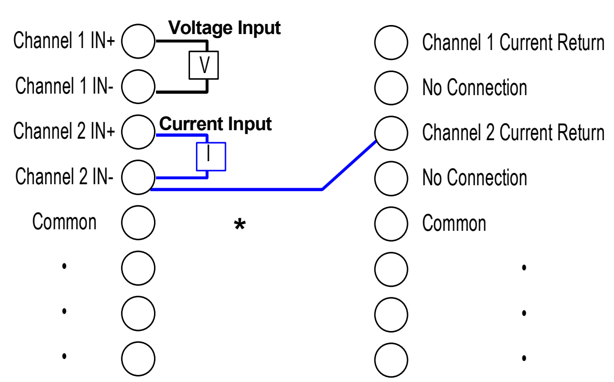
Field Wiring: IC695ALG626 and ALG628, Differential Mode

The table below lists wiring connections for modules configured for Differential mode.

Terminal	ALG628	ALG626	ALG628	ALG626	Terminal
1	Channel 1 IN+		Channel 1 Current Return (IRTN1)		19
2	Channel 1 IN -		No Connection		20
3	Channel 2 IN+		Channel 2 Current Return (IRTN3)		21
4	Channel 2 IN -		No Connection		22
5	Common		Common		23
6	Channel 3 IN+		Channel 3 Current Return (IRTN5)		24
7	Channel 3 IN-		No Connection		25
8	Channel 4 IN+		Channel 4 Current Return (IRTN7)		26
9	Channel 4 IN-		No Connection		27
10	No Connection	Channel 5 IN+	No Connection	Channel 5 Current Return (IRTN9)	28
11	No Connection	Channel 5 IN-	No Connection		29
12	No Connection	Channel 6 IN+	No Connection	Channel 6 Current Return (IRTN11)	30
13	No Connection	Channel 6 IN-	No Connection		31
14	Common		Common		32
15	No Connection	Channel 7 IN+	No Connection	Channel 7 Current Return (IRTN13)	33
16	No Connection	Channel 7 IN-	No Connection		34
17	No Connection	Channel 8 IN+	No Connection	Channel 8 Current Return (IRTN15)	35
18	No Connection	Channel 8 IN-	No Connection		36

There are no shield terminals on these modules. For shielding, tie the cable shields to the ground bar along the bottom of the backplane. M3 tapped holes are provided for this purpose. All the common terminals are connected together internally, so any common terminal can be used for the negative lead of the external power supply.

Differential Input Mode Connections



* Keep this jumper as short as possible to minimize error due to the added resistance of the wire. This resistance should be 25mΩ or less.

For differential inputs, two adjacent terminals are connected as one channel. The lower-numbered terminal acts as the high side.

A voltage input is connected between the two adjacent Channel IN terminals as shown at left.

A current input is connected between the channel's Channel IN+ and Current Return terminals. In addition, a jumper wire must be connected between the Channel IN - terminal and the corresponding Channel Current Return terminal.

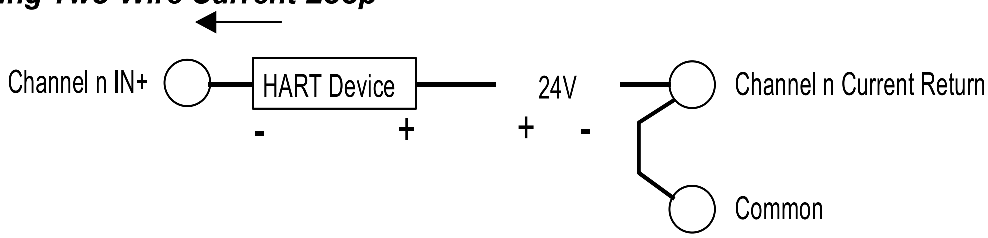
Tie the common to signal ground for improved channel-to-channel Crosstalk immunity.

Two door cards are provided with the module: one shows connections for single-ended mode and the other shows connections for differential mode. Insert the card that matches the wiring that will be used.

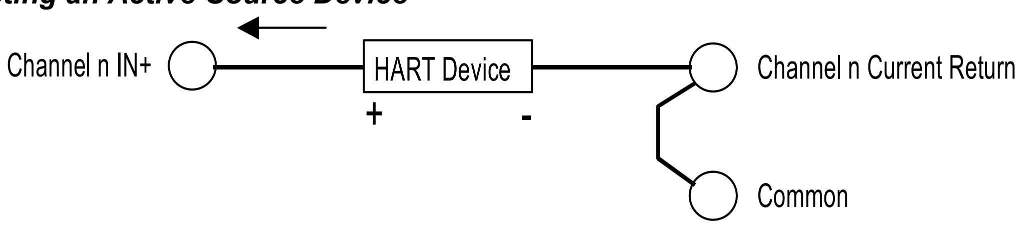
HART Device Connections

Example connections for 2-wire transmitters are shown below.

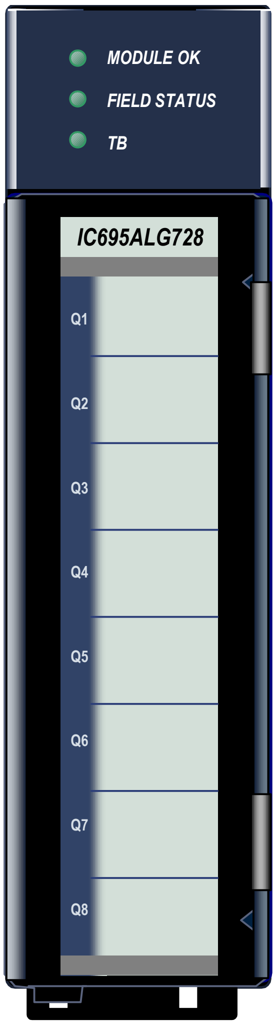
Connecting Two-Wire Current Loop



Connecting an Active-Source Device



Analog Output Module, 8 ChannelVoltage/Current with HART, IC695ALG728



Non-Isolated Analog Voltage/Current Output module IC695ALG728 provides 8 configurable voltage or current output channels with HART version 5.0 communications capability on each channel. The module has two internal HART modems. Four single-ended channels are multiplexed with each HART modem.

Analog channels can be configured for these output ranges:

- Current: 0 to 20mA, 4 to 20mA
- Voltage: +/- 10V, 0 to 10V

Channels that will use HART communications must be configured for the 4-20mA range.

Module Features

- Completely software-configurable, no module jumpers to set
- Individually enable or disable channels
- Clamping and Alarm Limits
- Latching of Alarms
- Configurable output bias
- Rapid channel acquisition times based on filter frequency
- Full autocalibration
- On-board error-checking
- Configurable scaling and offsets per channel
- High alarm, low alarm, high-high alarm, low-low alarm detection and reporting selectable per channel
- Module fault reporting
- Configurable Hold Last State or Output Defaults
- Version 5.0 HART communications

This module can be used with a Box-style (IC694TBB032), Extended Box-style (IC694TBB132), Spring-style (IC694TBS032), or Extended Spring-style (IC694TBS132) Terminal Block. Extended terminal blocks provide the extra shroud depth needed for shielded wiring. Terminal Blocks are ordered separately. The module must be located in an RX3i Universal Backplane. It requires an RX3i CPU with firmware version 3.5 or later. Machine Edition Version 5.0 SP3 Logic Developer-PLC or later must be used for configuration.

Isolated +24 VDC Power

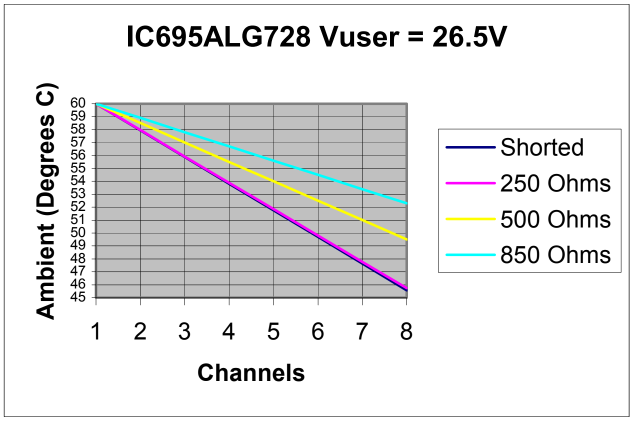
The module must receive its 24 VDC power from an external source. The external source must be connected directly to the module's terminal block. It cannot be connected via the TB1 connector on the RX3i Universal Backplane.

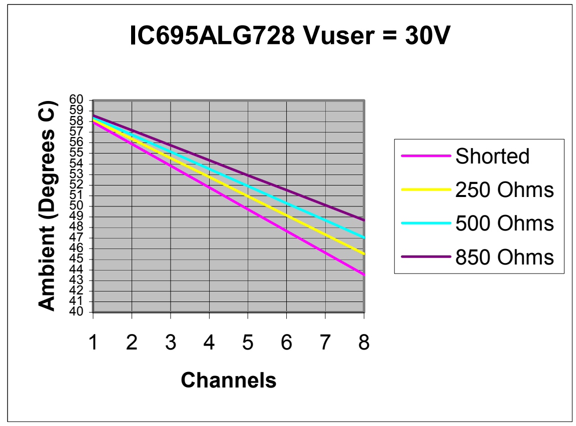
Specifications: IC695ALG728

Output Ranges	Current: 0 to 20mA, 4 to 20mA Voltage: +/- 10V, 0 to 10V
Backplane Power Requirements	380 mA maximum at 3.3V
Power Dissipation within Module (Vuser=24V)	7.25Watts maximum
Thermal Derating	TBD
External Power Supply V_{user}	Voltage Range: +19.2V to +30VDC Current required: 250mA maximum
Resolution	+/-10V: 15.9 bits, 0 to 10V: 14.9 bits, 0 to 20mA: 15.9 bits, 4 to 20mA : 15.6 bits
HART Communications	Version 5.0 HART protocol
Output Data Format	Configurable as floating point IEEE 32 bit or 16-bit integer in a 32-bit field
Analog Update Rate (Determined by I/O scan time, application dependent.)	16mS with HART (approximate, all eight channels) 8mS without HART (approximate, all eight channels)
HART Data Scan Time (in seconds) The HART data scan can consist of up to two acquisition cycles (similar but asynchronous to the analog scan time).. Each cycle includes a specific set of channels. For ALG728: 1-4, 5-8 are separate channel groups. Total HART scan time depends on the number of acquisition cycles in the scan, number of retries, enabling/disabling of slot variables, , and use of pass-thru commands. If slot variables are enabled, update times are doubled.	
1 HART device In group	Each HART Data channel updates every 0.7 second (typical)
2 HART devices in group	Each HART Data channel updates every 1.9 seconds (typical)
Output Overvoltage Protection	Current outputs only: -30V for 60 seconds, +30V for one hour
Calibrated Accuracy	Accurate to within 0.15% of full scale at 25°C Accurate to within 0.30% of full scale at 60°C In the presence of severe RF interference (IC 801-3, 10V/M), accuracy may be degraded to +/-1% FS.
Output Load Reactance	Current: 10μH maximum, Voltage: 1μF maximum
Maximum Output Load	Current: 850 Ohms maximum at V_{user} = 20V Voltage: 2 Kohms minimum
Output Gain Drift	Voltage output: 20ppm per degree C typical Current output: 35ppm per degree C typical
Output Settling Time	Voltage Output: 2ms, 0 to 95% Current output with HART: 70mS, 0 to 95% Current output without HART: 23ms, 0 to 95%
Isolation, Field to Backplane	2550VDC for one second
Maximum Compliance Voltage	V_{user} – 3V (minimum) to V_{user} (maximum)

Refer to Appendix A for product standards and general specifications.

Output Points vs. Temperature, Current Mode





LEDs

The **Module OK** LED indicates module status. The **Field Status** LED indicates whether the external +24 VDC power supply is present and is above the minimum level and whether or not faults are present. All LEDs are powered from the backplane power bus.

LED	***Indicates***
Module OK	ON Green: Module OK and configured. Quick Flashing Green: Module performing powerup sequence. Slow Flashing Green or Amber: Module OK but not configured. OFF: Module is defective or no backplane power present
Field Status	ON Green No faults on any enabled channel, Terminal Block is present, and field power is present. ON Amber and TB Green: Terminal Block is installed, fault on at least one channel, or field power is not present. ON Amber and TB Red: Terminal Block not fully removed, field power still detected. OFF and TB Red: Terminal block not present and no field power is detected.
TB	ON Red: Terminal block not present or not fully seated. See above. ON Green: Terminal block is present. See above. OFF: No backplane power to module.

Configuration Parameters: IC695ALG728

Module Parameters		
Parameter	***Default***	***Description***
Outputs Reference Address	%AQxxxxx	Starting address for the module's output data. This defaults to the next available %AQ block. The format of this data is shown on page 11-33.
Outputs Reference Length	ALG728: 16	The number of words used for the module's output data. This parameter cannot be changed.
Output Command Feedback Reference Address	%AIxxxxx	Stating address for the module's command feedback data. This defaults to the next available %AI address after a non-zero length is configured.
Output Command Feedback Length	0	The number of words used for the module's command feedback data. Length defaults to 0. It can be set to 8 or 16, depending on the module type being configured.
Diagnostic Reference Address	%Ixxxxx	Starting address for the channel diagnostics status data. This defaults to the next available %I block. The format of this data is shown on page 11-34.
Diagnostic Reference Length	0	Read Only. The number of bit reference bits required for the Channel Diagnostics data. Default is 0, which means mapping of Channel Diagnostics is disabled. Change this to a non-zero value to enable Channel Diagnostics mapping. Maximum length is 256 bits.
Module Status Reference Address	%Ixxxxx	Starting address for the module's status data. This defaults to the next available %I block. The format of this data is shown on page 11-35.
Module Status Reference Length	0	Read Only. The number of bits (0 or 32) required for the Module Status data. Default is 0, which means mapping of Module Status data is disabled. Change this to a non-zero value to enable Module Status data mapping.

Continued…

Analog Output Commanded Feedback

The module returns a copy of the analog output data received from CPU in its corresponding channel analog input shared memory. Output Feedback can be monitored to check the values being sent to the channels. The data is in the same scaled format as the output data for each channel. During normal operation this feedback data should match the actual output data after one or more PLC scans of module inputs. During faults, ramping, overrange, and clamping conditions, the analog output data may differ from the commanded output.

<table>
<tr><th colspan="4">Module Parameters</th></tr>
<tr><th>Parameter</th><th>Default</th><th colspan="2">Description</th></tr>
<tr><td>HART Data Scan Control</td><td>No data</td><td colspan="2">Selects whether the CPU will automatically scan from the HART module: no data, changed data only, or all data for each HART-enabled channel. See the below for details of memory usage.
Dynamic Data Only: the first 18 words or 288 bits of HART data per input device.
All Data: all of the HART data (88 words or 1408 bits for each HART input device.</td></tr>
<tr><td>HART Pass-thru Service Options</td><td>Once per two channel scans</td><td colspan="2">Selects whether the module will automatically service a HART pass-through command each 1, 2, or 4 channel scans or only upon change of HART device configuration or if data hasn’t been read for 10 seconds (Pass-Thru Only). If Pass-Thru Only is selected, scan data is not available to the application program.</td></tr>
<tr><td>HART Status Reference Address</td><td></td><td colspan="2">Starting address of the HART Status data. Format of this data is shown on page 11-41.</td></tr>
<tr><td>HART Status Reference Length</td><td></td><td colspan="2">Length of the HART Status data; 4 words or 64 bits.</td></tr>
<tr><td>HART Data Reference Address</td><td></td><td colspan="2">Starting address for the module’s HART data in %I, %Q, %AI, %AQ, %R, %W, %G, %M, or %T memory. Format of this data is shown on page 11-42.</td></tr>
<tr><td rowspan="5">HART Data Reference Length</td><td rowspan="5">0</td><td colspan="2">Length of the HART data. If Data Scan Control is set to no data, the length is 0. The length is automatically set according to the selection made for HART Data Scan Control:</td></tr>
<tr><td>HART Data Scan Control</td><td>HART Data Reference Length</td></tr>
<tr><td>No Data</td><td>0</td></tr>
<tr><td>Dynamic Data Only</td><td>Highest HART-enabled Channel Number X (18 words or 288 bits)</td></tr>
<tr><td>All Data</td><td>Highest HART-enabled Channel Number X (88 words or 1408 bits)</td></tr>
</table>

Continued…

Module Parameters		
Parameter	***Default***	***Description***
I/O Scan Set	1	The scan set 1 – 32 to be assigned to the module by the RX3i CPU.
Channel Faults w/o Terminal Block	Disabled	Enabled / Disabled: Controls whether channel faults and configured alarm responses will be generated after a Terminal Block removal. The default setting of Disabled means channel faults and alarms are suppressed when the Terminal Block is removed. This parameter does not affect module faults including the Terminal Block loss/add fault generation.
Module Fault Reporting Enabled	Enabled	Enabled / Disabled. Controls whether the module will report faults resulting from either loss of field power or overtemperature conditions.
Field Power Removed Enabled	Enabled	Enabled / Disabled. With Module Fault Reporting enabled, this parameter controls reporting of Field Power Removed module faults.
Over Temp Enabled	Enabled	Enabled / Disabled. With Module Fault Reporting enabled, this parameter controls reporting of Overtemperature module faults.
Module Interrupt Reporting Enabled	Disabled	Enabled / Disabled.
Field Power Removed Enabled	Disabled	Enabled / Disabled. With Module Interrupt Reporting enabled, this parameter controls interrupts for Field Power Removed module faults.
Over Temp Enabled	Disabled	Enabled / Disabled. With Module Interrupt Reporting enabled, this parameter controls interrupts for Overtemperature module faults.

Channel Parameters		
Parameter	***Default***	***Description***
Range Type	Disabled Current	Sets up the type of output to be used for each channel. Choices are: Disabled Voltage, Disabled Current, Voltage/Current. Channels used for HART communications must have Range Type set to Voltage/Current.
Range (Only for Range Type Voltage/Current)	-10V to +10V	For voltage/current: -10V to +10V, 0V to +10V, 4mA to 20 mA, 0mA to 20 mA. Channels used for HART communications must have Range set to 4mA to 20A.
Channel Value Format	32-bit Floating Point	16-bit integer or 32-bit floating point
Outputs Default	Force to Default Value	Controls the state the output will be set to in Outputs Disabled mode (stop), if a fault occurs, if power is lost, or if the configuration is cleared. Choices are Hold Last State, or default to a specific configured default value.

Continued …

OverTemperature

If OverTemperature is enabled, the module generates an OverTemperature alarm if the module’s internal temperature is too great for the number of outputs that are on at the same time. In addition to the configurable options for OverTemperature fault reporting and interrupts, an over temperature condition is also indicated by the OverTemperature bit in the module’s Status Reference data. Detection of the OverTemperature status bit is always enabled.

Range Type

Each channel on the module that will be used should be configured for Voltage/Current. Its voltage or current range and other parameters can then be configured as needed. If the channel output will not be used and is not wired, select either “Disabled” option. If a channel is disabled, it is not necessary to configure any of its other parameters.

If the channel is wired to a current output, but will not presently be used, select "Disabled Current". This will set the channel's current output to 0mA (the channel’s voltage output will be non-zero).

If the channel is wired to a voltage output, but will not presently be used, select "Disabled Voltage". This will set the channel's voltage output to 0V (the channel’s current output will be non-zero).

Output Defaults

If Hold Last State is enabled, an output will hold its last commanded value when the CPU indicates Outputs Not Enabled, or if one of the fault conditions listed below occurs. If Hold Last State is disabled, the output is commanded to go to the Default Value. The Default Value must be set within the selected output range. If both Default Value and Ramp Rate are enabled, the channel will ramp to the default value. Fault conditions are:

- CPU outputs are not enabled
- Backplane power is not ok. In that case, there is no ramping, even if ramping is enabled.
- Loss of communications from CPU.
- Loss of I/O communications.
- Loss of field power.

Outputs Default Notes

- Hot Removal of the module in an I/O Enabled mode will cause all outputs to Hold Last State (even channels configured for Force to Default Value). If that operation is not desirable, the outputs can be forced to default by first turning off field power and removing the module's Terminal Block before hot-removing the module.
- Resetting the module using SVC_REQ 24 causes all channels to Hold Last State even if Default Value is configured. The application program must handle output defaulting before execution of the Service Request.
- Default Ramp Rate configuration is ignored if backplane power from the power supply is lost. Channels configured for Default Value go to the default value immediately.
- The first time a configuration is stored following a return of backplane power, the Default Ramp rate is not used. Any channel configured for Default Value goes to its default value immediately. If analog power was not lost and the same configuration is restored on the next powerup, the channel state is unchanged from the time the power was lost. The Default Ramp Rate is used for any subsequent reconfiguration.

Output Default Conditions and Actions

Condition	***Hold Last State or Default Value***	***Default Ramp Rate Enabled***	***Outputs Enabled and Ramp Rate Enabled***	***Channel Output Setting*** (Except where indicated, field power is assumed to be present).
Outputs Enabled and No Faults	N/A	N/A	No	Output goes to its commanded value from reference memory; defaults don't apply.
	N/A	N/A	Yes	Output is ramped to the commanded output from reference memory at the Outputs Enabled ramp rate. Defaults don't apply.
Outputs Disabled, Fault Mode, or Reconfiguration	Default Value	No	N/A	Output is set to the Default Value
	Default Value	Yes	N/A	Output is ramped to the Default Value at the Default ramp rate, starting at the last commanded value before entering mode.
	Hold Last State	N/A	N/A	Output is held at the last commanded value
Loss of Backplane Power or First Configuration Store after Powerup	Default Value	N/A	N/A	Output is set to the Default Value.
	Hold Last State	N/A	N/A	Output is held at last commanded value.
Hot Removal, Reset with SVCREQ 24 or Cleared Configuration	N/A	N/A	N/A	Output is held at last commanded value.
Loss of Field Power	N/A	N/A	N/A	All outputs go to 0V and 0mA.

Channel Parameters, *continued*		
Parameter	***Default***	***Description***
High Scale Value (Eng Units)	The defaults for the 4 Scaling parameters depend on the configured Range Type and Range. Each Range and Range Type have a different set of defaults.	Note: Scaling is disabled if both High Scale Eng. Units equals High Scale A/D Units and Low Scale Eng. Units equals Low Scale A/D Units. Default = High A/D Limit of selected range type.
Low Scale Value (Eng Units)		Default is Low A/D Limit of selected range type. Must be lower than the high scaling value.
High Scale Value (A/D Units)		Default is High A/D Limit of selected range type. Must be greater than the low scaling value.
Low Scale Value (A/D Units)		Default is Low A/D Limit of selected range type.

Continued …

Output Scaling

By default, the module converts a floating point value from the CPU into a voltage or current output over the entire span of its configured Range. For example, if the Range of a channel is 4 to 20mA, the module accepts channel output values from 4.000 to 20.000. By modifying one or more of the four channel scaling parameters (Low/High Scale Value parameters) from their defaults, the scaled Engineering Unit range can be changed for a specific application. Scaling is always linear and inverse scaling is possible. All alarm values apply to the scaled Engineering Units value, not to the A/D units value.

The scaling parameters only set up the linear relationship between two sets of corresponding values. They do not have to be the limits of the output.

Example

In this example, the application should interpret 32000 counts as +10V and –32000 counts as -10V . The following channel configuration will scale a +/-10V output channel to +/-32000 counts.

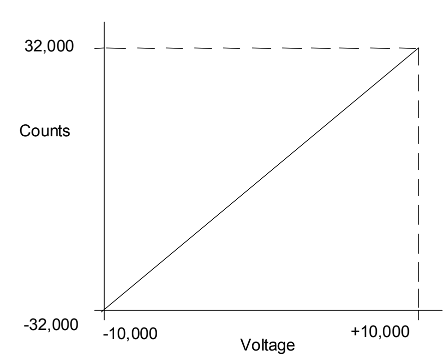
Channel Value Format = 16 Bit Integer

High Scale Value (Eng Units) = 32000.0

Low Scale Value (Eng Units) = -32000.0

High Scale Value (A/D Units) = 10.000

Low Scale Value (A/D Units) = -10.000



Channel Parameters, continued		
Parameter	***Default***	***Description***
High Alarm (Eng Units)	The defaults depend on the configured Range.	All of the alarm parameters are specified in Engineering Units. When the configured value is reached or below (above), a Low (High) Alarm is triggered.
Low Alarm (Eng Units)		
Outputs Enabled Ramp Rate (Eng Units)	0.0	The rate in Engineering Units at which the output will change during normal operation.
Default Ramp Rate (Eng Units)	0.0	The rate in Engineering Units at which the output will change if a fault condition occurs or if outputs are not enabled.
Output Clamping Enabled	Disabled	Enabled / Disabled. See description below.
Upper Clamp Limit (Eng Units)	The defaults depend on the configured Range.	The Upper Clamp Limit must be greater than the Lower Clamp Limit. This parameter can be used to restrict the output to a range that is narrower than its configured Range Type. For example, a channel configured for –10V to +10V could be restricted to -8V to +7.5V.
Lower Clamp Limit (Eng Units)		
Default Value (Eng Units)	0.0	If Hold Last State is disabled, the output is commanded to go to the Default Vale when the CPU is not in Outputs Enabled mode or under certain fault conditions.
User Offset (Eng Units)	0.0	A configurable value that can be used to change the base of the channel. This value is added to the scaled value of the channel before alarm-checking.

Continued …

Lower, Upper Clamp and Alarms

Alarms can be used to indicate when the module has been commanded to meet or exceed the configured high or low limits for each channel. These are set at six configurable alarm trigger points:

- High Alarm and Low Alarm
- Upper Clamp and Lower Clamp
- Overrange and Underrange Alarm

Each alarm is individually configurable per channel to generate diagnostics bit status, fault alarms, or interrupt alarms.

If a channel is commanded higher than the Upper Clamp value, the output is set to the Upper Clamp value and an Upper Clamp condition is indicated. If a channel is commanded lower than the Lower Clamp value, the output is set to the Lower Clamp value and a Lower Clamp condition is indicated.

The High and Low Alarm checks are performed on the engineering units output value after possibly being adjusted by ramping, clamping, and fault conditions.

Channel Parameters, *continued*		
Parameter	***Default***	***Description***
Diagnostic Reporting Enable *If Diagnostic Reporting is enabled, the additional parameters listed below can be used to enable specific types of alarms.*	Disabled	*Diagnostic Reporting Enable options* are used to enable reference memory reporting of alarms into the Diagnostic Reference area. *Fault Reporting Enable option*s enable fault logging of alarms into the I/O Fault Table. These parameters enable or disable the individual diagnostics features of a channel. When any of these parameters is enabled, the module uses associated parameters to perform the enabled feature. For example, if Over Range is enabled in the “Diagnostic Reporting Enable” menu, the module will set the Over Range bit in the Diagnostic Reference for the channel. If any of these parameters is disabled, the module does not react to the associated alarm conditions. *For example, if Low Alarm Enable is set to Disabled in the “Fault Reporting Enable” menu, the Low Alarm fault is not logged in the I/O Fault Table when Low Alarm is detected on the channel.*
Fault Reporting Enable *If Fault Reporting is enabled, the additional parameters listed below can be used to enable specific types of Faults.*	Disabled	
Interrupts Enable	Disabled	
Low Alarm Enable	Disabled	
High Alarm Enable	Disabled	
Under Range Enable	Disabled	
Over Range Enable	Disabled	
Lower Clamp Alarm Enable	Disabled	
Upper Clamp Alarm Enable	Disabled	

Alarming and Fault Reporting

The Diagnostic Reporting Enable, Fault Reporting Enable, and Interrupt Enable configuration parameters can be used to enable different types of responses for individual channel alarms. By default, all responses are disabled on every channel. Any combination of alarm enables can be configured for each channel.

- If Diagnostic Reporting is enabled, the module reports channel alarms in reference memory at the channel's Diagnostic Reference address.
- If Fault Reporting is enabled, the module logs a fault log in the I/O Fault table for each occurrence of a channel alarm.
- If Interrupts are enabled, an alarm can trigger execution of an Interrupt Block in the application program, as explained below.

Using Interrupts

To properly configure an I/O Interrupt, the Interrupt enable bit or bits must be set in the module's configuration. In addition, the program block that should be executed in response to the channel interrupt must be mapped to the corresponding channel's reference address.

Example:

In this example, the Channel Values Reference Address block is mapped to %AQ0001-%AQ0008. An I/O Interrupt block should be triggered if a High Alarm condition occurs on channel 2.

- Configure the High-Alarm condition.
- Set the High-Alarm Interrupt Enable flag for Channel 2 in the module configuration.

Channel 2's reference address corresponds to %AQ00003 (2 Words per channel), so the interrupt program block Scheduling properties should be set for the "I/O Interrupt" Type and "%AQ0003" as the Trigger.

Fault Reporting and Interrupts

These modules have separate enable/disable options for Diagnostic Reporting and Interrupts. Normally, disabling a diagnostic (such as Low/High Alarm or Over/Under range) in the configuration means that its diagnostic bit is never set. However, if interrupts are enabled for a condition and that interrupt occurs, the diagnostic bit for that condition is also set during the I/O Interrupt block logic execution. The next PLC input scan always clears this interrupt status bit back to 0, because Diagnostic Reporting has it disabled.

Channel Parameters continued		
Parameter	***Default***	***Description***
HART Communications	Disabled	Enabled/disabled. Set HART Communications to enabled if the channel will use HART communications. Enabling HART communications forces the channel to 4-20mA operation.
HART Slot Variables	Disabled	Enabled/disabled. If HART Slot Variables is enabled, the module will periodically send HART command #33 to request data. Channel variables will be read and placed in the HART scan block channel data. For each slot, the variable assignment code can be set between 0 and 255.
Slot Code 0, 1, 2, 3	1	The slot transmitter variable assignment code that will be used to retrieve data from the connected HART device. These values are used in the request data for HART command #33.

Output Module Data Formats

This section explains how the module uses separate reference areas that can be assigned during module configuration:

- *Output Value Reference Data*, required memory for the analog output channel values.
- *Output Channel Diagnostic Reference Data*, optional memory for channel faults and alarms.
- *Module Status Reference Data,* optional memory for general module status data.

In addition, during configuration, optional *HART Reference Data,* memory can be assigned. See the section "HART Reference Data" later in this chapter for details.

Output Value Reference Data

The module receives its channel data from its configured output words, beginning at its assigned *Outputs Reference Address*. Each channel occupies 2 words, whether the channel is used or not:

Outputs Reference Address	*Contains Data for:*
+0, 1	Channel 1
+2, 3	Channel 2
+4, 5	Channel 3
+6, 7	Channel 4
+8, 9	Channel 5
+10, 11	Channel 6
+12, 13	Channel 7
+14, 15	Channel 8

Depending on its configured Channel Value Format, each enabled channel output reference location is read as a 32-bit floating point or 16-bit integer value.

In the 16-bit integer mode, low word of the 32-bit channel data area contains the 16-bit integer channel value. The high word (upper 16-bits) of the 32-bits is ignored. The full range of the 16-bit integer is a signed decimal value from +32767 to –32768.

Because the channel reference location is 32 bits, it is possible for the application program to write 32-bit signed decimal values to the output reference. However, the program logic must restrict the magnitude of the value to the range +32767 to –32768. Exceeding this range will result in misinterpretation of the sign bit, and incorrect output channel operation.

Output Channel Diagnostic Reference Data

The module can optionally be configured to report channel diagnostics status data to the CPU. The CPU stores this data at the module's configured *Diagnostic Reference Address*. Use of this feature is optional.

The diagnostics data each channel occupies 2 words (whether the channel is used or not):

Diagnostic Reference Address	*Contains Diagnostics Data for:*
+0, 1	Channel 1
+2, 3	Channel 2
+4, 5	Channel 3
+6, 7	Channel 4
+8, 9	Channel 5
+10, 11	Channel 6
+12, 13	Channel 7
+14, 15	Channel 8

When a diagnostic bit equals 1, the alarm or fault condition is present on the channel. When a bit equals 0 the alarm or fault condition is either not present or detection is not enabled in the configuration for that channel.

For each channel, the format of this data is:

Bit	*Description*
1	Low Alarm Exceeded = 1
2	High Alarm Exceeded = 1
3	Underrange = 1
4	Overrange = 1
5 – 20	Reserved (set to 0).
21	Lower Clamp Active = 1
22	Upper Clamp Active = 1
23 - 32	Reserved (set to 0).

Module Status Reference Data

The module can also optionally be configured to return 4 bits of module status data to the CPU. The CPU stores this data in the module's 32-bit configured *Module Status Data reference* area.

Bit	***Description***
1	Module OK (1 = OK, 0 = failure, or module is not present)
2	Terminal Block Present (1 = Present, 0 = Not present)
3	Field Power (0 = Present, 1 = Not present)
4	Module Overtemperature (0 = Not overtemperature, 1 = Approaching or exceeding overtemperature)
5 - 32	Reserved

Terminal Block Detection

The module automatically checks for the presence of a Terminal Block. The module's TB LED indicates the state of the terminal block. It is green when the Terminal Block is present or red if it is not.

Faults are automatically logged in the CPU's I/O Fault table when the terminal block is inserted or removed from a configured module in the system. The fault type is Field Fault and the fault description indicates whether the fault is a "Loss of terminal block" or an "Addition of terminal block". If a Terminal Block is not present while a configuration is being stored, a "Loss of terminal block" fault is logged.

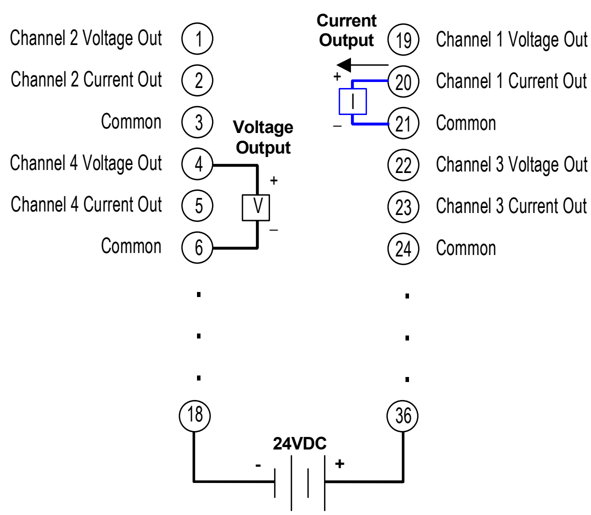
Bit 2 of the Module Status Reference indicates the status of the terminal block. To enable Module Status reporting, the Module Status Reference must be configured. During operation, the PLC must be in an I/O Enabled mode for the current Module Status to be scanned and updated in reference memory.

Field Wiring: IC695ALG728

The table below lists wiring connections for the module. There are no shield terminals. For shielding, tie cable shields to the ground bar along the bottom of the backplane. M3 tapped holes are provide in the ground bar for this purpose.

Terminal	Assignment	Assignment	Terminal
1	Channel 2 Voltage Out	Channel 1 Voltage Out	19
2	Channel 2 Current Out	Channel 1 Current Out	20
3	Common (COM)	Common (COM)	21
4	Channel 4 Voltage Out	Channel 3 Voltage Out	22
5	Channel 4 Current Out	Channel 3 Current Out	23
6	Common (COM)	Common (COM)	24
7	Channel 6 Voltage Out	Channel 5 Voltage Out	25
8	Channel 6 Current Out	Channel 5 Current Out	26
9	Common (COM)	Common (COM)	27
10	Channel 8 Voltage Out	Channel 7 Voltage Out	28
11	Channel 8 Current Out	Channel 7 Current Out	29
12	Common (COM)	Common (COM)	30
13	Common (COM)	Common (COM)	31
14	Common (COM)	Common (COM)	32
15	Common (COM)	Common (COM)	33
16	Common (COM)	Common (COM)	34
17	Common (COM)	Common (COM)	35
18	Common (COM)	+24V In	36

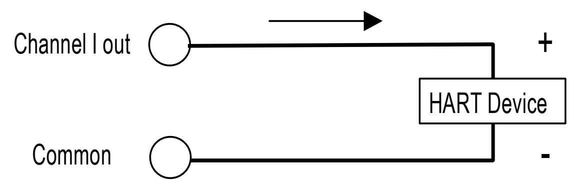
Each channel can be individually-configured to operate as a voltage output or a current output, not both simultaneously. All the common terminals are connected together internally. so any common terminal can be used for the negative lead of the external power supply.



HART Device ConnectionsError! Bookmark not defined.

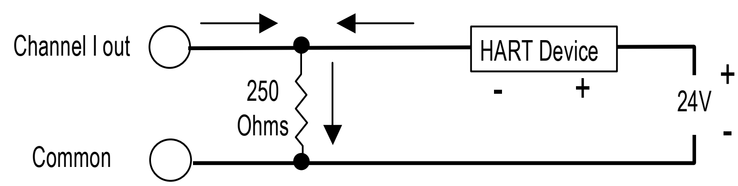
Example connections for 2-wire transmitters are shown below.

Connecting a HART Output Device



Connecting a HART Input Transmitter to an Output Channel

In this type of application, the HART output module, IC695ALG728, cannot read the analog current level from the HART device. However, the module can communicate with the HART signal. There is no analog input to the module.



HART Reference Data

If *HART Data Scan Control* is configured as “Dynamic Data Only” or “All Data”, the CPU automatically scans the HART data listed on the next page into the module’s configured *HART Data Reference Address*. The data length depends on whether All Data or Dynamic Data is selected.

This data includes response data associated with several HART Pass-Thru Commands. The module stores this data, and then passes it to the CPU either in the automatic HART data scan described above, or in response to function blocks in the application program.

Note that invalid or uninitialized REAL (floating point) data will be set to NaN (Not-A-Number).

HART Status Data

In addition to the HART Reference Data, the module reports the status of HART communications in its configured HART Status Reference Address. The length of this data is 4 words / 64 bits:

Word 1	Device Present, one bit per channel. Channel 1 in lowest bit. For 8-channel module, bits 9-16 are not used.
Word 2	Device Initializing, one bit per channel. Channel 1 in lowest bit. For 8-channel module, bits 9-16 are not used.
Words 3 and 4	Not used

HART Data Format

		Byte Offset		Field Description	Type
		Begin	**End**		
All HART Data	Dynamic HART Data Only	0x0000	0x0003	HART Primary Variable, CMD#3, Bytes 5-8	REAL
		0x0004	0x0007	HART Secondary Variable CMD#3, Bytes 10-13	REAL
		0x0008	0x000b	HART Tertiary Variable CMD#3, Bytes 15-18	REAL
		0x000c	0x000f	HART Fourth Variable CMD#3, Bytes 20-23	REAL
		0x0010	0x0013	Slot 0 value. CMD#33, Bytes 2-5	REAL
		0x0014	0x0017	Slot 1 value CMD#33, Bytes 8-11	REAL
		0x0018	0x001b	Slot 2 value CMD#33, Bytes 14-17	REAL
		0x001c	0x001f	Slot 3 value CMD#33, Bytes 20-23	REAL
		0x0020		HART communication status byte from the last HART command response. See page 11-48.	BYTE
		0x0021		HART device status byte from the last HART command response.	BYTE
		0x0022		Spare for alignment.	BYTE*2
		0x0024		HART device Manufacturer ID. CMD#0, Byte 1	BYTE
		0x0025		HART device type code. CMD#0, Byte 2	BYTE
		0x0026		Minimum number of preambles device requires. CMD#0, Byte 3	BYTE
		0x0027		HART Universal command code. CMD#0, Byte 4	BYTE
		0x0028		HART Transmitter specific revision. CMD#0, Byte 5	BYTE
		0x0029		HART device software revision number. CMD#0, Byte 6	BYTE
		0x002A		HART device hardware revision number. CMD#0, Byte 7	BYTE
		0x002B		HART flags. CMD#0, Byte 8	BYTE
		0x002C	0x002F	HART device ID number. CMD#0, Byte 9-11	BYTE*4
		0x0030	0x0037	8 character device tag. CMD#13, Bytes 0-5 in unpacked ASCII.	BYTE*8
		0x0038	0x0047	Device Descriptor. CMD#13, Bytes 6-17 in unpacked ASCII	BYTE*16
		0x0048		HART Primary Variable Units. CMD#3, Byte 4	BYTE
		0x0049		HART Secondary Variable Units. CMD#3, Byte 9, 0 if not present.	BYTE
		0x004a		HART Tertiary Variable Units. CMD#3, Byte 14, 0 if not present.	BYTE
		0x004b		HART Fourth Variable Units. CMD#3, Byte 19, 0 if not present.	BYTE
		0x004c		HART Primary Variable Code. CMD#50, Byte 0	BYTE
		0x004d		HART Secondary Variable Code. CMD#50, Byte 1	BYTE
		0x004e		HART Tertiary Variable Code. CMD#50, Byte 2	BYTE
		0x004f		HART Fourth Variable Code. CMD#50, Byte 3	BYTE
		0x0050		Units code for range parameter. CMD#15, Byte 2	BYTE
		0x0051	0x0053	Spare for alignment	BYTE*3
		0x0054	0x0057	Low transmitter range for analog signal in eng. units. CMD#15, Bytes 3-6	REAL
		0x0058	0x005b	High transmitter range for analog signal in eng. units. CMD#15, Bytes 7-10	REAL
		0x005c		Slot 0 units code. CMD#33, Byte 1	BYTE
		0x005d		Slot 1 units code. CMD#33, Byte 7	BYTE
		0x005e		Slot 2 units code. CMD#33, Byte 13	BYTE
		0x005f		Slot 3 units code. CMD#33, Byte 19	BYTE
		0x0060		Slot 0 variable code. CMD#33, Byte 0	BYTE
		0x0061		Slot 1 variable code. CMD#33, Byte 6	BYTE
		0x0062		Slot 2 variable code. CMD#33, Byte 12	BYTE
		0x0063		Slot 3 variable code. CMD#33, Byte 18	BYTE
		0x0064	0x0083	32 character message. CMD#12, Bytes 0-23 unpacked ASCII.	BYTE*32
		0x0084	0x0087	Stored date in the field device. CMD#13, Bytes 18-20.	BYTE*4
		0x0088	0x008b	The final assembly number is used for identifying the material and electronics that comprise the field device. CMD#16, Bytes 0-2	BYTE*4
		0x008c	0x00a4	The extended status returned by HART command 48.	BYTE*25
		0x00a5	0x00af	Spare	BYTE*11

COMMREQs for HART Modules

Two Communication Request (COMMREQ) functions can be used in the application program to communicate with RX3i HART modules.

COMMREQ 1, Get HART Device Information, reads

COMMREQ 2, Send HART Pass-Thru Command

Get HART Device Information, COMMREQ 1 Command Block

<table>
<tr><th>Word Offset</th><th>Value
Dec (Hex)</th><th colspan="3">Definition</th></tr>
<tr><td>Word 1</td><td>8 (0008)</td><td colspan="3">Length of command Data Block in words beginning at Word 7.</td></tr>
<tr><td>Word 2</td><td>0 (0000)</td><td colspan="3">Always 0 (no-wait mode request)</td></tr>
<tr><td rowspan="10">Word 3</td><td rowspan="10"></td><td colspan="3">Memory type of COMMREQ status word. (Words 3 and 4 specify the starting address where the status word will be written.) It can be:</td></tr>
<tr><th>Memory Type</th><th>Memory Type</th><th>Decimal code</th></tr>
<tr><td>%I</td><td>Discrete input table (Bitmode)</td><td>70</td></tr>
<tr><td>%Q</td><td>Discrete output table (Bit mode)</td><td>72</td></tr>
<tr><td>%I</td><td>Discrete input table (Byte mode)</td><td>16</td></tr>
<tr><td>%Q</td><td>Discrete output table (Byte mode)</td><td>18</td></tr>
<tr><td>%R</td><td>Register memory</td><td>8</td></tr>
<tr><td>%W</td><td>Word memory</td><td>196</td></tr>
<tr><td>%AI</td><td>Analog input table</td><td>10</td></tr>
<tr><td>%AQ</td><td>Analog output table</td><td>12</td></tr>
<tr><td>Word 4</td><td>0-based offset</td><td colspan="3">COMMREQ status word address minus 1.
Example: if Words 3 and 4 contain values of 8 and 9 respectively, the status word will be written to %R10.</td></tr>
<tr><td>Word 5, 6</td><td>0 (0000)</td><td colspan="3">Reserved</td></tr>
<tr><td>Word 7</td><td>1 (0001)</td><td colspan="3">Command code for the COMMREQ to be executed.
Get HART Device Information = 1.</td></tr>
<tr><td>Word 8</td><td>1 (0001)</td><td colspan="3">Number of Response Reference areas that follow (does not include COMMREQ status word). Always 1.</td></tr>
</table>

<table>
<tr><th>Word Offset</th><th>Value
Dec (Hex)</th><th colspan="3">Definition</th></tr>
<tr><td rowspan="10">Word 9</td><td rowspan="10"></td><td colspan="3">Memory type for the reply data. (Words 9—12 specify the starting address where the response will be written.)</td></tr>
<tr><td>Memory Type</td><td>Memory Type</td><td>Decimal code</td></tr>
<tr><td>%I</td><td>Discrete input table (Byte mode)</td><td>16</td></tr>
<tr><td>%Q</td><td>Discrete output table (Byte mode)</td><td>18</td></tr>
<tr><td>%W</td><td>Word memory</td><td>196</td></tr>
<tr><td>%R</td><td>Register memory</td><td>8</td></tr>
<tr><td>%AI</td><td>Analog input table</td><td>10</td></tr>
<tr><td>%AQ</td><td>Analog output table</td><td>12</td></tr>
<tr><td>%T</td><td>Discrete temporary memory (Byte)</td><td>20</td></tr>
<tr><td>%M</td><td>Discrete internal memory (Byte)</td><td>22</td></tr>
<tr><td>Word 10</td><td>0 (0000)</td><td colspan="3">Bit Offset (must be 0 for all requests).</td></tr>
<tr><td>Word 11</td><td>0-based offset (low word).</td><td colspan="3">Starting address to which the response will be written. The value entered is the 0-based offset from the beginning of PLC memory for the memory type specified in Word 9. This offset is in bytes or words depending on the memory type specified. Valid ranges of values depend on the PLC's memory ranges.
Example: If Words 9 and 11 contain values of 8 and 250 respectively, the response will be written to %R251.</td></tr>
<tr><td>Word 12</td><td>0-based offset (high word)</td><td colspan="3">High word of offset. Value = 0 for most memory types. High word is non-zero only on if %W memory is used.</td></tr>
<tr><td>Word 13</td><td>Words: 90 (005A)
Bytes: 180 (00B4)</td><td colspan="3">Maximum size of response area. Must be 90 if word memory type is used; 180 if discrete memory type is used.</td></tr>
<tr><td>Word 14</td><td>Range 1-16.</td><td colspan="3">Channel Number 1-16 (valid range depends on module channel count and single-ended versus differential mode)</td></tr>
</table>

COMMREQ Status Word

The COMMREQ status word for the Get HART Device Information command is shown below.

Value ***Dec (Hex)***	***Description***
0 (0000)	Device has not yet processed the COMMREQ.
1 (0001)	Command Complete **Note:** This status does not necessarily mean success. Some commands have reply data that must also be checked.
2 (0002)	Command Terminated – module busy
3 (0003)	Command Terminated – invalid command
4 (0004)	Command Terminated – invalid command data
5 (0005)	Command Terminated – not enough data
6 (0006)	Not used
7 (0007)	Command Terminated – not enough memory in reply area The command did not specify sufficient PLC memory for the reply. Command will be ignored.
8 (0008)	Command Terminated – command-specific error. See Additional Code in the Status Block for more information.
265 (0109)	Error, Hart device not connected
521 (0209)	Error, Channel not HART-enabled
777 (0309)	Error, Analog Output Module, No field power
1033 (0409)	Error. HART command now allowed
1289 (0509)	Error. Invalid HART command

Get HART Device Information, COMMREQ 1: Reply Data Format

The response to a Get HART Device Information COMMREQ is written to the PLC memory location specified in words 9-12 of the COMMREQ.

Byte	Name	Description
1, 2	Command Code	Echo of Command code. (0x0001)
3, 4	Channel Number	Echo of Channel Number
5-8	HART Primary Variable	CMD#3, Bytes 5-8. Type: REAL
9-12	HART Secondary Variable	CMD#3, Bytes 10-13 Type: REAL
13-16	HART Tertiary Variable	CMD#3, Bytes 15-18. Type: REAL
17-20	HART Fourth Variable	CMD#3, Bytes 20-23. Type: REAL
21-24	Slot 0 value	CMD#33, Bytes 2-5. Type: BYTE
25-28	Slot 1 value	CMD#33, Bytes 8-11. Type: BYTE
29-32	Slot 2 value	CMD#33, Bytes 14-17. Type: BYTE
33-36	Slot 3 value	CMD#33, Bytes 20-23. Type: BYTE
37	HART communication status byte from the last HART command response, see next page	
38	HART device status byte from the last HART command response, see next page.	
39-40	Spare for alignment.	Type: BYTE
41	HART device Manufacturer ID. CMD#0, Byte 1	Type: BYTE
42	HART device type code. CMD#0, Byte 2	Type: BYTE
43	Minimum number of preambles device requires	CMD#0, Byte 3. Type: BYTE
44	HART Universal command code	CMD#0, Byte 4. Type: BYTE
45	HART Transmitter specific revision	CMD#0, Byte 5 Type: BYTE
46	HART device software revision number	CMD#0, Byte 6 Type: BYTE
7	HART device hardware revision number	CMD#0, Byte 7 Type: BYTE
48	HART flags	CMD#0, Byte 8 Type: BYTE
49-52	HART device ID number	CMD#0, Byte 9-11 Type: 4 BYTEs
53-60	8 character device tag.	CMD#13, Type: 8 BYTEs. Bytes 0-5 are unpacked ASCII
61-76	Device Descriptor	CMD#13, TYPE: 16 BYTEs. Bytes 6-17 are unpacked ASCII
77	HART Primary Variable Units	CMD#3, Byte 4. Type: BYTE
78	HART Secondary Variable Units	CMD#3, Byte 9, 0 if not present. Type: BYTE
79	HART Tertiary Variable Units	CMD#3, Byte 14, 0 if not present. Type: BYTE
80	HART Fourth Variable Units	CMD#3, Byte 19, 0 if not present. Type: BYTE
81	HART Primary Variable Code	CMD#50, Byte 0 Type: BYTE
82	HART Secondary Variable Code	CMD#50, Byte 1 Type: BYTE
83	HART Tertiary Variable Code	CMD#50, Byte 2 Type: BYTE
84	HART Fourth Variable Code	CMD#50, Byte 3 Type: BYTE
85	Units code for range parameter	CMD#15, Byte 2 Type: BYTE
86-88	Spare for alignment	3 BYTEs
89-92	Low transmitter range for analog signal in engineering units	CMD#15, Bytes 3-6 Type: REAL
93-96	High transmitter range for analog signal in engineering units	CMD#15, Bytes 7-10 Type: REAL
97	Slot 0 units code	CMD#33, Byte 1 Type: REAL
98	Slot 1 units code	CMD#33, Byte 7 Type: REAL
99	Slot 2 units code	CMD#33, Byte 13 Type: REAL
100	Slot 3 units code	CMD#33, Byte 19 Type: REAL
101	Slot 0 variable code	CMD#33, Byte 0 Type: REAL
102	Slot 1 variable code	CMD#33, Byte 6 Type: REAL
103	Slot 2 variable code	CMD#33, Byte 12 Type: REAL
104	Slot 3 variable code	CMD#33, Byte 18 Type: REAL
105-136	32 character message	CMD#12, Bytes 0-23 unpacked ASCII. Type: 32 BYTEs
137-140	Stored date in the field device	CMD#13, Bytes 18-20. Type 4 BYTEs
141-144	Number identifying the field device’s material and electronics	CMD#16, Bytes 0-2. Type 4 BYTEs
145-169	The extended status returned by HART command 48.	Type: 25 BYTEs
170-180	Spare for alignment	Type: 11 BYTEs

Sending a HART Pass-Thru Command to a HART Device

The HART module automatically uses several HART Pass-thru commands as described earlier in this chapter, In addition, the application program can use the Send HART Pass-Thru Command (COMMREQ 2) to send HART Pass-Thru commands to an RX3i HART module. The HART module stores the data returned by the command in its on-board memory. This data can then be scanned automatically by the CPU or read as needed from the application program.

A list of Pass-Thru commands is included in this section. The RX3i HART module then passes the command to the intended HART input or output device. Responses to HART Pass-Thru commands are available to the application program in the COMMREQ replies.

The Send HART Pass-Thru Command COMMREQ automatically fills in the Start Character, Address, Byte Count, Status, and the checksum. The RX3i HART module waits until the data from the HART device is available before it replies to this command, so the application program does not have to query the module for the response. The application program must check the COMMREQ Status word to determine when the reply data is available. The reply is returned between 750mS and 8 seconds later. The reply time depends on the number of channels enabled, the pass thru rate selected, and whether other pass-thru operations are occurring at the same time.

Only one application program Pass-Thru command per channel is allowed at a time. If another request is made on a channel that has a Pass-Thru in-progress, the module returns a COMMREQ Status Word = 0x0002 (module busy).

HART Pass-Thru Command Block, COMMREQ 2

<table>
<tr><th rowspan="2">Word Offset</th><th colspan="2">Value</th><th rowspan="2" colspan="3">Definition</th></tr>
<tr><th>Dec</th><th>Hex</th></tr>
<tr><td>Word 1</td><td>10+x</td><td>000A + x</td><td colspan="3">Length of command Data Block in words beginning at Word 7</td></tr>
<tr><td>Word 2</td><td>0</td><td>0000</td><td colspan="3">Always 0 (no-wait mode request)</td></tr>
<tr><td rowspan="10">Word 3</td><td rowspan="10" colspan="2"></td><td colspan="3">Memory type of COMMREQ status word. It can be:</td></tr>
<tr><th>Memory Type</th><th>Memory Type</th><th>Decimal code</th></tr>
<tr><td>%I</td><td>Discrete input table (Bit mode)</td><td>70</td></tr>
<tr><td>%Q</td><td>Discrete output table (Btmode)</td><td>72</td></tr>
<tr><td>%I</td><td>Discrete input table (Byte mode)</td><td>16</td></tr>
<tr><td>%Q</td><td>Discrete output table (Byte mode)</td><td>18</td></tr>
<tr><td>%R</td><td>Register memory</td><td>8</td></tr>
<tr><td>%W</td><td>Word memory</td><td>196</td></tr>
<tr><td>%AI</td><td>Analog input table</td><td>10</td></tr>
<tr><td>%AQ</td><td>Analog output table</td><td>12</td></tr>
<tr><td>Word 4</td><td colspan="2">0-based offset</td><td colspan="3">COMMREQ status word address minus 1
Example: if Words 3 and 4 contain values of 8 and 9 respectively, the status word will be written to %R10.</td></tr>
<tr><td>Word 5</td><td>0</td><td>0000</td><td colspan="3">Reserved</td></tr>
<tr><td>Word 6</td><td>0</td><td>0000</td><td colspan="3">Reserved</td></tr>
<tr><td>Word 7</td><td>2</td><td>0002</td><td colspan="3">Command code for the COMMREQ to be executed.
HART Pass-Thru Command = 2</td></tr>
<tr><td>Word 8</td><td>1</td><td>0001</td><td colspan="3">Number of Response Reference areas that follow (does not include COMMREQ status word). Always 1</td></tr>
<tr><td rowspan="10">Word 9</td><td rowspan="10" colspan="2"></td><td colspan="3">Memory type for the reply data. (Words 9—12 specify the starting address where the response will be written).</td></tr>
<tr><th>Memory Type</th><th>Memory Type</th><th>Decimal code</th></tr>
<tr><td>%I</td><td>Discrete input table (Byte mode)</td><td>16</td></tr>
<tr><td>%Q</td><td>Discrete output table (Byte mode)</td><td>18</td></tr>
<tr><td>%W</td><td>Word memory</td><td>196</td></tr>
<tr><td>%R</td><td>Register memory</td><td>8</td></tr>
<tr><td>%AI</td><td>Analog input table</td><td>10</td></tr>
<tr><td>%AQ</td><td>Analog output table</td><td>12</td></tr>
<tr><td>%T</td><td>Discrete temporary memory (Byte)</td><td>20</td></tr>
<tr><td>%M</td><td>Discrete internal memory (Byte)</td><td>22</td></tr>
<tr><td>Word 10</td><td>0</td><td>0000</td><td colspan="3">Bit Offset (must be 0 for all requests)</td></tr>
<tr><td>Word 11</td><td colspan="2">0-based offset (low word)</td><td colspan="3">Starting address to which the response will be written. The value entered is the 0-based offset from the beginning of PLC memory for the memory type specified in Word 9. This offset will be in bytes or words depending on the memory type specified. Valid ranges of values depend on the PLC’s memory ranges.
Example: If Words 9 and 11 contain values of 8 and 250 respectively, the response will be written to %R251.</td></tr>
<tr><td>Word 12</td><td colspan="2">0-based offset (high word)</td><td colspan="3">High word of offset. Value = 0 for most memory types. Would only have a non-zero value if %W memory is used</td></tr>
<tr><td>Word 13</td><td colspan="2">Response data size</td><td colspan="3">Maximum size of response area. Size in bytes if discrete memory type used for response. Size in words if word type used</td></tr>
<tr><td>Word 14</td><td colspan="2">Channel Number (1-16).</td><td colspan="3">Channel Number 1-16 (valid range depends on module channel count and single-ended versus differential mode)</td></tr>
<tr><td>Word 15</td><td colspan="2">HART command (0x0 – 0xff)</td><td colspan="3">HART Pass-Thru Command type. HART Pass-Thru Commands that can be sent to an RX3i HART module are listed in this section.</td></tr>
</table>

Word 16	Command Data byte count	Size in bytes of command data that follows
…	…	…
Word 16+x	…	HART Command Data. Request data must be byte-packed and in big-endian format, PLC CPU format is little-endian, so some commands may require swapping of fields from little-endian to big-endian format as described in this chapter. This is usually needed for floating point data.

HART Pass-Thru Reply Data Format

The RX3i HART module returns the response data below to the CPU memory location specified by words 9-12 of the COMMREQ. Data beginning at Word 7 of the reply is byte-packed and in big-endian format. PLC CPU format is little-endian, so some commands may require swapping of fields from big-endian to little-endian format as described in this chapter. This is usually needed for floating point data.

Word	Name	Description
1	Command Code	Echo of Command code (0x0002)
2	Channel Number	Echo of Channel Number (same as request)
3	HART command	Echo of HART Pass-Thru Command type. See the tables in this section.
4	HART Status	Low byte is HART Comm Status and high byte is HART Dev Status from HART device response.
5	Spare	Spare for future use. User logic should not check this value because future module revisions may make this non-zero.
6	Response Byte Count (x)	Size in bytes of the response data that follows.
7L	Data Low	First response data byte from device.
7H	Data High	Second response data byte from device.
…	…	…
7+(x-1)/2 L	Data Low	….
7+(x-1)/2 H	Data High	Last response data byte from device.

COMMREQ Status Word

The following table defines the values that can be returned in the COMMREQ status word.

Value Dec (Hex)	*Description*
0 (0000)	Device has not yet processed the COMMREQ.
1 (0001)	Command Complete. This status does not necessarily mean success. Some commands have reply data that must also be checked.
2 (0002)	Command Terminated – module busy
3 (0003)	Command Terminated – invalid command
4 (0004)	Command Terminated – invalid command data
5 (0005)	Command Terminated – not enough data
6 (0006)	Not used
7 (0007)	Command Terminated – not enough memory in reply area. The command did not specify sufficient PLC memory for the reply. Command will be ignored.
8 (0008)	Command Terminated – command-specific error. See Additional Code in the Status Block for more information.
265 (0109)	Error, Hart device not connected
521 (0209)	Error, Channel not HART-enabled
777 (0309)	Error, Analog Output Module, No field power
1033 (0409)	Error. HART command now allowed
1289 (0509)	Error. Invalid HART command

This status information relates to the execution of the COMMREQ function, not to the status of the HART communications. HART communications status is provided in the response data, as shown previously in this section.

HART Pass-Thru Commands and Command Codes for RX3i Modules

Within a HART command, data can be represented as integers, floating point numbers, ASCII text strings, or enumerated item lists. Unmarked data types are 8-, 16, or 24-bit integers (including code values)

Universal Commands		Data in Command			Data in Reply		
#	Function	Byte	Data	Type	Byte	Data	Type
0	Read unique identifier		None		0	"254" (expansion)	
					1	Manufacturer identification code	
					2	Manufacturer device type code	
					3	Number of preambles required	
					4	Universal command revision	
					5	Device-specific command revision	
					6	Software revision	
					7	Hardware revision	Integer
					8	Device function flags: bit 0 = multisensor device, bit 1 = protocol bridge device	Bit
					9-11	Device ID number	
1	Read primary variable		None		0	PV units code	
					1-4	Primary variable (PV)	Floating pt
2	Read current and percent of range		None		0-3	Current (mA)	Floating pt
3	Read current and four predefined dynamic variables		None		0-3	Current (mA)	Floating pt
					4	PV units code	
					5-8	Primary variable (PV)	Floating pt
					9	SV units code	
					10-13	Secondary variable (SV)	Floating pt
					14	TV units code	
					15-18	Third variable (VT)	Floating pt
					19	FV units code	
					20-23	Fourth variable (FV)	Floating pt
6	Write polling address	0	Polling address		same as command		
11	Read unique identifier associated with tag	0-5	Tag	ASCII	0-11	Same as command #0, see above	
12	Read message		None		0-23	Message (32 characters)	ASCII
13	Read tag, descriptor, date		None		0-5	Tag (8 characters)	ASCII
					6-17	Descriptor (16 characters)	ASCII
					18-20	Date	date
14	Read Primary Variable sensor information		None		0-2	Sensor serial number	
					3	Units code for sensor limits and min. span	
					4-7	Upper sensor limit	Floating pt
					8-11	Lower sensor limit	Floating pt
					12-15	Minimum span	Floating pt
15	Read output information		None		0	Alarm select code	
					1	Transfer function code	
					2	PV/range units code	
					3-6	Upper range value	Floating pt
					7-10	Lower range value	Floating pt
					11-14	Damping value (seconds)	Floating pt
					15	Write-protect code	
					16	Private-label distributor code	
16	Read final assembly number		None		0-2	Final assembly number	
17	Write message	0-23	Message (32 characters)	ASCII	Same as command		
18	Write tag, descriptor, date	0-5	Tag (8 characters)	ASCII	Same as command		
		6-17	Descriptor (16 characters)	ASCII			
		18-20	Date	date			
19	Write final assembly number	0-2	Final assembly number		Same as command		

Among the common-practice commands listed below, commands #60 and #62 through #70 are used to configure and control the multiple outputs generated by some multivariable transmitters. Such multiple outputs are numbered 1 to 4, corresponding to the HART dynamic variables: PV (primary variable), SV (secondary variable), TV (third variable) and FV (fourth variable).

Common-Practice Commands		***Data in Command***			***Data in Reply***		
#	***Function***	***Byte***	***Data***	***Type***	***Byte***	***Data***	***Type***
33	Read transmitter variables	0	Transmitted variable code for slot 0		0	Transmitted variable code for slot 0	
		1	Transmitted variable code for slot 1		1	Units code for slot 0	
		2	Transmitted variable code for slot 2		2-5	Variable for slot 0	Floating pt
		3	Transmitted variable code for slot 3		6	Transmitted variable code for slot 1	
		Truncated after last requested code			7	Units code for slot 1	
					8-11	Variable for slot 1	Floating pt
					12	Transmitted variable code for slot 2	
					13	Units code for slot 2	
					14-17	Variable for slot 2	Floating pt
					18	Transmitted variable code for slot 3	
					19	Units code for slot 3	
					20-23	Variable for slot 3	Floating pt
					Truncated after last requested variable		
34	Write damping value	0-3	Damping value (seconds	Floating pt	Same as command		
35	Write range values	0	Range units code		Same as command		
		1-4	Upper range value	Floating pt			
		5-8	Lower range value	Floating pt			
36	Set upper range value (= push SPAN button)	None			none		
37	Set lower range value (= push ZERO button)	None			none		
38	Reset Configuration Changed flag	None			none		
39	EEPROM control	0	EEPROM control code: (0 = write to EEPROM 1 = read EEPROM to RAM)		Same as command		
40	Enter/exit fixed current mode	0-3	Current (mA) (0 = fixed current mode)	Floating pt	Same as command		
41	Perform device self-test	None			none		
42	Perform master reset	None			none		
43	Set (trim) PV zero	None			none		
44	Write PV units	0	PV units code		Same as command		
45	Trim DAC zero	0-3	Measured current (mA)	Floating pt	Same as command		
46	Trim DAC gain	0-3	Measured current (mA)	Floating pt	Same as command		
47	Write transfer function	0	Transfer function code		Same as command		
48	Read additional device status	none			0-5	Device-specific status	Bit
					6-7	Operational modes (1-5)	
					8-10	Analog outputs saturated*	Bit
					11-13	Analog outputs fixed*	Bit
					14-24	Device-specific status	Bit
					* 24 bites each: LSB…MS refers to analog outputs 1 to 24. Response is truncated after last byte implemented		
49	Write PV sensor serial number	0-2	Sensor serial number		Same as command		
50	Read dynamic variable assignments	None			0	PV transmitter variable code	
					1	SV transmitter variable code	
					2	TV transmitter variable code	
					3	FV transmitter variable code	

Common-Practice Commands		Data in Command			Data in Reply		
#	**Function**	**Byte**	**Data**	**Type**	**Byte**	**Data**	**Type**
51	Read dynamic variable assignments	0	PV transmitter variable code		Same as command		
		1	SV transmitter variable code				
		2	TV transmitter variable code				
		3	FV transmitter variable code				
52	Set transmitter variable zero	0	Transmitter variable code		Same as command		
53	Write transmitter variable units	0	transmitter variable code		Same as command		
		1	transmitter variable units code				
54	Read transmitter variable information	0	Transmitter variable code		0	Transmitter variable code	
					1-3	Transmitter variable sensor serial number	
					4	Transmitter variable limits units code	
					5-8	Transmitter variable upper limit	Floating pt
					9-12	Transmitter variable lower limit	Floating pt
					13-16	Transmitter variable damping value (sec.)	Floating pt
					17-20	Transmitter variable minimum span	Floating pt
55	Write transmitter variable damping value	0	transmitter variable code		Same as command		
		1-4	transmitter variable damping value (seconds)	Floating pt			
56	Write transmitter variable sensor serial number	0	transmitter variable code		Same as command		
		1-3	transmitter variable sensor serial number	Floating pt			
57	Read unit tag, descriptor, date	None			0-5	Unit tag (8 characters)	ASCII
					6-17	Unit descriptor (16 characters)	ASCII
					18-20	Unit date (3 bytes: day, month, year)	Date
58	Write unit tag, descriptor, date	0-5	Unit tag (8 characters)	ASCII	Same as command		
		6-17	Unit descriptor (16 characters)	ASCII			
		18-20	Unit date (3 bytes: day, month, year)	Date			
59	Write number of response preambles	0	Number of response preambles		Same as command		
60	Read analog output and percent of range	0	analog output number code		0	Analog output number code	
					1	Analog output units code	
					2-5	Analog output level	Floating pt
					6-9	Analog output percent of range	Floating pt
61	Read dynamic variables and Primary Variable analog output	None			0	PV analog output units code	
					1-4	PV analog output level	Floating pt
					5	PV units code	
					6-9	Primary variable (PV)	Floating pt
					10	SV analog output units code	
					11-14	Secondary variable	Floating pt
					15	TV analog output units code	
					16-19	Third variable	Floating pt
					20	FV analog output units code	
					21-24	Fourth variable	Floating pt
					Truncated after last supported variable		
62	Read analog outputs (5.1)	0	Analog output number code for slot 0		0	Slot 0 analog output number code	
		1	Analog output number code for slot 1		1	Slot 0 units code	
		2	Analog output number code for slot 2		2-5	Slot 0 level	Floating pt
		3	Analog output number code for slot 3		6	Slot 1 analog output number code	
		Truncated after last requested level			7	Slot 1 units code	
					8-11	Slot 1 level	Floating pt
					12	Slot 2 analog output number code	
					13	Slot 2 units code	
					14-17	Slot 2 level	Floating pt
					18	Slot 3 analog output number code	
					19	Slot 3 units code	
					20-23	Slot 3 level	Floating pt
					Truncated after last requested level		

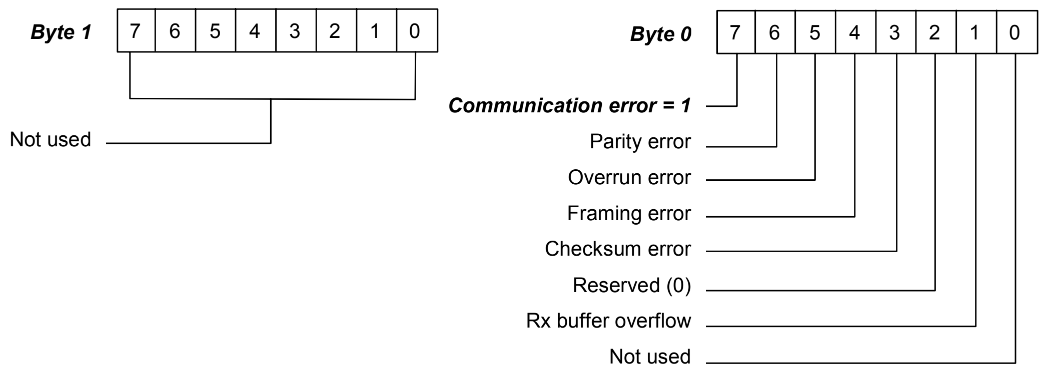
Common-Practice Commands		Data in Command			Data in Reply		
#	Function	Byte	Data	Type	Byte	Data	Type
63	Read analog output information	0	Analog output number code		0	Analog output number code	
					1	Analog output alarm select code	
					2	Analog output transfer function code	
					3	Analog output range units code	
					4-7	Analog output upper range value	Floating pt
					8-11	Analog output lower range value	Floating pt
					12-15	Analog output additional damping value (seconds)	Floating pt
64	Write analog output additional damping value	0	Analog output number code		Same as command		
		1-4	Analog output additional damping value	Floating pt			
65	Write analog output range values	0	Analog output number code		Same as command		
		1	Analog output units code				
		2-5	Analog output upper range value	Floating pt			
		6-9	Analog output lower range value	Floating pt			
66	Enter/exit fixed analog output mode	0	Analog output number code		Same as command		
		1	Analog output units code				
		2-5	Analog output level *	Floating pt			
		* "not a number" exits fixed output mode					
67	Trim analog output zero	0	Analog output number code		Same as command		
		1	Analog output units code				
		2-5	Externally-measured analog output level *	Floating pt			
68	Trim analog output gain	0	Analog output number code		Same as command		
		1	Analog output units code				
		2-5	Externally-measured analog output level *	Floating pt			
69	Write analog output transfer function	0	Analog output number code		Same as command		
		1	Analog output transfer function code				
70	Read analog output endpoint values	0	Analog output number code		0	Analog output number code	
					1	Analog output endpoint units code	
					2-5	Analog output upper endpoint value	Floating pt
					6-9	Analog output lower endpoint value	Floating pt
107	Write burst mode transmitter variable (for command 33)	0	Transmitter variable code for slot 0		Same as command		
		1	Transmitter variable code for slot 1				
		2	Transmitter variable code for slot 2				
		3	Transmitter variable code for slot 3				
108	Write burst mode command number	0	Burst mode command number		Same as command		
109	Burst mode control	0	Burst mode control code (0 = exit, 1 = enter)		Same as command		
110	Read all dynamic variables	none			0	Primary Variable units code	
					1-4	Primary Variable value	Floating pt
					5	Second Variable units code	
					6-9	Second Variable value	Floating pt
					10	Third Variable units code	
					11-14	Third Variable value	Floating pt
					15	Fourth Variable units code	
					16-19	Fourth Variable value	Floating pt

HART Communications Status

Each message from a field slave device includes two bytes of status information, which is also referred to as the "response code". The format of the HART communications status data is shown in this section.

Response Data with Command Response = 1

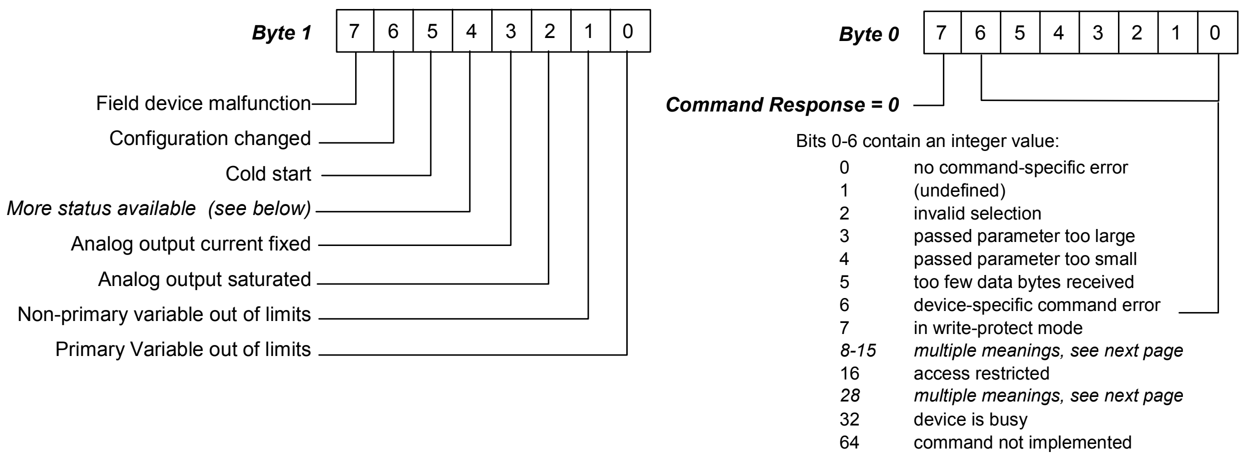
If the Most Significant Bit of the first byte is 1 (Communications Error), an error has occurred in the outgoing HART communication. The rest of the bits individually indicate one or more error conditions:



Error conditions include parity and overrun errors. In addition, a field device will report an overflow of its receive buffer, and any discrepancy between the message content and the received checksum.

Response Data with Command Response = 0

If the Most Significant Bit of the first byte is 0 (Command Response), the outgoing HART communications completed normally. The first byte then contains an integer value (the Command Response code) with the command status. The second byte contains the field device status, indicating the operational state of the slave device:



Field Device Status Codes

The Field Device Status codes in the second byte are explained below.

Field Device Status Code	*Meaning*
Field device malfunction	Measurements may not be correct.
Configuration changed	The configuration has been changed, so the master should check the configuration, and clear the bit by sending Command #38.
Cold start	Set for the first transaction when a field device is powered up.
More status available	The master should issue Command #48 to read more status information.
Analog output fixed	The output has been set to a fixed value for testing. This bit applies only to analog output #1. In a multidrop output device, command #48 may return similar status information for the other outputs.
Analog output saturated	Analog output #1 is out of range.
Primary variable out of limits	The primary measurement is outside the sensor operating limits. The analog signal and the digital signal read by HART commands may be incorrect.
Non-primary variable out of limits	A non-primary measurement is outside the sensor operating limits. The analog signal and the digital signal read by HART commands may be incorrect. Command #48 may provide more information.

Command Codes with Multiple Meanings

The interpretation of Command Codes 8-15 and 28 in the first Command Response byte depends on the command that was issued.

Code in First Byte	***For these Commands***	***Meaning of the Code***
8 (warning)	1, 2, 3, 33, 60, 62, 110	Update failure
	34, 55, 64	Set to nearest possible value
	48	Update in progress
9 (error)	35, 65	Lower range value too high
	36, 37, 43, 52	Applied process too high
	45, 46, 67, 68	Not in proper current mode (fixed at 4 or 20mA)
10 (error)	6	Multidrop not supported
	35, 65	Lower range value too low
	36, 37, 43, 52	Applied process too low
11 (error)	35, 65	Upper range value too high
	40, 45, 46, 66, 67, 68	In multidrop mode
	53	Invalid transmitter variable code
12 (error)	35, 65	Upper range value too high
	53, 66, 67, 68	Invalid units code
13 (error)	35, 65	Both range values out of limits
	69	Invalid transfer function code
14 (warning)	35, 36, 65	Span too small
	37	Pushed upper range value over limit
15 (error)	65, 66, 67, 68, 69	Invalid analog output number code
28 (error)	65	Invalid range units code

Function Blocks to Read HART Data

Proficy Machine Edition release 5.5 includes two custom HART function blocks for use in ladder logic application programs. These function blocks can be used to assign variable names to HART data inputs or on HART Get Device Information response data, beginning at word 3.

- DYN_HART_STRUCT interprets the first 36 bytes of the HART data map for a channel. This function block reads on demand the same data that would be automatically scanned if the module were configured for *HART Data Scan Control* set to “Dynamic Data”.
- ALL_HART_STRUCT interprets the entire HART data for a channel, including the data interpreted by the DYN_HART_STRUCT function block. This function block reads on demand the same data that would be automatically scanned if the module were configured for *HART Data Scan Control* set to “All Data”.

Instead of being read into an assigned CPU reference address, the data read by these Function Blocks is placed into a reference address that is defined by the Function Block.

The HART function blocks are located in the Toolchest under the folder "HART Utilities". To create an instance of one of these function blocks, drag and drop the desired function from the Toolchest folder into LD logic.

DYN_HART_STRUCT

The DYN_HART_STRUCT function block interprets the first 36 bytes on the data (offsets 0x0000 to 0x0023) of the HART data map for a channel. See the example in this section. Use of this function block is not required. It only provides a mechanism to assign variable names to the HART data,

When the DYN_HART_STRUCT function executes (receives power flow), each of the HART variables in reference memory is assigned to DYN_HART_STRUCT instance variables. The instance variable names closely match the names listed in the table, The instance variables can be used as input to other functions, or for debugging purposes. The entire instance can be added to a Data Watch window so that HART data is easily viewed.

The instance data variables are only updated when the function block receives power flow. An instance of the function block is needed for each HART channel on which automatic assignment is desired.

Parameter types:

IN - Type = WORD, Length = 18, Pass-by = Reference

Data Obtained with the DYN_HART_STRUCT Function Block

Byte Offset		***Field Description***	***Data Type***
Begin	***End***		
0x0000	0x0003	HART Primary Variable, CMD#3, Bytes 5-8	REAL
0x0004	0x0007	HART Secondary Variable CMD#3, Bytes 10-13	REAL
0x0008	0x000b	HART Tertiary Variable CMD#3, Bytes 15-18	REAL
0x000c	0x000f	HART Fourth Variable CMD#3, Bytes 20-23	REAL
0x0010	0x0013	Slot 0 value. CMD#33, Bytes 2-5	REAL
0x0014	0x0017	Slot 1 value CMD#33, Bytes 8-11	REAL
0x0018	0x001b	Slot 2 value CMD#33, Bytes 14-17	REAL
0x001c	0x001f	Slot 3 value CMD#33, Bytes 20-23	REAL
0x0020		HART communication status byte from the last HART command response. See page 11-48.	BYTE
0x0021		HART device status byte from the last HART command response. (Dynamic Data)	BYTE
0x0022		Spare for alignment. (Dynamic Data)	BYTE*2

ALL_HART_STRUCT

The ALL_HART_STRUCT function block interprets the entire HART data map for a channel. This is the same data obtained by the DYN_HART_STRUCT block, plus the additional data shown below.

Parameter types: IN - Type = WORD, Length = 88, Pass-by = Reference

Additional Data Obtained with the ALL_HART_STRUCT Function Block

Byte Offset		***Field Description***	***Data Type***
Begin	***End***		
0x0024		HART device Manufacturer ID. CMD#0, Byte 1	BYTE
0x0025		HART device type code. CMD#0, Byte 2	BYTE
0x0026		Minimum number of preambles device requires. CMD#0, Byte 3	BYTE
0x0027		HART Universal command code. CMD#0, Byte 4	BYTE
0x0028		HART Transmitter specific revision. CMD#0, Byte 5	BYTE
0x0029		HART device software revision number. CMD#0, Byte 6	BYTE
0x002A		HART device hardware revision number. CMD#0, Byte 7	BYTE
0x002B		HART flags. CMD#0, Byte 8	BYTE
0x002C	0x002F	HART device ID number. CMD#0, Byte 9-11	BYTE*4
0x0030	0x0037	8 character device tag. CMD#13, Bytes 0-5 in unpacked ASCII.	BYTE*8
0x0038	0x0047	Device Descriptor. CMD#13, Bytes 6-17 in unpacked ASCII	BYTE*16
0x0048		HART Primary Variable Units. CMD#3, Byte 4	BYTE
0x0049		HART Secondary Variable Units. CMD#3, Byte 9, 0 if not present.	BYTE
0x004a		HART Tertiary Variable Units. CMD#3, Byte 14, 0 if not present.	BYTE
0x004b		HART Fourth Variable Units. CMD#3, Byte 19, 0 if not present.	BYTE
0x004c		HART Primary Variable Code. CMD#50, Byte 0	BYTE
0x004d		HART Secondary Variable Code. CMD#50, Byte 1	BYTE
0x004e		HART Tertiary Variable Code. CMD#50, Byte 2	BYTE
0x004f		HART Fourth Variable Code. CMD#50, Byte 3	BYTE
0x0050		Units code for range parameter. CMD#15, Byte 2	BYTE
0x0051	0x0053	Spare for alignment	BYTE*3
0x0054	0x0057	Low transmitter range for analog signal in engineering units. CMD#15, Bytes 3-6	REAL
0x0058	0x005b	High transmitter range for analog signal in engineering units. CMD#15, Bytes 7-10	REAL
0x005c		Slot 0 units code. CMD#33, Byte 1	BYTE
0x005d		Slot 1 units code. CMD#33, Byte 7	BYTE
0x005e		Slot 2 units code. CMD#33, Byte 13	BYTE
0x005f		Slot 3 units code. CMD#33, Byte 19	BYTE
0x0060		Slot 0 variable code. CMD#33, Byte 0	BYTE
0x0061		Slot 1 variable code. CMD#33, Byte 6	BYTE
0x0062		Slot 2 variable code. CMD#33, Byte 12	BYTE
0x0063		Slot 3 variable code. CMD#33, Byte 18	BYTE
0x0064	0x0083	32 character message. CMD#12, Bytes 0-23 unpacked ASCII.	BYTE*32
0x0084	0x0087	Stored date in the field device. CMD#13, Bytes 18-20.	BYTE*4
0x0088	0x008b	The final assembly number is used for identifying the material and electronics that comprise the field device. CMD#16, Bytes 0-2	BYTE*4
0x008c	0x00a4	The extended status returned by HART command 48.	BYTE*25
0x00a5	0x00af	Spare	BYTE*11

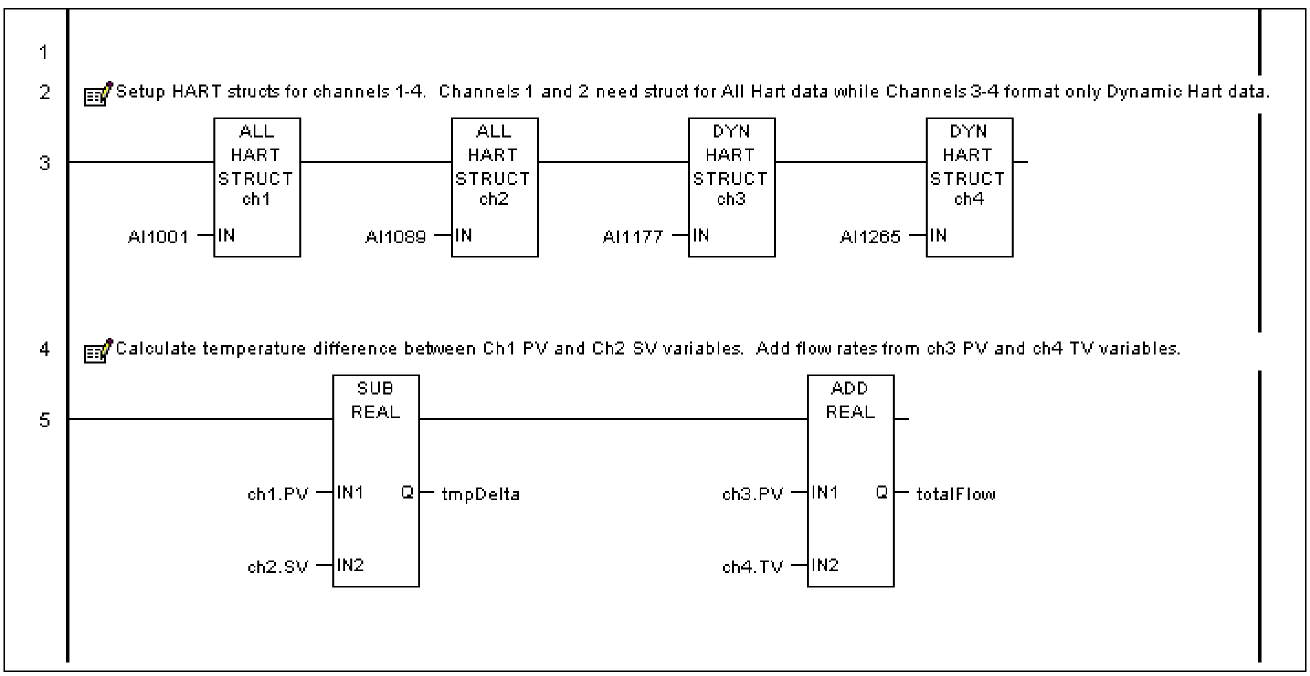
Example 1: ALL_HART_STRUCT and DYN_HART_STRUCT

This example uses the following HART module hardware configuration parameters:

- HART Data Scan Control is set to: All Data
- HART Data Reference Address is configured as: %AI1001

The example shows ALL_HART_STRUCT for channels 1 and 2 on a HART module, and DYN_HART_STRUCT for channels 3 and 4 on the same module. The math function blocks in the example show how the structure instance variables can be used on the HART data.

When using either ALL_HART_STRUCT or DYN_HART_STRUCT, the instance data should be made global. This is done by adding ",g" to the end of the instance name when it is created (for example, "ch1,g" creates a global instance named "ch1"). If the instance data is not global, the instance can only be used in the program block where the ALL_HART_STRUCT or DYN_HART_STRUCT function block is executed.



Converting HART Data to / from RX3i Format

When using HART Pass-Thru COMMREQ (command 2) only, HART data must be both byte-packed and in big-endian format as defined by the HART Specification. Because PACSystems CPUs use little-endian format, floating point values and ASCII data must be reformatted by the program logic.

Note that this conversion is not required when using COMMREQ 1 or for HART data that is automatically scanned.

Two function blocks in the Proficy Machine Edition release 5.5 toolchest can be used to pack/unpack HART ASCII data:

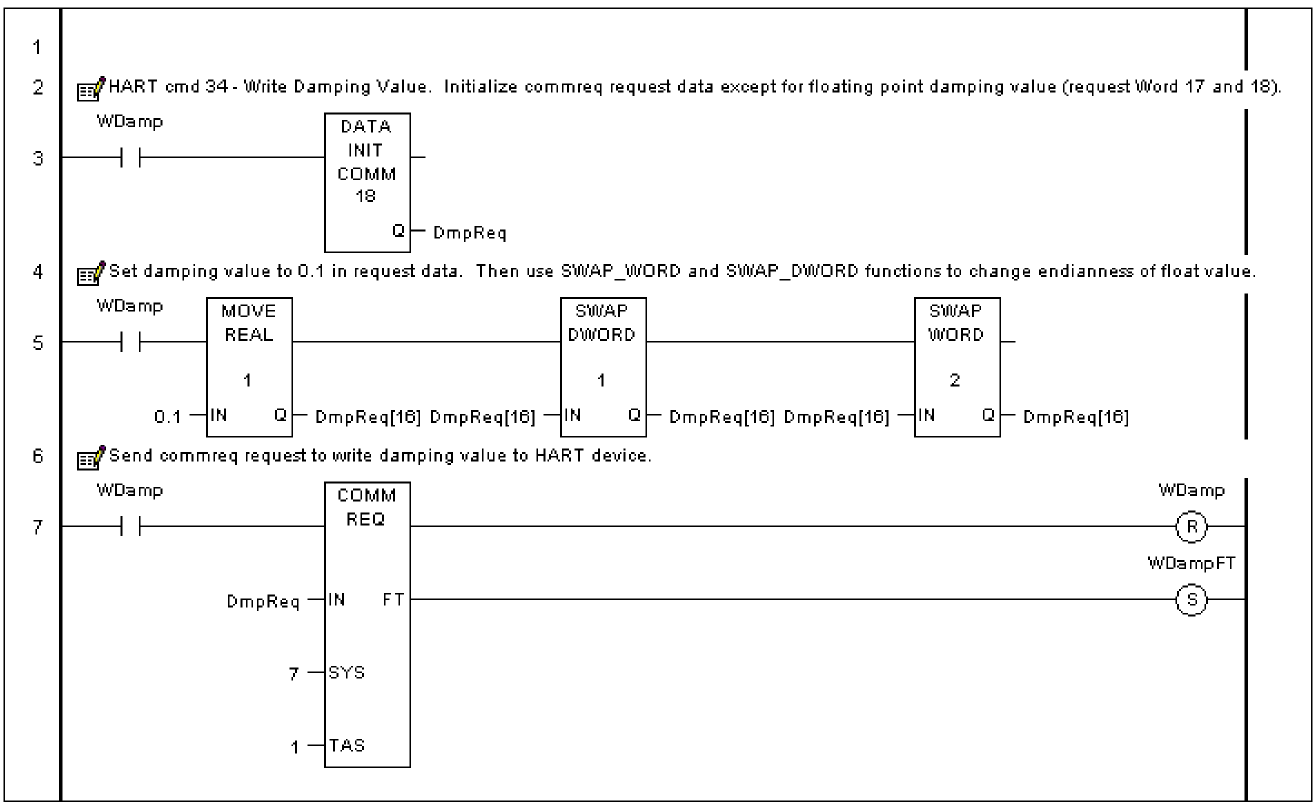
- ASCII_PACK prepares ASCII data before sending it to a HART module.
- ASCII_UNPACK can be used to unpack ASCII characters returned by a HART device.

These are described in the next section.

Converting Floating Point Data (Endian Flip)

Floating point values that begin at word 17 of a Pass-Thru Request must converted TO big-endian format. Floating point values that begin at word 7 of the reply must converted FROM big-endian format.

The basic procedure is to pass any HART float values through the SWAP_DWORD (size = 1) and SWAP_WORD (size = 2) functions, as shown below. This swaps the words within the float dword, and swaps the bytes within the two float words. In this example shows how to format floating point data prior to sending HART command 34, "Write Damping Value".



ASCII_PACK

ASCII_PACK prepares ASCII data before sending it to a HART module using COMMREQ2 (HART Pass-Thru Request). All of the function block parameters are either Type = WORD, Pass-By = Value or word arrays of Type = WORD and Pass-by = Reference. All word-based reference memory types and symbolics can be used.

It is possible to use data of a different type for the array data (for example, using a byte array of data as input to the ASCII_PACKED and ASCII_UNPACKED blocks), although Machine Edition will issue a warning during verification. In the example mentioned, the size of the input byte array would need to be at least as large as the data size of the function block parameter word array.

Parameter types:

IN - Type = WORD, Length = 16, Pass-by = Reference

NUM - Type = WORD, Length = 1, Pass-by = Value

Q - Type = WORD, Length = 12, Pass-by = Reference

Example Function Block: ASCII_PACK

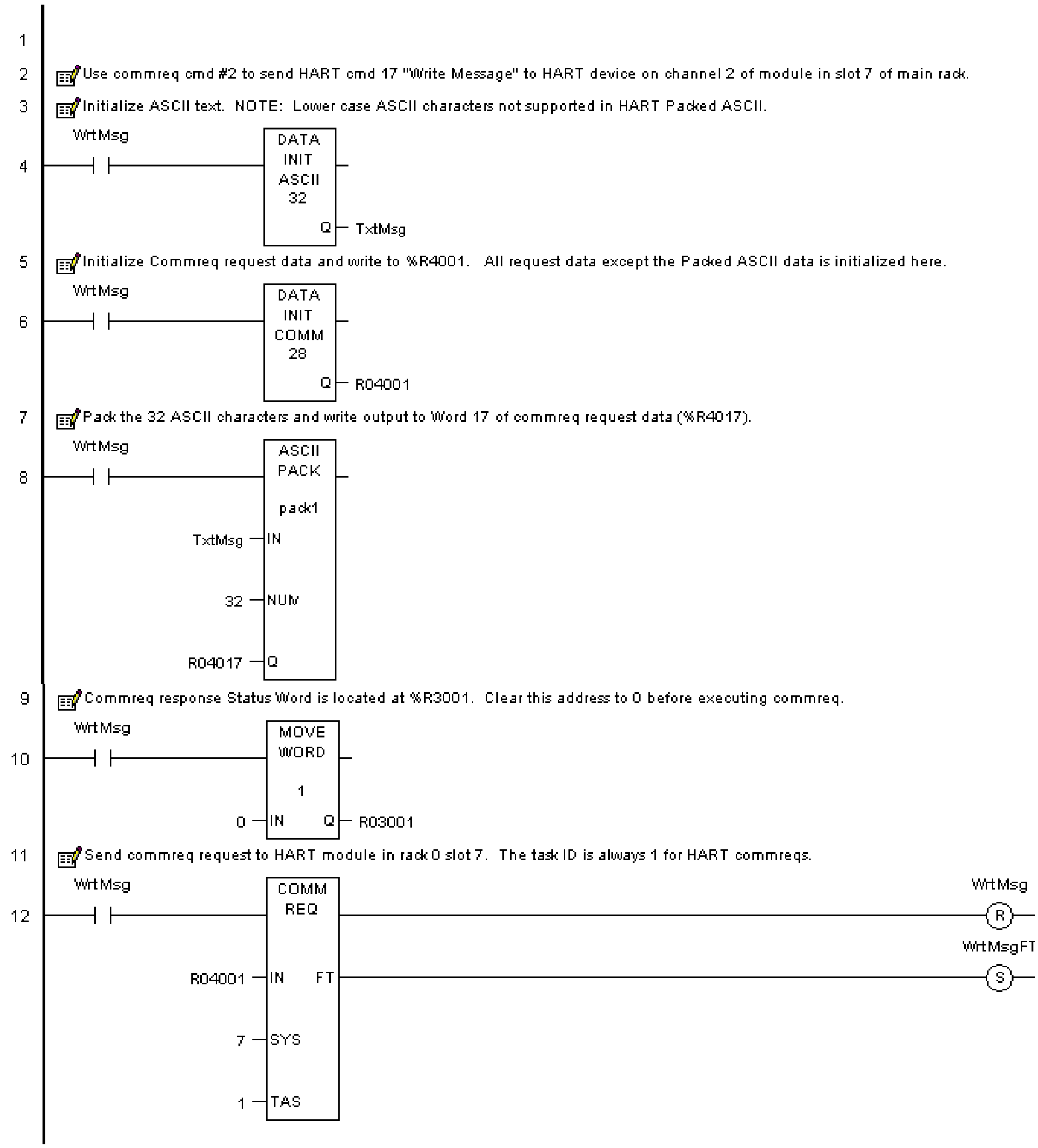
This example shows how ASCII_PACK can be used to prepare ASCII data before using a COMMREQ to send it to a HART module. First, the logic sets up the data that will be used by the COMMREQ. The ASCII_PACK function block packs the 32 ASCII characters of the message and also places that into the COMMREQ data area. After clearing the COMMREQ status to 0, the logic uses a COMMREQ to send HART command 17 "Write Message" to the device.

HART ASCII format packs data into 6 bits per character, 4 characters per 3 bytes. This chart shows the format with the most significant hex digits in the rightmost column and the lowest row.

Less significant

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
2	SP	!	“	#	$	%	&	‘	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?

More significant


1
2 Use commreq cmd #2 to send HART cmd 17 "Write Message" to HART device on channel 2 of module in slot 7 of main rack.
3 Initialize ASCII text. NOTE: Lower case ASCII characters not supported in HART Packed ASCII.
WrtMsg
4
DATA INIT ASCII 32
Q
TxtMsg
5 Initialize Commreq request data and write to %R4001. All request data except the Packed ASCII data is initialized here.
WrtMsg
6
DATA INIT COMM 28
Q
R04001
7 Pack the 32 ASCII characters and write output to Word 17 of commreq request data (%R4017).
WrtMsg
8
ASCII PACK
pack1
TxtMsg
IN
32
NUM
R04017
Q
9 Commreq response Status Word is located at %R3001. Clear this address to 0 before executing commreq.
WrtMsg
10
MOVE WORD
1
0
IN
Q
R03001
11 Send commreq request to HART module in rack 0 slot 7. The task ID is always 1 for HART commreqs.
WrtMsg
12
COMM REQ
WrtMsg
R
WrtMsgFT
S
R04001
IN
FT
7
SYS
1
TAS

ASCII_UNPACK

ASCII_UNPACK can be used to unpack ASCII characters returned by a HART device in Pass-Thru Reply data send in response to COMMREQ 2.

All of the function block parameters are either Type = WORD, Pass-By = Value or word arrays of Type = WORD and Pass-by = Reference. All word-based reference memory types and symbolics can be used.

Parameter types:

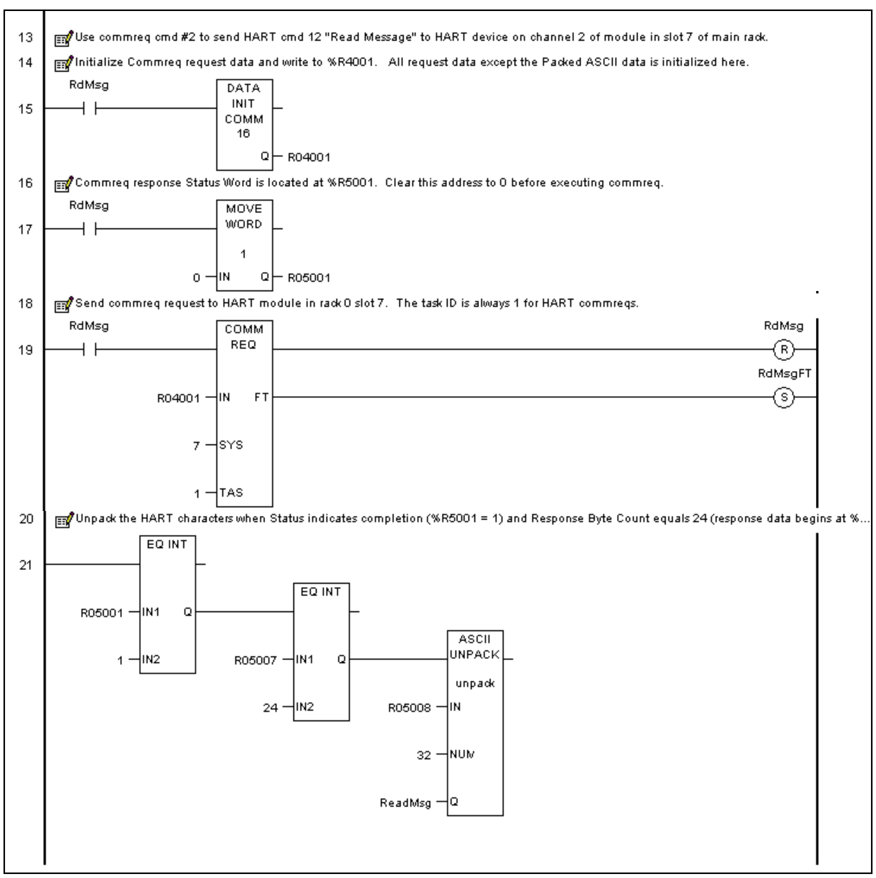
IN - Type = WORD, Length = 12, Pass-by = Reference

NUM - Type = WORD, Length = 1, Pass-by = Value

Q - Type = WORD, Length = 16, Pass-by = Reference

Example Function Block 3: ASCII_UNPACK:

In this example, after initializing the COMMREQ completion status, the ladder logic sends COMMREQ command #12, "Read Message" to the HART module in Rack 0, Slot 7. When the status = complete and the Response Byte Count =24, showing that all the data is present, the ASCII_UNPACK function block unpacks the HART ASCII data.

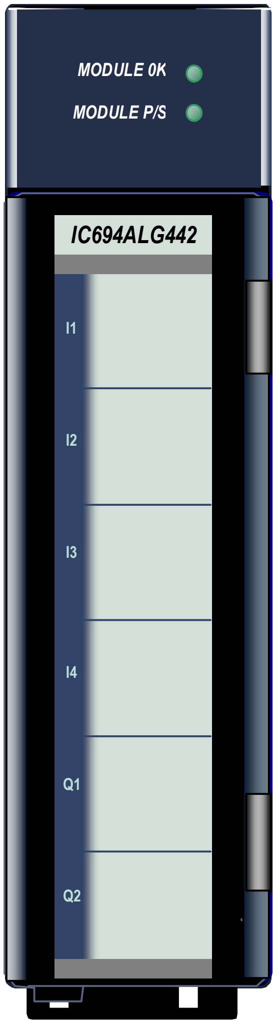


Chapter 12 Analog Mixed Modules

This chapter describes the following Analog Mixed module for PACSystems RX3i controllers.

Analog Mixed Module	***Catalog Number***
Output Module, 4 Inputs, 2 Outputs, Current/Voltage	IC694ALG442

Analog Module, 4 Inputs/2 Outputs, Current/Voltage: IC694ALG442



Analog Current/Voltage Input/Output module, IC694ALG422, provides four differential input channels and two single-ended output channels. Each channel can be configured with the Machine Edition software for one of the following ranges:

- 0 to +10 volts (unipolar), default.
- -10 to +10 volts (bipolar)
- 0 to 20 mA
- 4 to 20 mA

Input channels can also be configured for 4 - 20 mA Enhanced mode.

This module may be installed in any I/O slot in the RX3i system.

Module Features

Outputs can be configured to either Hold Last State if system power is interrupted or to reset to the low end of their range. Outputs can also be configured to operate in ramp mode on command from the application program. In ramp mode, the output channel ramps to a new value over a period of time, rather than taking the new value immediately.

High and low alarm limits can be set for all input channels and an open–wire fault (current output modes) can be reported to the CPU for each output channel.

Isolated +24 VDC Power

This module must receive 24 VDC power from an external source. If the module is located in an RX3i Universal Backplane, the external source can be connected via the TB1 connector on the left side of the backplane or directly on the module's terminal block. If the module is located in an Expansion Backplane, the external source must be connected to the module's terminal block.

LEDs

The **Module OK** LED indicates module status. The **Module P/S** LED indicates whether the external +24 VDC power supply is present and is above a minimum designated level. Both LEDs are powered from the +5 VDC backplane power bus.

LED	Description
Module OK	ON: Module OK and configured Flashing: Module OK but not configured OFF: Module is defective or no +5 VDC backplane power present
Module P/S	ON: User power is present OFF: No user power

Specifications: ALG442

Power Requirements	
External Supply Voltage Range	20 to 30 VDC (24 VDC typical)
Power Supply Rejection Ratio	Current: 5 µA/V (typical), 10 µA/V (maximum) Voltage: 25 mV/V (typical), 50 mV/V (maximum) (measured by varying V_{USER} from 24 VDC to 30 VDC)
Voltage Ripple	10%
Power Consumption	95 mA from internal +5 VDC Supply, 129 mA from external supply
Isolation Field to Backplane (optical) and to frame ground	250 VAC continuous; 1500 VAC for 1 minute
Analog Outputs	2, Single–Ended
Analog Current Output	
Output Current Ranges	0 to 20 mA, 4 to 20 mA
Resolution	at 0 to 20 mA: 0.625 µA (1 LSB = 0.625 A) at 4 to 20 mA: 0.5 µA (1 LSB = 0.5 µA)
Absolute Accuracy[1]	+/-0.1% of full scale @ 25°C (77°F), typical +/-0.25% of full scale @ 25°C (77°F), maximum +/-0.5% of full scale over operating temperature range (maximum)
Maximum Compliance Voltage	V_{USER} –3 V (minimum) to V_{USER} (maximum)
User Load	0 to 850Ω (minimum at V_{USER} = 20 V, maximum 1350Ω at V_{USER} = 30 V)
Output Load Capacitance	2000 pF (maximum)
Output Load Inductance	1 H (maximum)
Analog Voltage Output	
Output Ranges	-10 to +10 V (bipolar), 0 to +10 V (unipolar)
Resolution	at –10 V to +10 V: 0.3125 mV (1 LSB = 0.3125 mV) at 0 to +10 V: 0.3125 mV (1 LSB = 0.3125 mV)
Absolute Accuracy[2]	+/-0.25% of full scale @ 25°C (77°F), typical +/-0.5% of full scale @ 25°C (77°F), maximum +/-1.0% of full scale over operating temperature range (maximum)
Output Loading	5 mA (2 K Ohms minimum resistance)
Output Load Capacitance	1 µF (maximum capacitance)

1. In the presence of severe RF interference (IEC 801–3, 10V/m), accuracy may be degraded to +/-1% FS.
2. In the presence of severe RF interference (IEC 801–3, 10V/m), accuracy may be degraded to +/-4% FS.

Continued…

Specifications, continued

Analog Inputs	4, differential
Analog Current Input	
Input Ranges	0 to 20 mA, 4 to 20 mA, 4 to 20 mA Enhanced
Resolution	5 µA (1 LSB = 5µA)
Absolute Accuracy[3]	+/- 0.25% of full scale @25°C (77°F) +/-0.5% of full scale over specified operating temperature range
Linearity	<1 LSB
Common Mode Voltage	200 VDC (maximum)
Common Mode Rejection	>70 dB at DC; >70 dB at 60 Hz
Cross Channel Rejection	>80 dB from DC to 1 kHz
Input Impedance	250 Ω
Input Filter Response	29 Hz
Analog Voltage Input	
Input Ranges	0 to +10 V (unipolar), -10 to +10 V (bipolar)
Resolution	at 0 to +10 V: 2.5 mV (1 LSB = 2.5 mV) at –10 to +10 V: 5 mV (1 LSB = 5 mV)
Absolute Accuracy[3]	+/-0.25% of full scale @25°C (77°F); +/-0.5% of full scale over specified operating temperature range
Linearity	<1 LSB
Common Mode Voltage	200 VDC (maximum)
Common Mode Rejection	>70 dB at DC; >70 dB at 60 Hz
Cross Channel Rejection	>80 dB from DC to 1 kHz
Input Impedance	800 K Ohms typical)
Input Filter Response	29 Hz

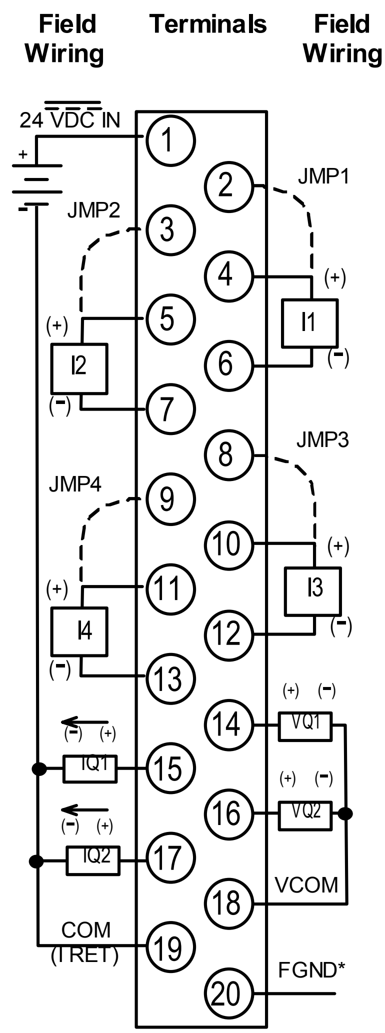
3. In the presence of severe RF interference (IEC 801–3, 10V/m), accuracy may be degraded to +/-2% FS.

Refer to Appendix A for product standards and general specifications. In order to meet the IEC 1000-4-3 levels for RF Susceptibility specified in Appendix A, when this module is present, the system must be mounted in a metal enclosure.

Field Wiring: ALG442

The diagram below shows voltage and current connections for the module. Each channel can be configured independently as a voltage or a current channel, not both simultaneously.

Terminal	Signal	Definition
1	24VIN	User Supplied +24 VDC Input
2	JMP1	Jumper terminal for connecting 250Ω sense resistor for CH1
3	JMP2	Jumper terminal for connecting 250Ω sense resistor for CH2
4	+CH1	Positive connection for differential analog input channel 1
5	+CH2	Positive connection for differential analog input channel 2
6	-CH1	Negative connection for differential analog input channel 1
7	-CH2	Negative connection for differential analog input channel 2
8	JMP3	Jumper terminal for connecting 250Ω sense resistor for CH3
9	JMP4	Jumper terminal for connecting 250Ω sense resistor for CH4
10	+CH3	Positive connection for differential analog input channel 3
11	+CH4	Positive connection for differential analog input channel 4
12	-CH3	Negative connection for differential analog input channel 3
13	-CH4	Negative connection for differential analog input channel 4
14	V_{out} CH1	Voltage output for channel 1
15	I_{out} CH1	Current output for channel 1
16	V_{out} CH2	Voltage output for channel 2
17	I_{out} CH2	Current output for channel 2
18	V COM	Common return for voltage outputs
19	I RET	Common return for User supplied +24 V and current outputs
20	GND	Frame ground connections for cable shields



* Optional Shield Connection

Input Scaling

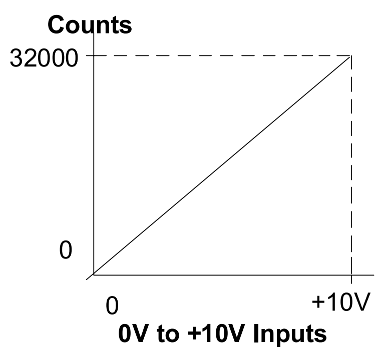
Resolution per bit depends on the configured input or output range as shown in the table of module specifications. The module scales each current and voltage input to a value in counts for the CPU.

Configured Range	Scaled Counts Values
0 to 10 V (default)	0 to 32767
-10 to 10 V	-32768 to 32767
4 to 20 mA	0 to 32767
0 to 20 mA	0 to 32767
0 to 20 mA Enhanced	-8000 to 32767

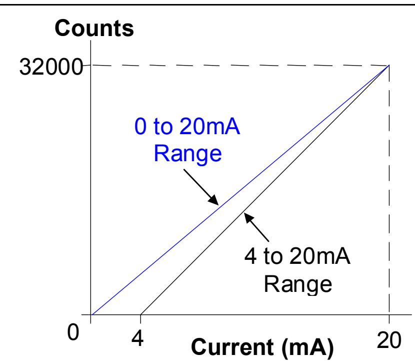
In the 0 to +10 V default range, 0 volts corresponds to a count of 0 and +10 volts corresponds to a count of 32000. In the -10 to +10 volt range, -10 volts corresponds to a count of -32000 and +10 volts corresponds to a count of +32000. Full 12–bit resolution is available over either range. In the 4 to 20 mA range, 4 mA corresponds to a count of 0 and 20 mA corresponds to a count of 32000. In the 0 to 20 mA range, 0 mA corresponds to a count of 0 and 20 mA corresponds to a count of 32000. Full 12–bit resolution is available over the 0 to 20 mA range.

In the 4 to 20 mA Enhanced range, 0 mA corresponds to a count of -8000, 4 mA corresponds to a count of 0 (zero) and 20 mA corresponds to a count of +32000. The Enhanced range automatically provides 4 to 20 mA range scaling. Negative digital values are provided for input current levels between 4 mA and 0 mA. This creates a low alarm limit that detects when the input current falls from 4 mA to 0 mA, providing open–wire fault detection in 4 to 20 mA applications.

Input Voltage Scaling



Input Current Scaling



If the current source is reversed into the input, or is less than the low end of the current range, the module inputs a data word corresponding to the low end of the current range (0000H in %AI). If an input is out of range (greater than 20 mA), the A/D converter adjusts it to full scale (corresponding to 7FFFH in %AI).

Output Scaling

The module scales counts data received from the CPU to a current or voltage value for each output.

Configured Range	Values Sent By CPU	Values Accepted by Module
0 to 10 V (default)	0 to 32767	0 to 32767
-10 to 10 V	-32768 to 32767	- 32768 to 32767
4 to 20 mA	0 to 32767	0 to 32000
0 to 20 mA	0 to 32767	0 to 32767

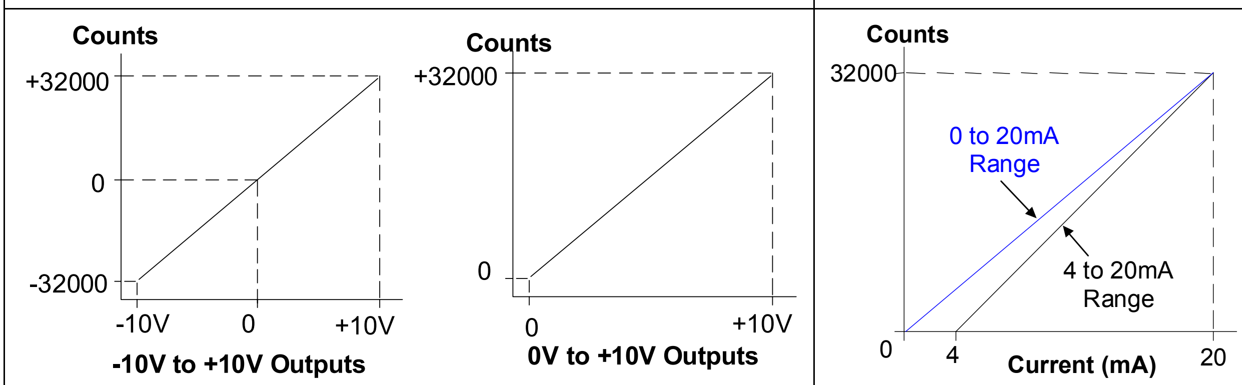
For a 0 to 10 V output, the module scales count outputs from 0 to 32000 to output voltages from 0 to +10 volts. The module scales count values from 32001 to 32767 to overrange voltages up to a maximum of approximately 10.24 volts.

For a -10 to +10 V output, the module scales count outputs in the range +/-32000 to output voltages from –10 V to +10 V. The module scales count values from -32001 to -32768 and from +32001 to +32767 to overrange voltages up to a maximum of approximately +/-10.24 V.

For a 4 to 20 mA output, the module scales count outputs from 0 to 32000 counts to output currents from 4 to 20 mA. If the CPU sends a value above 32000 counts, the module uses the value 32000 in the D/A converter. No error is returned.

For a 0 to 20 mA output, the module scales count outputs from 0 to 32000 to output currents from 0 to 20 mA. The module scales count values from 32001 to 32767 up to a maximum output current of approximately 20.5 mA.

Output Voltage Scaling	*Output Current Scaling*



I/O Data: ALG442

This module uses two %AQ references and four %AI references, depending on configuration. Data in the %AI and %AQ registers is in 16–bit 2's complement format.

MSB															LSB
X	11	10	9	8	7	6	5	4	3	2	1	0	X	X	X

The module also uses 8, 16 or 24 %I references for status data, depending on the alarm status configuration. Status data format is shown on the next page.

Input Data

Resolution of the converted signal is 12 bits binary (1 part in 4096). The placement of the 12 bits from the A/D converter in the %AI data word is shown above.

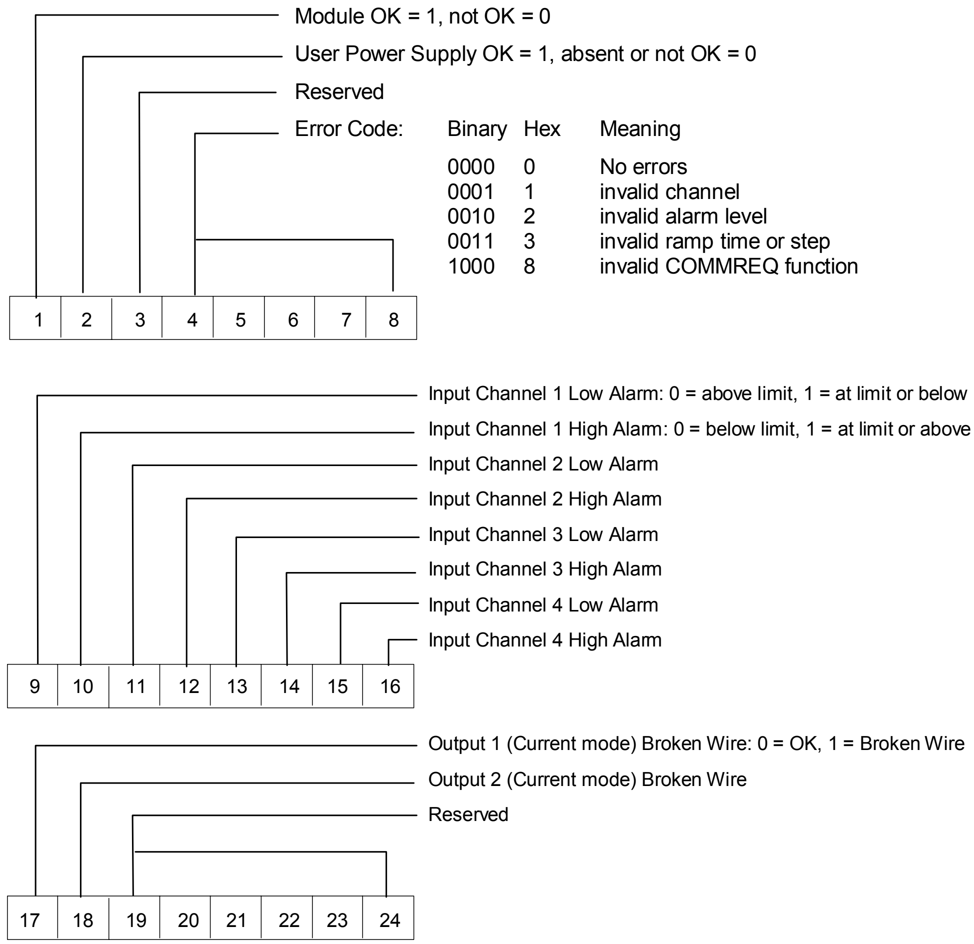
The bits in the %AI data table that were not used are forced to 0 (zero) by the analog input channel.

Output Data

Each output channel is capable of converting 15 to 16 bits (depending on the range selected) of binary data to an analog output.

Status Data: ALG222

Analog Module IC694ALG222 can be configured to return 8, 16, or 32 status bits to the PLC CPU. Content of the status data is shown below.



Error Code

Byte 1 of the status data contains a status/error code for COMMREQs sent to the module. Only the most recent error is reported; an existing error code will be overwritten if another error occurs. The priority of errors is:

1. Invalid COMMREQ function (highest priority)
2. Invalid channel.
3. Invalid data (ramp or alarm parameter) (lowest priority).

If multiple errors occur, the one with the highest priority is reported in the error code. The module will not stop standard operation if an error is detected; these error bits are informational only, and can be ignored.

Configuration: ALG442

The following module parameters can be configured using the Machine Edition software:

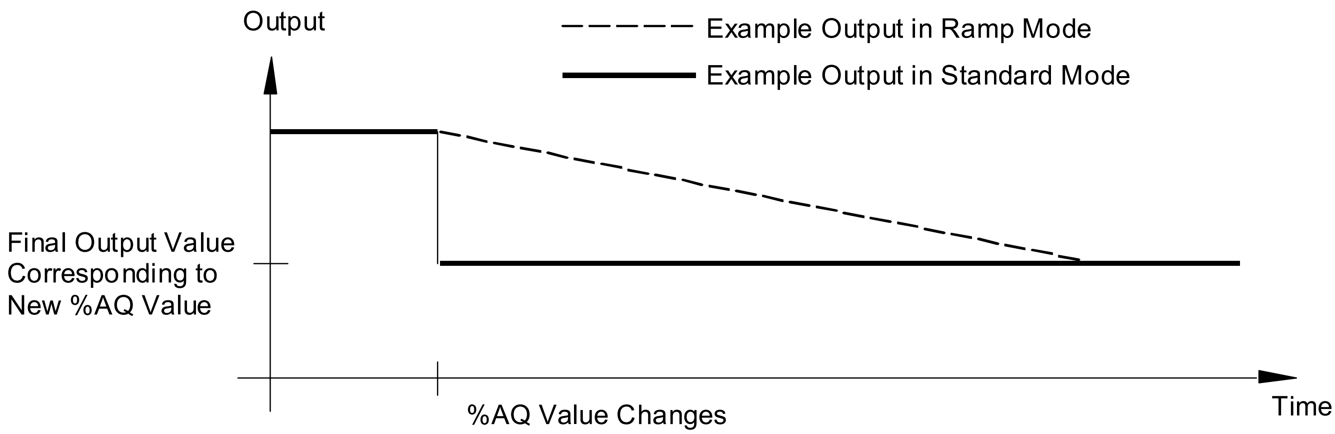
Parameter	***Description***	***Values***
Stop Mode	Output state when module goes from Run to Stop mode	Hold or Default Low
Reference Address	Starting %AI address for the module's analog input data	
Reference Address	Starting %AQ address for the module's analog output data	
Reference Address	Starting %I address for the module's status data	
%I Length	Number of %I status bits that will be used for module and channel status data:	8 (module and power status only) 16 (above plus input status) 24 (all above plus output status)
Output Range	Type of output range	0 to +10 V, -10 to +10 V, 4 to 20 mA, 0 to 20 mA
Input Range	Type of input range	0 to +10 V, -10 to +10 V, 4 to 20 mA, 0 to 20 mA, 4 to 20 mA Enhanced
Alarm Low Limit	Low limit alarm value for each input. Must be less than the same channel's high alarm	-32768 to 32759
Alarm High Limit	High limit alarm value for each input	-32767 to 32760

The choice for Stop Mode (Hold or Default Low) determines how outputs operate when the module goes from Run to Stop mode. If the configured Stop Mode is Hold (the default), the module holds outputs at the last state received from the CPU. If the Stop Mode is Default Low, the outputs will go to their low values. In current mode (4-20 mA), outputs go to 4 mA if configured for DEFLOW. In current mode (0-20 mA), outputs go to 0 mA if configured for DEFLOW. In voltage mode (unipolar (0 to +10V) and bipolar (+10V to -10V), outputs go to 0V if configured for DEFLOW.

The Alarm Low and Alarm High parameters can be used to set up limits that cause alarm indications to be passed to the PLC for each channel. Values entered without a sign are assumed to be positive. These configured alarm limits are stored until changed by a new configuration. The configured high and low alarm limits can be changed temporarily by a COMMREQ from the application program as described later in this chapter.

Ramp Mode Operation for ALG442

Outputs on module ALG442 can be set up to operate in Ramp mode. In normal operating mode, a new value entered in an output channel's %AQ reference causes the output to change directly to the new value. In Ramp mode, the output goes to the new value over a period of time. The output channel starts a new ramp (either up or down) each time the value in its %AQ reference changes. The module performs range checking on new output values and automatically adjusts out-of-range values before making the ramp computations.



Use of Ramp mode is set up for either channel or both output channels using a COMMREQ command as explained in this chapter. The ramp slope can be set up in the COMMREQ as:

- a total ramp time from 1 millisecond to 32 seconds, or:
- a sequence of 1 to 32000 1-millisecond steps.

A channel stays in Ramp mode until the module receives a new COMMREQ either changing or canceling the ramp operation, or until power is cycled. The channel will not change modes after a hardware configuration download. Because COMMREQ settings are temporary, it will be lost after a power cycle.

If the module receives a new COMMREQ that changes ramp operation while an output is in the process of ramping, the new ramp settings take effect as follows:

- If Ramp mode is turned off during a ramp, the channel goes directly to the value in its %AQ reference.
- If a channel is set up to ramp over a period of time, but a new COMMREQ is received commanding the channel to instead ramp in a sequence of measured steps, ramp operation changes as soon as the COMMREQ is processed (assuming that the step is valid).
- If a channel is set up to ramp as a sequence of measured steps, but a new COMMREQ is received commanding the channel to instead ramp over a period of time, it immediately starts a new ramp using the present output as the starting output and the present time as the start time.

If the module receives a Ramp command for an invalid channel, step height or ramp time, the module ignores the command and returns an error code in the first byte of its %I status references. The error code can be cleared by a Clear Errors COMMREQ as described in this chapter, or by reconfiguring the module.

Changing Module Operation on Command

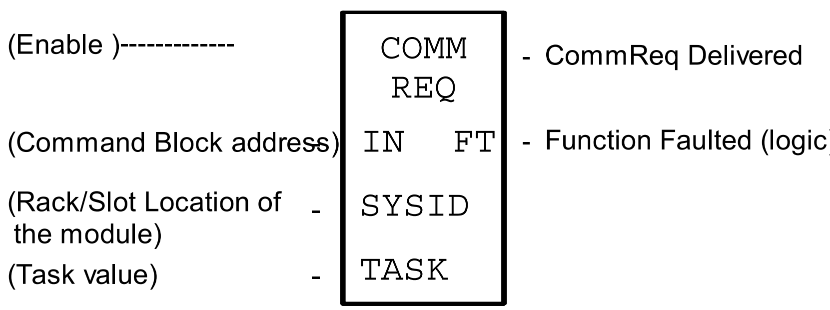
Module ALG442 can respond directly to a specific COMMREQ command from the application program to:

- clear the module's %I error code
- modify the Input alarm limits, and
- put one or both outputs in Ramp mode and set up the ramp characteristics

These changes to module are not retained during loss of power. If the module is power-cycled, new commands must be sent to the module to again modify the configured alarm limits, or to set up Ramp operation for the outputs.

COMMREQ Format

The Communications Request is triggered when the logic program passes power to the COMMREQ Function Block.



When sent to module ALG442, the parameters of the COMMREQ are:

Enable: Control logic for activating the COMMREQ Function Block.

IN: The location of the Command Block. The Command Block contains the parameters of the COMMREQ request. It can be located at any valid address within a word-oriented memory area (%R, %AI, %AQ, %P, %L, or %W) in the PACSystems PLC.

SYSID: A hexadecimal word value that gives the rack (high byte) and slot (low byte) location of the analog module.

TASK: Task must be set to zero.

FT Output: The FT output is set if the PLC CPU is unable to deliver the COMMREQ to the module. When the FT output is set, the module is unable to return a COMMREQ status word to the PLC logic application.

COMMREQ Command Block

The format of the COMMREQ for module ALG442 is shown below. For more information about using COMMREQs, check the online help and the *PACSystems Reference Manual*.

Word Offset	***Value***	***Description***
Word 1	Must be 0004	Length of the command block
Word 2	0000	Not used
Word 3	(See below)	Memory type of COMMREQ Status Word
Word 4	0-based.	Offset of COMMREQ Status Word
Word 5	0	Reserved
Word 6	0	Reserved
Word 7	E201H (-7679 decimal)	COMMREQ command number
Word 8	0006	Byte length of Command Data (see below)
Word 9	(See below)	Memory type in the CPU for the Command Data
Word 10	0-based	Memory offset for the Command data

Memory Types and Offsets

The COMMREQ Command Block specifies a memory type and location to receive status information about the execution of the command (word 3), and for the command data (word 9). The memory types are listed in the table below. ***For word 4 and word 10, the address offset is a zero-based number.*** For example, the offset for %R100 is 99 decimal.

Type	**Value (Decimal)**	**Value (Hex.)**	**Description**
%R	8	08H	Register memory (word mode)
%AI	10	0AH	Analog input memory (word mode)
%AQ	12	0CH	Analog output memory (word mode)
%I	16 70	10H 46H	Discrete input memory (byte mode) Discrete input memory (bit mode)
%Q	18 72	12H 48H	Discrete output memory (byte mode) Discrete output memory (bit mode)
%T	20 74	14H 4AH	Discrete temporary memory (byte mode) Discrete temporary memory (bit mode)
%M	22 76	16H 4CH	Discrete momentary internal memory (byte mode) Discrete momentary internal memory (bit mode)
%G	56 86	38H 56H	Discrete global data table (byte mode) Discrete global data table (bit mode)
%W	196	C4H	Word memory (word mode; limited to %W1-%W65536)

COMMREQ Command Data Format

In the COMMREQ Command Block (above) words 9 and 10 assign a CPU memory location for six bytes of command data. The program logic can use these bytes to set the parameters of the COMMREQ. This module does not use the last command data word.

word 1	command word
word 2	alarm or ramp data
word 3	Unused for module ALG442

Command to be Performed	*Word 1 Contains*	*Word 2 Contains*
Change the specified input's low alarm limit to the value in word 2.	0000 (Input 1) 0001 (Input 2) 0002 (Input 3) 0003 (Input 4)	New low alarm limit for the input
Change the specified input's high alarm limit to the value in word 2.	0010 (Input 1) 0011 (Input 2) 0012 (Input 3) 0013 (Input 4)	New high alarm limit for the input
Change the specified input's low alarm limit by the increment in word 2.	0020 (Input 1) 0021 (Input 2) 0022 (Input 3) 0023 (Input 4)	Increment to change the input's configured low alarm limit. Increment can be + or -.
Change the specified input's high alarm limit by the increment in word 2.	0030 (Input 1) 0031 (Input 2) 0032 (Input 3) 0033 (Input 4)	Increment to change the input's high alarm limit. Increment can be + or -.
Turn off Ramp operation for the specified output channel and put it in normal mode.	0040 (Output 1) 0041 (Output 2)	--
Put the specified output channel in Ramp step mode. Step increment in word 2.	0050 (Output 1) 0051 (Output 2)	Step (1 to 32000 counts) to be taken each millisecond.
Put the specified output channel in Ramp time mode. Ramp total time in word 2.	0060 (Output 1) 0061 (Output 2)	Time in milliseconds: 1 to 32000 (1 ms to 32 seconds)
Clear the module's %I error code	00C0	--

If the requested command is not valid (for example, if the changed alarm limit would be out of range) the module ignores the COMMREQ command and returns an error code in the module's %I status data. The module does NOT stop operating; these error bits are informational only and can be ignored. The error code remains in the %I status bits until cleared by another COMMREQ (command 00C0, see directly above), or until the module is reconfigured.

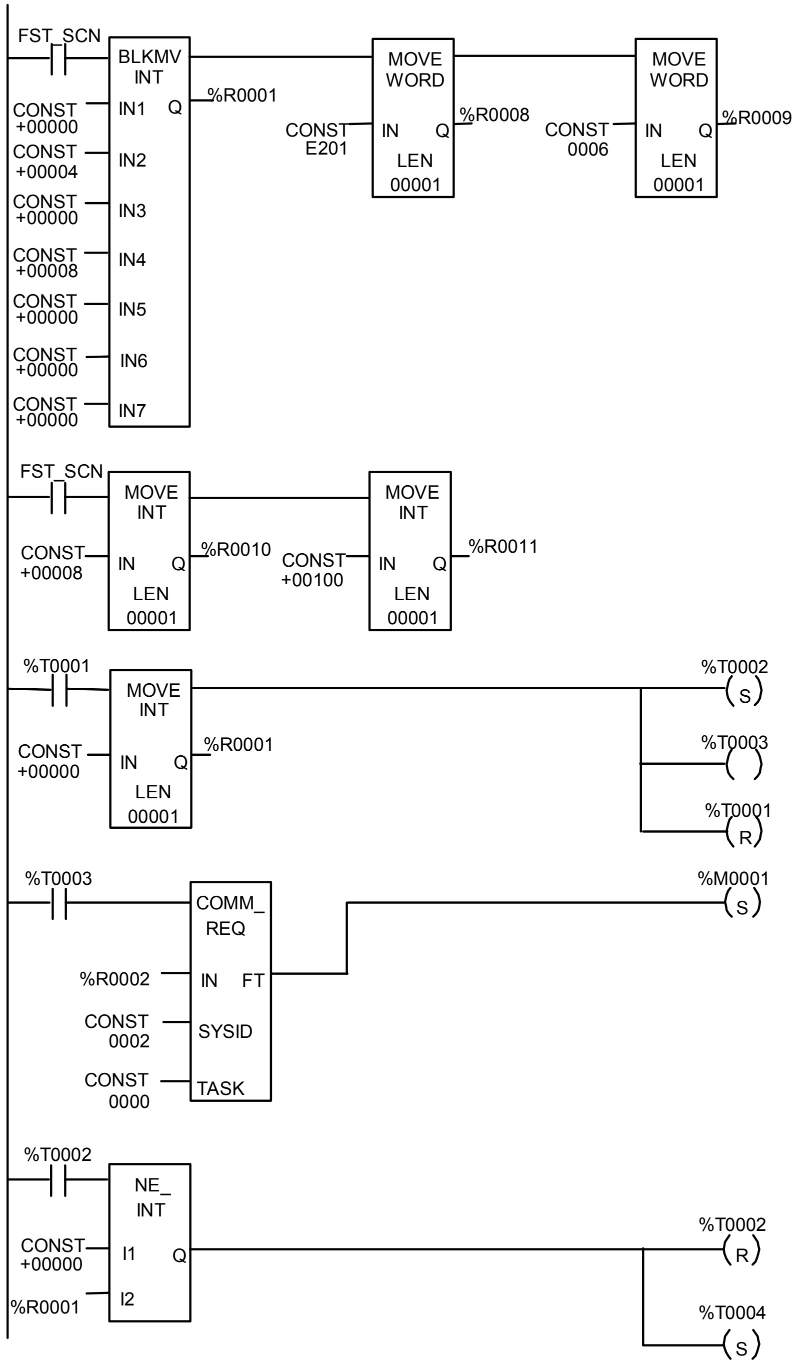
COMMREQ Example

This example shows setting up COMMREQ data and issuing the COMMREQ to an Analog Mixed module.

The application program should verify the completion of the COMMREQ in progress before initiating another, so the module does not receive COMMREQs faster than it can process them. One way to do that is to zero the contents of the COMMREQ status (%R0001 in this example) as the COMMREQ is enabled. Since the status returned for a completed COMMREQ is never zero, a non–zero status word indicates that the COMMREQ has completed.

In this example, the COMMREQ command block starts at %R0002 and is initialized on the first scan. The 6 bytes of COMMREQ data sent to the module must have been moved into%R0101-%R0103 before the COMMREQ is enabled.

The module is located in rack 0, slot 2 so the SYSID input to the COMMREQ is 0002.



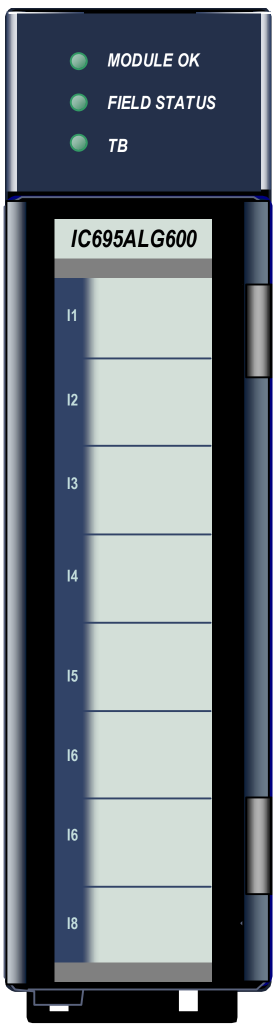
Setting %T0001 moves zero into the COMMREQ status word, enables %T0003 for one sweep to initiate the COMMREQ, and sets %T0002 to begin checking the status word. When a non–zero status word is detected, %T0002 is reset to discontinue checking and %T0004 is set to indicate that the module is ready for the next COMMREQ. Reference %M0001 is set if a COMMREQ fault occurs.

Chapter 13 Universal Analog Input Module

This chapter describes the following Analog module for PACSystems RX3i controllers.

Universal Analog Input Module	***Catalog Number***
Universal Input, Voltage, Current, Resistance, RTD, Thermocouple, 8 Channels	IC695ALG600

Universal Analog Input Module, 8 Inputs, RTD, Thermocouple, Resistance, Current/Voltage: IC695ALG600



Universal Analog Input module IC695ALG600 provides eight general purpose input channels and two Cold Junction Compensation (CJC) channels. Inputs are divided into two equal groups of four. Channels can be individually-configured using the Machine Edition software for:

- Any combination of up to 8 channels of voltage, current, thermocouple, RTD, and resistance inputs.
- Thermocouple Inputs: B, C, E, J, K, N, R, S, T
- RTD Inputs: PT 385 / 3916, N 618 / 672, NiFe 518, CU 426
- Resistance Inputs: 0 to 250 / 500 / 1000 / 2000 / 3000 / 4000 Ohms
- Current: 0–20 mA, 4–20 mA, ±20 mA
- Voltage: ±50mV, ±150 mV, 0–5 V, 1–5 V, 0–10 V, ±10V

Module Features

- Completely software-configurable, no module jumpers to set
- Six hardware analog-to-digital filter frequencies, individually-selectable by channel
- Rapid channel acquisition times based on filter frequency
- Full autocalibration
- On-board error-checking
- Open-circuit detection for most input types
- Short-circuit detection for RTDs.
- User-defined scaling
- High alarm, low alarm, high-high alarm, low-low alarm detection and reporting
- Module fault reporting
- Supports diagnostic point fault contacts in the logic program.
- Flash memory for future upgrades
- Module Status, Field Status, and TB LEDs
- CJC compensation on terminal block
- Temperature in Celsius or Fahrenheit
- Positive and negative Rate of Change Alarms
- Configurable software filters for each input channel
- Configurable interrupts for channel alarms and faults
- Terminal Block insertion or removal detection

This module must be located in an RX3i Universal Backplane. It cannot be located in an expansion or remote backplane.

CIMPLICITY® Machine Edition 5.0 SP1A LD-PLC Hotfix 1 or later must be used to configure and program a PACSystems RX3i system that includes this module. The CPU must be RX3i model IC695CPU310 Firmware Revision 2.80 (Build ID 43A1) or later.

Specifications: ALG600

Backplane Power Requirements	400 mA maximum @ 5V 350 mA maximum @ 3.3V	
CPU Memory Usage	40 bytes (20 words) of input references for channel input data. 40 bytes for enhanced diagnostics 4 bytes for module status reporting.	
Power Dissipation within Module	5.4 watts maximum	
LEDs	One green LED to indicate the module status One bi-color green/yellow LED to indicate the field status One bi-color red/green LED to indicate the terminal block status	
Channel Acquisition Time	10 msec @ 1000 Hz, 13 msec @ 200 Hz, 27 msec @ 40 Hz, 67 msec @ 16 Hz, 87 msec @ 12 Hz, 127 msec @ 8 Hz	
Channel Update Time	The sum of the channel acquisition times for a bank of 4 channels plus one of the following if applicable: 1. RTD Lead resistance measurement time (equals channel acquisition time) 2. CJC acquisition time 7 msec.	
Input resolution	11 to 16 bits, depending on configured range and A/D filter frequency. See page 12-17 for details.	
Inputs in Ohms	Resistance	0-250, 0-500, 0-1000, 0-2000, 0-3000, 0-4000
	Platinum 385	100, 200, 500,1000
	Platinum 3916	100, 200, 500,1000
	Nickel 672	120
	Nickel 618	100,200, 500,1000
	Nickel-Iron 518	604
	Copper 426	10
RTD Inputs	Copper 426	-100 to 260 degrees C
	Nickel 618	-100 to 260 degrees C
	Nickel 672	-80 to 260 degrees C
	Nickel-Iron 518	-100 to 200 degrees C
	Platinum 385	-200 to 850 degrees C
	Platinum 3916	-200 to 630 degrees C
Thermocouple Inputs	Type B	300 to 1820 degrees C
	Type C	0 to 2315 degrees C
	Type E	-270 to 1000 degrees C
	Type J	-210 to 1200 degrees C
	Type K	-270 to 1372 degrees C
	Type N	-210 to 1300 degrees C
	Type R	0 to 1768 degrees C
	Type S	0 to 1768 degrees C
	Type T	-270 to 400 degrees C

Specifications, continued

Voltage / Current Inputs	-10V to +10V, 0V to +10V, 0 V to +5V, 1V to +5V, -50mV to +50mV, -150mV to +150mV, -20mA to +20mA, 4 to 20 mA, 0 to 20 mA
Configurable Input Filter	8Hz, 12Hz, 16Hz, 40Hz, 200Hz, 1000Hz
Scaling	Floating point user scaling.
Max RTD Cable Impedance	25 ohms
RTD Wire Length	1000 ft max w/settling time of 1mSec
Input Impedance	>1M ohm for Tc/V/RTD
Current Input Resistance	249 ohms +/- 1%
Open circuit detection time	5 seconds max. Open circuit detection is available for all configurations except +/-20mA current, 0-20mA current, and +/-10V voltage.
Max Overvoltage	+/-14.5VDC continuous
Max Overcurrent	28mA continuous
Normal Mode Noise Rejection	95 dB minimum @ 50/60 Hz with 8 Hz filter 85 dB minimum @ 50/60 Hz with 12 Hz filter
Common Mode Noise Rejection	120dB minimum @ 50/60 Hz with 8 Hz filter 110dB minimum @ 50/60 Hz with 12 Hz filter
Settling time to 5% of Full Scale (notch filter dependent)	<80mS
Calibrated Accuracy at 25°C	Better than 0.1% of range (except 10 ohm CU RTD) Accuracy depends on A/D filter, data format, input noise, and ambient temperature.
Calibration interval	12 months typical to meet accuracy specifications over time. Module will allow for user offset to be applied as a periodic calibration adjustment.
Input Offset Drift with Temperature	3.0 milliohm/°C maximum 2.0 uV/°C maximum
Gain Drift with Temperature	50 ppm/°C typical (90 ppm/°C maximum)
Module error over Full Temp range	0.5% of range typical (depends on range) 1.0% of range maximum
Module Scan Time (notch filter dependent)	(Assumes 2 ADC's running in parallel, no CJC or lead resistance) 10ms per Channel * 4 Channels = 40ms (1KHz filter) 127ms per Channel * 4 Channels = 508ms (8Hz filter) Channels that are disabled are not scanned, shortening scan time.
Module conversion method	Sigma-delta
Isolation Voltage channel to channel group to group terminal block to backplane/chassis	Opto-isolated, transformer isolated +-12.5Vdc channel to channel Tc/V/I/RTD 250 VAC continuous/1500 VAC for 60 seconds 250 VAC continuous/1500 VAC for 60 seconds

Accuracy Specifications							
	Maximum Error at:	**+25°C**			**0°C to +60°C**		
	Configured Input Filter	**8, 12, 16Hz**	**200Hz**	**1000Hz**	**8, 12, 16Hz**	**200Hz**	**1000Hz**
Voltage Inputs*	+/- 10.5 V, 0.0 to +10.5 V	+/- 5 mV	+/- 5.5 mV	+/- 7 mV	+/- 10 mV	+/- 11 mV	+/- 14 mV
	0 to +5.25 V, +1.0 to +5.25 V	+/- 3 mV	+/- 3.3 mV	+/- 4.2 mV	+/- 5 mV	+/- 5. mV	+/- 7 mV
	+/- 155 mV	+/- 30 uV	+/- 33 uV	+/- 42 uV	+/- 110 uV	+/- 121 uV	+/- 154 uV
	+/- 55 mV	+/- 15 uV	+/- 17 uV	+/- 21 uV	+/- 70 uV	+/- 77 uV	+/- 98 uV
Current Inputs*	+/- 22.5 mA, 0.0 to +22.5 mA, +3.0 to +22.5 mA	+/- 20 uA	+/- 22 uA	+/- 28 uA	+/- 40 uA	+/- 44 uA	+/- 56 uA
Thermocouple Inputs*	Type J (-180°C to +1200°C)	+/- 0.6°C	+/- 0.7°C	+/- 0.9°C	+/- 2.3°C	+/- 2.6°C	+/- 3.3°C
	Type J (-210°C to -180°C)	+/- 0.8°C	+/- 0.9°C	+/- 1.2°C	+/- 3.3°C	+/- 3.7°C	+/- 4.7°C
	Type N (-160°C to +1300°C)	+/- 1.0°C	+/- 1.1°C	+/- 1.4°C	+/- 4.5°C	+/- 5.0°C	+/- 6.3°C
	Type N (-210°C to -160°C)	+/- 1.8°C	+/- 2.0°C	+/- 2.6°C	+/- 8.0°C	+/- 8.8°C	+/- 11.2°C
	Type T (-190°C to +400°C)	+/- 0.9°C	+/- 1.0°C	+/- 1.3°C	+/- 4.0°C	+/- 4.4°C	+/- 5.6°C
	Type T (-270°C to -190°C)	+/- 6.7°C	+/- 7.4°C	+/- 9.4°C	+/- 18.0°C	+/- 19.8°C	+/- 25.2°C
	Type K (-200°C to +1372°C)	+/- 1.0°C	+/- 1.1°C	+/- 1.4°C	+/- 4.0°C	+/- 4.4°C	+/- 5.6°C
	Type K (-270°C to -200°C)	+/- 9.5°C	+/- 10.5°C	+/- 13.3°C	+/- 21.0°C	+/- 23.1°C	+/- 29.4°C
	Type E (-200°C to +1000°C)	+/- 0.6°C	+/- 0.7°C	+/- 0.9°C	+/- 2.5°C	+/- 2.8°C	+/- 3.5°C
	Type E (-270°C to -200°C)	+/- 5.3°C	+/- 5.8°C	+/- 7.5°C	+/- 14.0°C	+/- 15.4°C	+/- 19.6°C
	Type S and R	+/- 2.8°C	+/- 3.1°C	+/- 4.0°C	+/- 11.5°C	+/- 12.7°C	+/- 16.1°C
	Type C	+/- 1.7°C	+/- 1.9°C	+/- 2.4°C	+/- 7.0°C	+/- 7.7°C	+/- 9.8°C
	Type B	+/- 3.3°C	+/- 3.7°C	+/- 4.5°C	+/- 20.0°C	+/- 22.0°C	+/- 28.0°C
RTD Inputs*	100 Ω Platinum 385	+/- 0.7°C	+/- 0.8°C	+/- 1.0°C	+/- 1.2°C	+/- 1.4°C	+/- 1.7°C
	200 Ω Platinum 385	+/- 0.6°C	+/- 0.7°C	+/- 0.9°C	+/- 1.0°C	+/- 1.1°C	+/- 1.4°C
	500 Ω Platinum 385	+/- 0.5°C	+/- 0.6°C	+/- 0.7°C	+/- 0.9°C	+/- 1.0°C	+/- 1.3°C
	1000 Ω Platinum 385	+/- 0.5°C	+/- 0.6°C	+/- 0.7°C	+/- 0.9°C	+/- 1.0°C	+/- 1.3°C
	100 Ω Platinum 3916	+/- 0.6°C	+/- 0.7°C	+/- 0.9°C	+/- 1.1°C	+/- 1.2°C	+/- 1.6°C
	200 Ω Platinum 3916	+/- 0.5°C	+/- 0.6°C	+/- 0.7°C	+/- 0.9°C	+/- 1.0°C	+/- 1.3°C
	500 Ω Platinum 3916	+/- 0.4°C	+/- 0.5°C	+/- 0.6°C	+/- 0.8°C	+/- 0.9°C	+/- 1.2°C
	1000 Ω Platinum 3916	+/- 0.4°C	+/- 0.5°C	+/- 0.6°C	+/- 0.8°C	+/- 0.9°C	+/- 1.2°C
	Nickel 672	+/- 0.3°C	+/- 0.4°C	+/- 0.5°C	+/- 0.5°C	+/- 0.6°C	+/- 0.7°C
	Nickel 618	+/- 0.3°C	+/- 0.6°C	+/- 0.5°C	+/- 0.5°C	+/- 0.6°C	+/- 0.7°C
	Nickel-Iron 518	+/- 0.4°C	+/- 0.5°C	+/- 0.6°C	+/- 0.7°C	+/- 0.8°C	+/- 1.0°C
	Copper 426	+/- 1.0°C	+/- 1.1°C	+/- 1.4C	+/- 2.4 °C	+/- 2.7 °C	+/- 3.4 °C
Resistance Inputs*	250 ohms	+/- 0.25 Ω	+/- 0.28 Ω	+/- 0.35 Ω	+/- 0.35 Ω	+/- 0.39 Ω	+/- 0.49 Ω
	500 ohms	+/- 0.3 Ω	+/- 0.33 Ω	+/- 0.42 Ω	+/- 0.45 Ω	+/- 0.5 Ω	+/- 0.63 Ω
	1000 ohms	+/- 0.5 Ω	+/- 0.55 Ω	+/- 0.7 Ω	+/- 0.8 Ω	+/- 0.88 Ω	+/- 1.2 Ω
	2000 ohms	+/- 0.9 Ω	+/- 1.0 Ω	+/- 1.26 Ω	+/- 1.5 Ω	+/- 1.65 Ω	+/- 2.1 Ω
	3000 ohms	+/- 1.3 Ω	+/- 1.43 Ω	+/- 1.82 Ω	+/- 2.2 Ω	+/- 2.42 Ω	+/- 3.08 Ω
	4000 ohms	+/- 1.7 Ω	+/- 1.87 Ω	+/- 2.38Ω	+/- 2.9 Ω	+/- 3.19 Ω	+/- 4.06 Ω
Cold Junction Temperature	+/- 1.5°C maximum						
CJC Sensor	+/- 0.3°C maximum 0°C to +80°C						

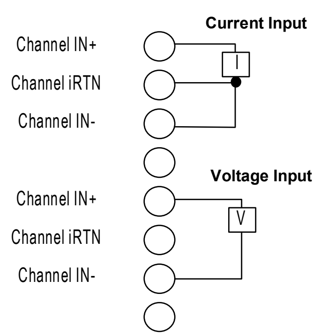
* Accuracy is dependent on the ADC output rate selection, data format, and input noise. In severe RF environments, accuracy may be degraded by up to +/-2% of full scale.

Field Wiring: ALG600

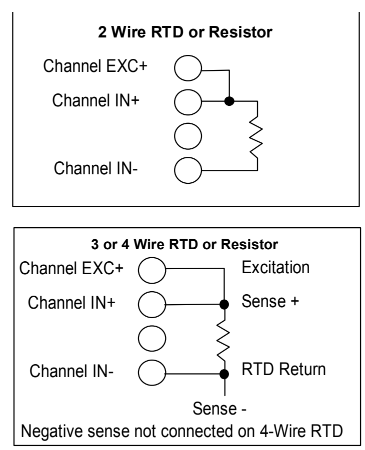
The table below lists wiring connections for the module. Except for RTD and resistance type inputs, channels are wired as differential inputs. There are no shield terminals. For shielding, tie cable shields to the ground bar along the bottom of the backplane. M3 tapped holes are provide in the ground bar for this purpose.

Terminal	RTD or Resistance	TC / Voltage / Current	RTD or Resistance	TC / Voltage / Current	Terminal
1		CJC1 IN+	Channel 1 EXC+		19
2		CJC1 IN-	Channel 1 IN+	Channel 1 IN+	20
3	Channel 2 EXC+			Channel 1 iRTN	21
4	Channel 2 IN+	Channel 2 IN+	Channel 1 IN-	Channel 1 IN -	22
5		Channel 2 iRTN	Channel 3 EXC+		23
6	Channel 2 IN-	Channel 2 IN -	Channel 3 IN+	Channel 3 IN+	24
7	Channel 4 EXC+			Channel 3 iRTN	25
8	Channel 4 IN+	Channel 4 IN+	Channel 3 IN-	Channel 3 IN-	26
9		Channel 4 iRTN	Channel 5 EXC+		27
10	Channel 4 IN-	Channel 4 IN -	Channel 5 IN+	Channel 5 IN+	28
11	Channel 6 EXC+			Channel 5 iRTN	29
12	Channel 6 IN+	Channel 6 IN+	Channel 5 IN-	Channel 5 IN-	30
13		Channel 6 iRTN	Channel 7 EXC+		31
14	Channel 6 IN-	Channel 6 IN-	Channel 7 IN+	Channel 7 IN+	32
15	Channel 8 EXC+			Channel 7 iRTN	33
16	Channel 8 IN+	Channel 8 IN+	Channel 7 IN-	Channel 7 IN-	34
17		Channel 8 iRTN		CJC2 IN+	35
18	Channel 8 IN-	Channel 8 IN-		CJC2 IN-	36

Thermocouple / Voltage / Current



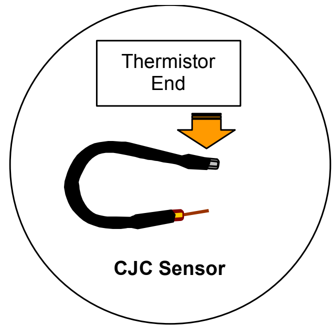
RTD / Resistance



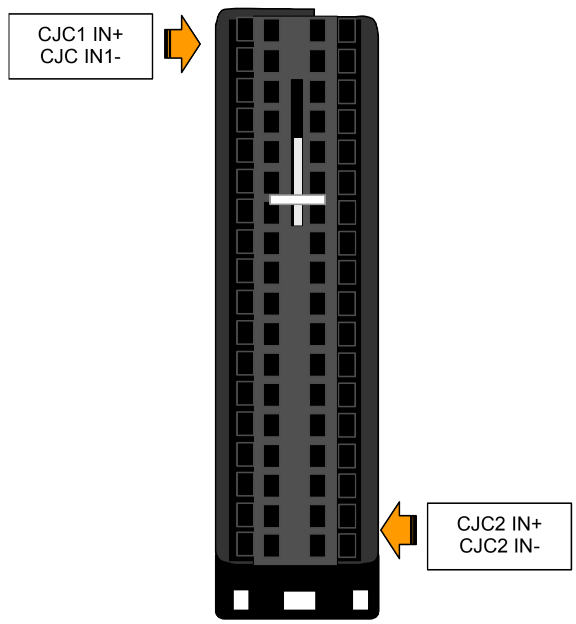
- For current inputs, tie the Return to the associated IN- pin.
- For 2 wire RTDs, tie EXC+ and IN+ together at the terminal block.
- For 4 wire RTDs, leave one of the negative sense leads unconnected.
- For 3 wire RTDs, IN+ = Sense+, IN- = RTD Return, and EXC+ = Excitation current.

Installing CJC Sensors

When using any thermocouple inputs on this module, the use of CJC sensors is recommended. Installing one CJC sensor will greatly improve the accuracy of thermocouple readings. Installing two CJC sensors will provide the highest thermocouple input accuracy for the module. See “CJC Scan Enable” later in this chapter for information about configuring and using CJC sensors.



A CJC sensor compensates for offset voltages introduced into the input signal where the thermocouple wires are connected to the module. A set of two CJC sensors is available as part number IC695ACC600.



Spring-style Terminal Block

The thermistor end of the CJC sensor must be installed in the CJC1 IN+ or CJC2 IN+ terminal for accurate thermocouple temperature measurements. The gold pin end of the CJC sensor must be installed in the CJC1 IN- or the CJC2 IN- terminal.

Open the Terminal Block contacts fully before installing the CJC sensor. Insert the sensor into the Terminal Block contact, maintaining metal-to-metal contact between the thermistor and the Terminal Block contact.

For a Box-style Terminal Block, maintain pressure while screwing down the contact.

Connecting Channels to the Same Thermocouple Point

When connecting one or more channels from channels 1 - 4 and one or more channels from channels 5 - 8 to the same thermocouple point electrically, the point should be grounded. It can be grounded at either the sensor or the module, by adding a jumper wire from frame ground to the low side of one thermocouple input.

Configuration Parameters: ALG600

Module Parameters		
Parameter	***Default***	***Description***
Channel Value Reference Address	%AIxxxxx	Starting address for the module's input data. This defaults to the next available %AI block.
Inputs Default	Force Off	In the event of module failure or removal, this parameter specifies the state of the Channel Value References. Force Off = Channel Values clear to 0. Hold Last State = Channel Values hold their last state.
Channel Value Reference Length	20	The number of words used for the module's input data
Diagnostic Reference Address	%Ixxxxx	Starting address for the channel diagnostics status data. This defaults to the next available %I block.
Diagnostic Reference Length	0	The number of bit reference bits (0 – 320) required for the Channel Diagnostics data. Default is 0, which means mapping of Channel Diagnostics is disabled. Change this to a non-zero value to enable Channel Diagnostics mapping.
Module Status Reference Address	%Ixxxxx	Starting address for the module's status data. This defaults to the next available %I block.
Module Status Reference Length	0	The number of bits (0 – 32) required for the Module Status data. Default is 0, which means mapping of Module Status data is disabled. Change this to a non-zero value to enable Module Status data mapping.
CJC Scan Enable	Disabled	Cold Junction Compensation can be: No Scan, Scan CJC1, Scan CJC2, Scan Both CJCs. Use of these parameters is described later in this section.
Channel Faults w/o Terminal Block	Disabled	Enabled / Disabled: Controls whether channel faults and configured alarm responses will be generated after a Terminal Block removal. The default setting of Disabled means channel faults and alarms are suppressed when the Terminal Block is removed. This parameter does not affect module faults including the Terminal Block loss/add fault generation.
I/O Scan Set	1	The scan set 1 – 32 to be assigned to the module by the RX3i CPU

Channel 1 – 8 Parameters		
Parameter	***Default***	***Description***
Range Type	Disabled	Voltage/Current, Thermocouple, RTD, Resistance, Disabled
Range (Not for Range Type Disabled)	-10V to +10V	For voltage/current: -10V to +10V, 0V to +10V, 0V to +5V, 1V to +5V, -50mV to +50mV, -150mV to +150mV, -20mA to +20mA, 4 to 20 mA, 0 to 20 mA
		For Thermocouple: B, C, E, J, K, N, R, S, T
		For RTD: Platinum 385, 100 ohm / 200 ohm / 500 ohm / 1000 ohm, Platinum 3916, 100 ohm / 200 ohm / 500 ohm / 1000 ohm, Nickel 672, 120 ohms, Nickel 618, 100 ohms / 200 ohms / 500 ohms / 1000 ohms, Nickel-Iron 518, 604 ohms, Copper 426, 10 ohms
		For Resistance: 0-250 Ohm, 0 – 500 Ohm, 0 – 1000 Ohm, 0 – 2000 Ohm, 0 – 3000 Ohm, 0 – 4000 Ohm
Channel Value Format	32-bit Floating Point	16-bit integer or 32-bit floating point
Temperature Units (for Thermocouple or RTD Range Type only)	Celsius	Celsius, Fahrenheit
RTD	RTD 2 Wire	(for RTD Range Type only) RTD 2 or 3 Wire
RTD Lead Resistance Compensation	Enabled	(for RTD Range Type only)Enabled, Disabled
High Scale Value (Eng Units)	The defaults for the 4 Scaling parameters depend on the configured Range Type and Range. Each Range and Range Type have a different set of defaults.	Note: Scaling is disabled if both High Scale Eng. Units equals High Scale A/D Units and Low Scale Eng. Units equals Low Scale A/D Units. Default is High A/D Limit of selected range type.
Low Scale Value (Eng Units)		Default is Low A/D Limit of selected range type. Must be lower than the high scaling value.
High Scale Value (A/D Units)		Default is High A/D Limit of selected range type. Must be greater than the low scaling value.
Low Scale Value (A/D Units)		Default is Low A/D Limit of selected range type.

Input Scaling

By default, the module converts a voltage, current, resistance, or temperature input over the entire span of its configured Range into a floating point value for the CPU. For example, if the Range of a channel is 4 to 20mA, the module reports channel input values from 4.000 to 20.000. By modifying one or more of the four channel scaling parameters (Low/High Scale Value parameters) from their defaults, the scaled Engineering Unit range can be changed for a specific application. Scaling can provide inputs to the PLC that are already converted to their physical meaning, or convert input values into a range that is easier for the application to interpret. Scaling is always linear and inverse scaling is possible. All alarm values apply to the scaled Engineering Units value, not to the A/D input value.

The scaling parameters only set up the linear relationship between two sets of corresponding values. They do not have to be the limits of the input.

Example 1

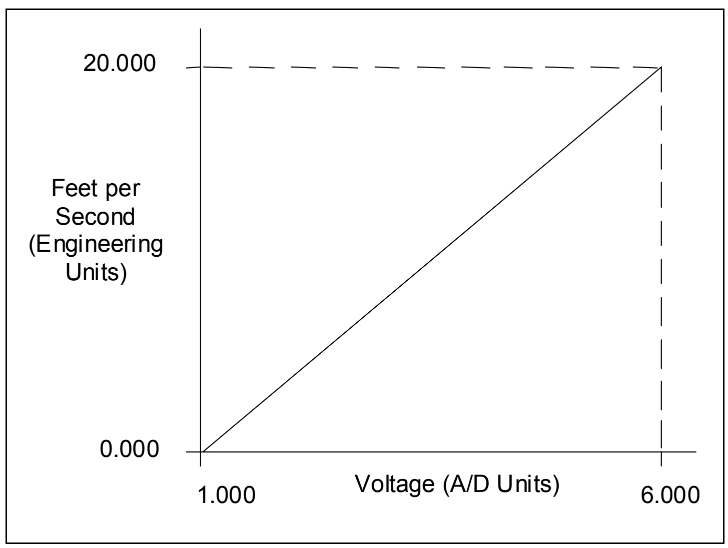
For a voltage input, 6.0 volts equals a speed of 20 feet per second, and 1.0 volt equals 0 feet per second. The relationship in this range is linear. For this example, the input values should represent speed rather than volts. The following channel configuration sets up this scaling:

High Scale Value (Eng Units) = 20.000

Low Scale Value (Eng Units) = 0.000

High Scale Value (A/D Units) = 6.000

Low Scale Value (A/D Units) = 1.000



For this example, 1.0V to 6.0V is the normal voltage range, but the module will attempt to scale the inputs for a voltage that lies outside the range. If a voltage of 10.0V were input to the channel, the module would return a scaled channel value of 36.000. The application should use alarms or take other precautions for scaled inputs that are outside the acceptable range or invalid.

Example 2

An existing application uses traditional analog to digital (A/D) count integer values. With scaling and the optional 16-bit integer input option, a channel can be configured to report integer count values. In this example, the application should interpret +10V as 32000 counts and -10V as -32000 counts. The following channel configuration will scale a +/-10V input channel to +/- 32000 counts.

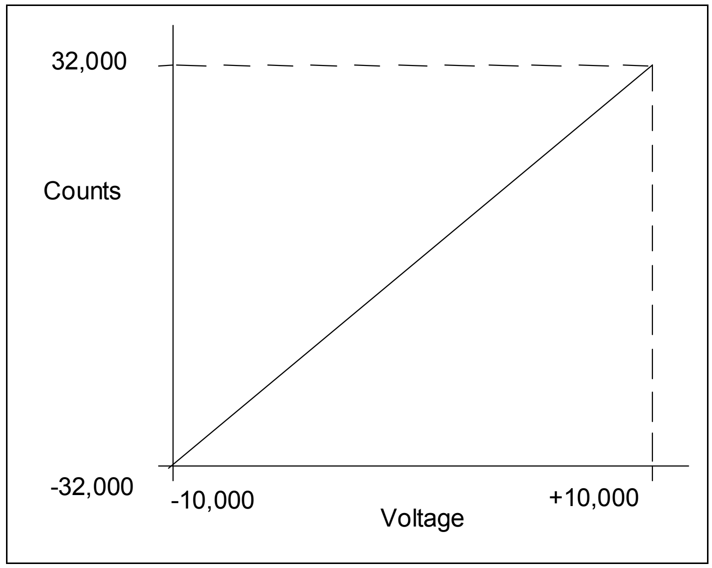
Channel Value Format = 16 Bit Integer

High Scale Value (Eng Units) = 32000.0

Low Scale Value (Eng Units) = -32000.0

High Scale Value (A/D Units) = 10.000

Low Scale Value (A/D Units) = -10.000



Channel 1 – 8 Parameters continued		
Parameter	***Default***	***Description***
Positive Rate of Change Limit (Eng Units)	0.000	Rate of change in Engineering Units per Second that will trigger a Positive Rate of Change alarm. Default is disabled. Used with “Rate of Change Sampling Rate” parameter.
Negative Rate of Change Limit (Eng Units)	0.000	Rate of change in Engineering Units per Second that will trigger a Negative Rate of Change alarm. Default is disabled. Used with “Rate of Change Sampling Rate” parameter.
Rate of Change Sampling Rate	0.000	Time from 0 to 300 seconds to wait between comparisons. Default of 0.0 is to check after every input sample.

Rate of Change Alarms

The Universal Analog module can detect both Negative Rate of Change and Positive Rate of Change in Engineering Units per Second. When either of the Rate of Change parameters is configured to be non-zero, the module takes the difference in Engineering Units between the previous rate of change sample and the current sample, then divides by the elapsed time between samples.

If the Engineering Unit change from the previous sample to current sample is negative, the module compares the rate change with the Negative Rate of Change parameter.

If the Engineering Unit change between samples is positive, the module compares the results in comparing the rate change with the Positive Rate of Change parameter value.

In either case, if the rate of change is greater than the configured rate, a rate of change alarm occurs. The actions taken by the module following the alarm depend on the enabled rate of change actions that have been set up in the "Diagnostic Reporting Enable", "Fault Reporting Enable", and "Interrupts Enabled" parameters.

The Rate of Change Sampling Rate parameter determines how frequently the module compares the Rate of Change. If the Rate of Change Sampling Rate is 0 or any time period less than the channel update rate, the module compares the Rate of Change for every input sample of the channel.

<table>
<tr><th colspan="3">Channel 1 – 8 Parameters continued</th></tr>
<tr><th>Parameter</th><th>Default</th><th>Description</th></tr>
<tr><td>High-High Alarm (Eng Units)</td><td rowspan="7">The defaults for the High-High, High, Low, and Low-Low parameters depend on the configured Range Type and Range. Each Range and Range Type has a different set of default values.</td><td rowspan="7">Alarms and Deadbands
All of the alarm parameters are specified in Engineering Units. To use alarming, the A/D Alarm Mode must also be configured as enabled.
High-High Alarm and Low-Low Alarm: When the configured value is reached or passed, a Low-Low Alarm or High-High Alarm is triggered. The configured values must be lower than/higher than the corresponding low/high alarm limits.
High Alarm and Low Alarm: When the configured value is reached or below (above), a Low (High) Alarm is triggered.
High and Low Alarm Deadbands: A range in Engineering Units above the alarm condition (low deadband) or below the alarm condition (high deadband) where the alarm status bit can remain set even after the alarm condition goes away. For the alarm status to clear, the channel input must fall outside the deadband range.
Alarm Deadbands should not cause the alarm clear to be outside the Engineering Unit User Limits range. For example, if the engineering unit range for a channel is -1000.0 to +1000.0 and a High Alarm is set at +100.0, the High Alarm Deadband value range is 0.0 to less than 1100.0. A deadband of 1100.0 or more would put the High Alarm clear condition below –1000.0 units making the alarm impossible to clear within the limits.</td></tr>
<tr><td>High Alarm (Eng Units)</td></tr>
<tr><td>Low Alarm (Eng Units)</td></tr>
<tr><td>Low-Low Alarm (Eng Units)</td></tr>
<tr><td>High-High Alarm Deadband (Eng Units)</td></tr>
<tr><td>High Alarm Deadband (Eng Units)</td></tr>
<tr><td>Low Alarm Deadband (Eng Units)</td></tr>
</table>

Channel 1 – 8 Parameters continued		
Parameter	***Default***	***Description***
User Offset	0.000	Engineering Units offset to change the base of the input channel. This value is added to the scaled value on the channel prior to alarm checking.
Software Filter Integration Time in milliseconds.	0.000	Specifies the amount of time in milliseconds for the software filter to reach 63.2% of the input value. A value of 0 indicates software filter is disabled. A value of 100 indicates data will achieve 63.2% of its value in 100ms. Default is disabled
A/D Filter Frequency	40 Hz	Low pass A/D hardware filter setting: 8, 12,16,40,200,or 1000Hz. Default is 40Hz. Frequencies below this are not filtered by hardware.
Diagnostic Reporting Enable *If Diagnostic Reporting is enabled, the additional parameters listed below can be used to enable specific types of alarms.*	Disabled	*Diagnostic Reporting Enable options* are used to enable reference memory reporting of alarms into the Diagnostic Reference area. *Fault Reporting Enable option*s enable fault logging of alarms into the I/O Fault Table. *Interrupts Enable options* enable I/O Interrupt trigger when alarm conditions occur. These parameters enable or disable the individual diagnostics features of a channel. When any of these parameters is enabled, the module uses associated parameters to perform the enabled feature. For example, if Over Range is enabled in the "Diagnostic Reporting Enable" menu, the module will set the Over Range bit in the Diagnostic Reference for the channel. If any of these parameters is disabled, the module does not react to the associated alarm conditions. For example, if Low Alarm Enable is set to Disabled in the "Fault Reporting Enable" menu, the Low Alarm fault is not logged in the I/O Fault Table when Low Alarm is detected on the channel.
Fault Reporting Enable *If Fault Reporting is enabled, the additional parameters listed below can be used to enable specific types of Faults.*	Disabled	
Interrupts Enable *If Interrupts are enabled, the additional parameters listed below can be used to enable specific types of Interrupts.*	Disabled	
Low Alarm Enable	Disabled	
High Alarm Enable	Disabled	
Under Range Enable	Disabled	
Over Range Enable	Disabled	
Open Wire Enable	Disabled	
Calibration Fault Enable	Disabled	
Low-Low Alarm Enable	Disabled	
High-High Alarm Enable	Disabled	
Negative Rate of Change Detection Enable	Disabled	
Positive Rate of Change Detection Enable	Disabled	

Using Alarming

The Diagnostic Reporting Enable, Fault Reporting Enable, and Interrupt Enable configuration parameters can be used to enable different types of responses for individual channel alarms. By default, all responses are disabled on every channel. Any combination of alarm enables can be configured for each channel.

- If Diagnostic Reporting is enabled, the module reports channel alarms in reference memory at the channel's Diagnostic Reference address.
- If Fault Reporting is enabled, the module logs a fault log in the I/O Fault table for each occurrence of a channel alarm.
- If Interrupts are enabled, an alarm can trigger execution of an Interrupt Block in the application program, as explained below.

Using Interrupts

To properly configure an I/O Interrupt, the Interrupt enable bit or bits must be set in the module's configuration. In addition, the program block that should be executed in response to the channel interrupt must be mapped to the corresponding channel's reference address.

Example:

In this example, the Channel Values Reference Address block is mapped to %AI0001-%AI0020. An I/O Interrupt block should be triggered if a High Alarm condition occurs on channel 2.

- Configure the High-Alarm condition.
- Set the High-Alarm Interrupt Enable flag for Channel 2 in the module configuration.

Channel 2's reference address corresponds to %AI00003 (2 Words per channel), so the interrupt program block Scheduling properties should be set for the "I/O Interrupt" Type and "%AI0003" as the Trigger.

Note on Using Interrupts

This module has separate enable/disable options for Diagnostic Reporting and Interrupts. Normally, disabling a diagnostic (such as Low/High Alarm or Over/Under range) in the configuration means that its diagnostic bit is never set. However, if interrupts are enabled for a condition and that interrupt occurs, the diagnostic bit for that condition is also set during the I/O Interrupt block logic execution. The next PLC input scan always clears this interrupt status bit back to 0, because Diagnostic Reporting has it disabled.

CJC Parameters		
Parameter	**Default**	**Description**
Channel Value Format	16-bit Integer	16-bit integer or 32-bit floating point
Temperature Units	Celsius	Celsius, Fahrenheit
User Offset (Temperature Units)	0.000	Temperature offset added to CJC values. Range –25 to +25 degC and -45 to +45 degF in F temp mode.
Diagnostic Reporting Enable	Disabled	These parameters enable or disable the individual diagnostics features of a CJC input.
Under Range Enable	Disabled	
Over Range Enable	Disabled	
Open Wire Enable	Disabled	
Fault Reporting Enable	Disabled	
Under Range Enable	Disabled	
Over Range Enable	Disabled	
Open Wire Enable	Disabled	
Interrupts Enable	Disabled	
Under Range Enable	Disabled	
Over Range Enable	Disabled	
Open Wire Enable	Disabled	

CJC Scan Enable

Cold Junction Compensation for the module can be configured as: Disabled, CJC1 only, CJC2 only, or Both CJCs.

Compensation Options	Description	CJC1 Scanning	CJC2 Scanning
No Scan	Module assumes 25 degrees C for any thermocouple compensation.	Disabled	Disabled
Scan Both	Highest thermocouple compensation accuracy. Uses both values in thermocouple compensation as explained below.	Enabled	Enabled
Scan CJC1 only.	Lowers the thermocouple compensation accuracy, but can improve scan time for channels 5-8.	Enabled	Disabled
Scan CJC2 only.	Lowers the thermocouple compensation accuracy, but can improve scan time for channels 1-4.	Disabled	Enabled

When scanning both CJC inputs, the module subtracts the temperature of CJC2 from the temperature of CJC1. It then multiplies the difference by a specific multiplier for each channel to compensate for the position of the channel on the terminal block.

Channel	Channel Multiplier	Channel	Channel Multiplier
1	0.10	5	0.45
2	0.05	6	0.60
3	0.25	7	0.75
4	0.25	8	0.90

For example: if CJC1 is 30 degrees Celsius and CJC2 is 25 degrees Celsius, the compensated channel 1 terminal block temperature is 30 - [(30-25) * 0.10] = 29.5 degrees Celsius. The module then adjusts this temperature for the particular thermocouple type to determine the thermoelectric effect (mV) caused by the connection at the terminal block.

Module Data: ALG600

The module reports its input channel data in 20 input words, beginning at its assigned Channel Value Reference Address. Each channel occupies 2 words (whether the channel is used or not):

Channel Value Reference Address	***Contains this Input***
+0, 1	Channel 1
+2, 3	Channel 2
+4, 5	Channel 3
+6, 7	Channel 4
+8, 9	Channel 5
+10, 11	Channel 6
+12, 13	Channel 7
+14, 15	Channel 8
+16, 17	CJC1
+18, 19	CJC2

Depending on its configured Channel Value Format, each enabled channel reports a 32-bit floating point or 16-bit integer value to the CPU.

In the 16-bit integer mode, low word of the 32-bit channel data area contains the 16-bit integer channel value. The high word (upper 16-bits) of the 32-bit value are set with the sign extension of the 16-bit integer. This sign-extended upper word allows the 16-bit integer to be read as a 32-bit integer type in logic without losing the sign of the integer. If the 16-bit integer result is negative, the upper word in the 32-bit channel data has the value 0xFFFF. If the 16-bit integer result is positive, the upper word is 0x0000.

Resolution and Update Time

The actual resolution and update time for each input depend on the channel's configured Range Type and A/D Filter Frequency. At higher Filter Frequencies, channel update time increases while input resolution decreases. The approximate number of bits for each Filter Frequency and Range Type are shown in the table below.

Filter Frequency	***Range Type: Voltage / Current Approximate Number of Bits***	***Range Type: TC / mV Approximate Number of Bits***	***Channel Update Time***
8 Hz	16	16	127 ms
12 Hz	16	16	87 ms
16 Hz	16	16	67 ms
40 Hz	16	14	27 ms
200 Hz	14	13	13 ms
1000 Hz	11	11	10 ms

Isolated Input Groups

This module provides two isolated groups of four input channels each. This allows fast inputs and slower or highly-filtered inputs to be connected to the same module without adversely affecting the update rate of the fast inputs. To take advantage of this feature, up to four inputs requiring fast response should be placed together in one isolated group while slower inputs should be connected to the other isolated group. For example, voltage and current inputs with higher frequency input filter settings should be grouped together on one of the isolated groups while thermocouple, RTD, resistance, or voltage/current inputs with low-frequency input filter settings should be grouped together on the other isolated group.

Each isolated group provides a CJC input. The CJC input is considered a slow-response input and will reduce the update rate for the associated channel group when enabled.

Channel Diagnostic Data: ALG600

In addition to the 20 words of input data from field devices, the module can be configured to report 320 bits (20 words) of channel diagnostics status data to the CPU. The CPU stores this data at the module's configured *Diagnostic Reference Address*. Use of this feature is optional.

The diagnostics data for each channel occupies 2 words (whether the channel is used or not):

Diagnostic Reference Address	***Contains Diagnostics Data for:***
+0, 1	Channel 1
+2, 3	Channel 2
+4, 5	Channel 3
+6, 7	Channel 4
+8, 9	Channel 5
+10, 11	Channel 6
+12, 13	Channel 7
+14, 15	Channel 8
+16, 17	CJC1
+18, 19	CJC2

When a diagnostic bit equals 1, the alarm or fault condition is present on the channel. When a bit equals 0 the alarm or fault condition is either not present or detection is not enabled in the configuration for that channel.

For each channel, the format of this data is:

Bit	***Description***
1	Low Alarm
2	High Alarm
3	Underrange
4	Overrange
5	Open Wire
6 – 16	Reserved (set to 0).
17	Low-Low Alarm
18	High-High Alarm
19	Negative Rate of Change Alarm
20	Positive Rate of Change Alarm
21 - 32	Reserved (set to 0).

Module Status Data: ALG600

The module can also optionally be configured to return 2 bits of module status data to the CPU. The CPU stores this data in the module's 32-bit configured Module Status Data reference area.

Bit	Description
1	Module OK (1 = OK, 0 = failure, or module is not present)
2	Terminal Block Present (1 = Present, 0 = Not present)
3 - 32	Reserved

Terminal Block Detection

The module automatically checks for the presence of a Terminal Block.

The module's TB LED indicates the state of the terminal block. It is green when the Terminal Block is present or red if it is not.

Faults are automatically logged in the CPU's I/O Fault table when the terminal block is inserted or removed from a configured module in the system. The fault type is Field Fault and the fault description indicates whether the fault is a "Loss of terminal block" or an "Addition of terminal block". If a Terminal Block is not present while a configuration is being stored, a "Loss of terminal block" fault is logged.

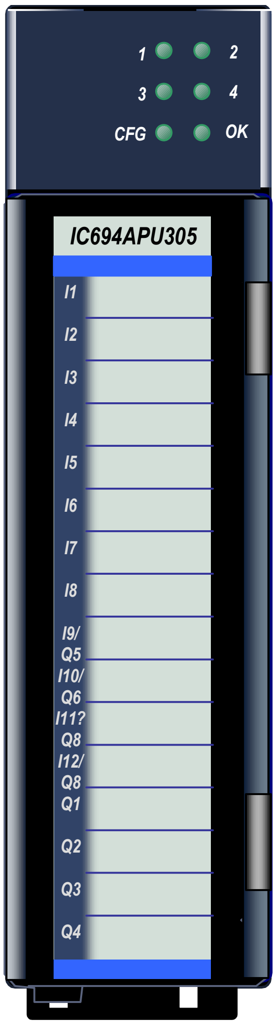
Bit 1 of the Module Status Reference indicates the status of the terminal block. To enable Module Status reporting, the Module Status Reference must be configured. During operation, the PLC must be in an I/O Enabled mode for the current Module Status to be scanned and updated in reference memory.

Chapter 14 Special-Purpose Modules

This chapter describes special-purpose modules for PACSystems RX3i controllers:

Module	***Catalog Number***
Serial I/O Processor Module	IC694APU305
I/O Link Interface Module	IC694BEM320
I/O Link Master Module	IC694BEM321
Genius Bus Controller Module	IC694BEM331
DeviceNet Master Module	IC694DNM200
Motion Mate Module	IC694DSM314
Motion Controller Module	IC694DSM324
Ethernet Interface Module	IC695ETM001
Profibus Master Module	IC695PBM300
Profibus Slave Module	IC695PBS301

Serial I/O Processor Module: IC694APU305



The PACSystems RX3i I/O Processor module (IC694APU305) provides direct processing of rapid pulse signals for industrial control applications such as:

- Fast response process control
- Velocity measurement
- Material handling, marking, and packaging

The module is able to sense inputs, process the input information, and control the outputs without needing to communicate with a CPU.

Features

- Up to 12 positive logic (source) inputs with input voltage range selection of either 5 VDC (TTL) or 10 to 30 VDC (non-TTL).
- Up to eight positive logic (source) outputs: four outputs with 1 amp rating and four configurable outputs with 0.5 amp rating
- Outputs protected by replaceable fuse (one fuse for all outputs)
- Counts per Timebase register for input rate measurement
- Total Counts register accumulates total counts received by module
- Four Strobe data registers for input position capture
- Two Timer data registers for indicating input pulse length or input spacing in milliseconds
- Thirty-two range comparators (outputs returned in %I and %AI data)
- Internal module diagnostics

Inputs can be used as count signals or edge-sensitive strobe signals. Outputs can be used to drive indicating lights, solenoids, relays, and other devices.

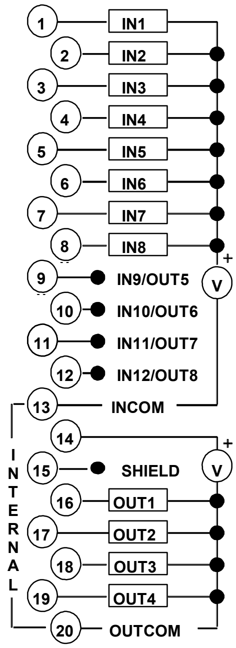
Power to operate the module's logic circuitry is obtained from the 5 VDC bus on the backplane. +24VDC power sources for the input and output devices must be supplied. The I/O Processor module provides a configurable threshold voltage to allow the inputs to respond to either a 5 VDC signal level or a 10 to 30 VDC signal level.

Six green LEDs indicate the operating status of the module, the status of configuration parameters, and the state of hardware outputs 1 through 4.

Specifications: IC694APU305

Power Supply Voltage	5 VDC from backplane
Power Supply Current	360 mA + (10mA x number of ON faceplate outputs)
Field I/O to logic isolation	Peak (1 second): 1500 V Steady State: 30V AC/DC
Maximum Number of modules per RX3i system	No limit
Input Specifications	
Input type	Positive Logic, optically isolated. Note: Input Common is internally connected to Output Common
Input Circuit Power	Supplied by module using DC/DC converter
Encoder Power	Supplied by user (5V or 10–30V DC). (Inputs will operate with Output Circuit power dis-connected)
Input Impedance	4300 ohms typical
Input Threshold	8.0v (non–TTL), 1.5V (TTL)
Input Hysteresis	250 mV typical
Maximum Input Voltage	+30 VDC
Input duty cycle limit	If Input 1–12 voltages exceed 24.0V, derate total input duty cycle from 100% at 40° C to 50% at 60° C
Input filter delays	Absolute Encoder: 20 ms AQUADB Encoder & Preload: 20 ms / 2 ms selectable AQUADB Home Switch: 10 ms AQUADB IN: 6–810 ms
Minimum Strobe Input pulse width	2 ms
Maximum Count Rate	30 khz (Absolute Encoder) 200 khz (A Quad B Encoder)
Input Cable	Shielded cable recommended, Maximum length: 30m
Output Specifications	
Output type	Positive Logic, optically isolated
Maximum Supply Voltage	30.0 VDC
Continuous Output Current (10–30 VDC supply)	1.0 A (each output 1–4) 0.5 A (each output 5–8)
Total Continuous Output Current at 40° C	4.0 A (total of outputs 1–8)
Output 1–4 derating above 40° C	Derate total Output 1–4 current to 2.0A at 60° C
Output 5–8 derating above 40° C	Derate total Output 5–8 current to 0.5A at 60° C
Output current using 5 VDC supply	20 mA typical with 5.0 VDC supply 2 mA minimum with 4.9 VDC supply
Inductive Load Clamp Voltage	–8.0 V typical (outputs 1–4) –1.0 V typical (outputs 5–8)
OFF state leakage current	10 mA (each output)
Output Fuse	5 A (5x20mm replaceable) common to all outputs
Output Response Time	500 ms typical

Field Wiring: IC694APU305



The I/O Processor Module has a removable terminal strip for connection to field devices.

Caution

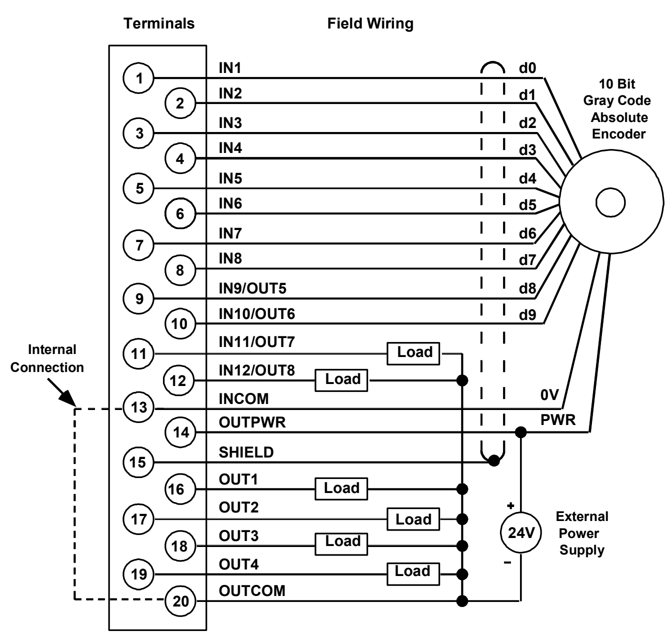
Do not apply loads greater than 0.5 Amp to the OUT5 through OUT8 outputs (terminals 9 through 12), or 1.0 Amp to OUT 1 through OUT4 (terminals 16 through 19). Doing so may damage the module.

Notes

- Pin 13 (Input Common) and pin 20 (Output Common) are internally connected together in the IOP module.
- All 12 I/O Processor inputs are positive logic (source) type.
- Transducers using TTL open collector outputs must include a 2000 Ohm (maximum) pullup resistor (to 5V) to guarantee compatibility with the inputs.

Transducers using high voltage open collector (sink) type outputs must have a 1K–ohm (maximum) pullup resistor to +12V for compatibility with the 10 to 30 volt input range.

Typical Connections



Configurable Parameters: IC694APU305

Settings Tab

Reference Addresses and Lengths	32 discrete inputs (%I), 15 words of analog inputs (%AI), 32 discrete outputs (%Q), and 6 words of analog outputs (%AQ).
Input Threshold	Selects the Input voltage level to be used. If 5 VDC inputs are used, select TTL, otherwise select Non-TTL (for 10–30 VDC inputs). *Default: Non-TTL*
In Timer #1 Mode	Selects the inputs that control the starting and stopping of Timer 1. The resulting time recorded for Timer 1 is reported in the eleventh %AI word. IN10 causes Timer 1 to report the elapsed time (in milliseconds) from the configured edge of input 10 to the other edge of input 10. IN09-10 causes Timer 1 to report the elapsed time (in milliseconds) from the configured edge of input 10 to the configured edge of input 9. *Default: IN10*
In Timer #2 Mode	Selects the inputs that control the starting and stopping of Timer 2. The resulting time recorded for Timer 2 is reported in the twelfth %AI word. IN12 causes Timer 2 to report the elapsed time (in milliseconds) from the configured edge of input 12 to the other edge of input 12. IN11-12 causes Timer 2 to report the elapsed time (in milliseconds) from the configured edge of input 12 to the configured edge of input 11. *Default: IN12*
Timebase (mSec)	The timebase for the Counts per Timebase return data (second %AI word). The default is 1000 milliseconds (1 second) resulting in Counts per Timebase return data that indicates input counts per second.
Strobe1 Edge	The strobe 1 (Input 9) trigger edge: positive (rising) or negative (falling).
Strobe2 Edge	The strobe 2 (Input 10) trigger edge: positive (rising) or negative (falling).
Strobe3 Edge	The strobe 3 (Input 11) trigger edge: positive (rising) or negative (falling).
Strobe4 Edge	The strobe 4 (Input 12) trigger edge: positive (rising) or negative (falling).
Strobe1 Enable	Selects whether strobe 1 (Input 9) is Always enabled (default selection) or is only enabled when preset output 5 is On (Rcomp-05 selection).
Strobe2 Enable	Selects whether strobe 2 (Input 10) is Always enabled (default selection) or is only enabled when preset output 6 is On (Rcomp-06 selection).
Strobe3 Enable	Selects whether strobe 3 (Input 11) is Always enabled (default selection) or is only enabled when preset output 7 is On (Rcomp-07 selection).
Strobe4 Enable	Selects whether strobe 4 (Input 12) is Always enabled (default selection) or is only enabled when preset output 8 is On (Rcomp-08 selection).
Output 5	Selects whether point 9 is output or an input. Disabled (default) defines the point as Input #9. Enabled defines it as output #5.
Output 6	Selects whether point 10 is an output or an input. Disabled (default) defines the point as Input #10. Enabled defines it as output #6.
Output 7	Selects whether point 11 is an output or an input. Disabled (default) defines the point as Input 11. Enabled defines it as output #7.
Output 8	Selects whether point 12 is to be used for an output or an input. Disabled (default) defines the point as Input #12. Enabled defines it as output #8.
Outputs Default	The state outputs will assume if the CPU's output mode is set to Outputs Disabled or the CPU is no longer available. Continue (default) indicates that outputs continue to operate under control of the input counts to the I/O Processor. Force Off causes the outputs to be forced to off Hold Last State causes the I/O Processor to retain the last state of the outputs.

Function	ABS-256 (default): Encoder 8-bit parallel gray code input (for 0–255 counts) ABS-360: Encoder 9-bit parallel (excess 76 gray code for 0–359 count rollover) ABS-512: Encoder 9-bit parallel gray code (for 0–511 counts) If ABS-360 or 512 is selected, Input 9 is not available for a strobe Input and Output 5 is unavailable. ABS-1024: Encoder 10-bit parallel gray code (for 0–1023 counts) If ABS-1024 is selected, Inputs 9 and 10 are not available for strobe Inputs and Outputs 5 and 6 are unavailable. AQUADB: Encoder AQUADB input selection
Encoder Direction	Changes the count direction (up or down) without reversing the Absolute Encoder direction of rotation. If Normal (default) is selected, increasing the count input causes the IOP to register up counts and decreasing the count input causes the IOP to register down counts. The Reverse selection produces the opposite effect.
Position Offset	Adjusts the count input with an offset value to compensate for a rotational offset error in the Encoder coupling. Enter any required count value within the count range. *Default: 0*

A Quad B Encoder Parameters

Input Filter	The Input filter range for the AQUADB Count inputs, the Marker input, and the Preload input. If the maximum count input rate is < 25 khz, use the 20µs default selection, otherwise use the 2µs selection. *Default: 20µs*
Max Counts	The count range for the internal counter registering the AQUADB input counts. It counts from 0 to this maximum value and then rolls over to 0. The range for this parameter is 10 to 64,999 counts. *Default: 255*
Preload Position	The initializing count value to be set into the input counter when the Preload command is received by the I/O Processor. The Preload command can be from either the Preload input or the %Q bit command. *Range: 0 to maximum counts*
Home Position	The initializing count value to be set into the input counter when the Marker input is received by the I/O Processor when executing the Home cycle. *Range: 0 to maximum counts*

ABS or AQUADB Encoder Parameters

These parameters are repeated for each output.

Mode	The type of pulse generated by the range comparator output. Preset (the default) causes the output to be On (or Off) continuously from one preset point to the other. Timer causes timed pulses to be produced at the preset points defined by Timer 1 and Timer 2.
ON Preset	The count input value that causes the output to turn On. Can be any value in the count range. *Default: Maximum encoder value for Absolute Encoders, 255 for AQUADB mode*
OFF Preset	The count input value that causes the output to turn Off. Can be any value in the count range. *Default: 0*
Timer# 1 (mSec)	Effective only when the output mode is Timer. The length of the pulse (in milliseconds) produced by the output when the input count reaches the On preset value. 0 specifies no output pulse at the On preset point. Default: 0
Timer #2 (mSec)	Effective only when the output mode is Timer. The length of the pulse (in milliseconds) produced by the output when the input count reaches the Off preset value. 0 specifies no output pulse at the Off preset point. Default: 0

Module Data: IC694APU305

Each CPU sweep, the I/O Processor Module automatically exchanges the following status and command data, with the CPU:

- Status Bits: 32 bits of %I data
- Status Words: 15 words of %AI data
- Discrete Commands: 32 bits of %Q data
- Immediate Command Data: 6 words of %AQ data

%I Status Bits

The Starting Address of the Status Bits is selected during configuration. The table below lists bit offsets from the Starting Address.

Offset	Description	Offset	Description
00	Range Comparator 1 status	16	Input 9 status
01	Range Comparator 2 status	17	Input 10 status
02	Range Comparator 3 status	18	Input 11 status
03	Range Comparator 4 status	19	Input 12 status
04	Range Comparator 5 status	20	Strobe 1 status (Input 9 latch)
05	Range Comparator 6 status	21	Strobe 2 status (Input 10 latch)
06	Range Comparator 7 status	22	Strobe 3 status (Input 11 latch)
07	Range Comparator 8 status	23	Strobe 4 status (Input 12 latch)
08	Range Comparator 9 status	24	Home Found*
09	Range Comparator 10 status	25	Preload Latch status*
10	Range Comparator 11 status	26	Home Switch Input (IN5) status*
11	Range Comparator 12 status	27	IN6 status*
12	Range Comparator 13 status	28	IN7 status*
13	Range Comparator 14 status	29	IN8 status*
14	Range Comparator 15 status	30	Module Ready
15	Range Comparator 16 status	31	Error

* Applies to AQUADB function only

%I Status Bit Descriptions

Range Comparator 1-8 Status	The ON/OFF state for range comparator outputs 1-8. If the Output Mode = Preset, the state of the status bit is defined by the ON/OFF presets. If the Output Mode = Timer, the status bit will be on after each preset point is passed for the length of time designated by Timer 1 or Timer 2. These bits always indicate the output state for range comparators 1-8, even if the corresponding hardware output is disabled (and Terminal Points 9-12 are used as Inputs).
Range Comparator 9-16 Status	The ON/OFF state for range comparator outputs 9-16 based solely on the ON & OFF presets defined for each output.
Input 9-12 Status	The present on/off input status for Inputs 9-12. State changes in these inputs produce strobe inputs 1-4 according to the configured strobe edge (input 9 = strobe 1, input 10 = strobe 2, etc.).
Strobe 1-4 status (Input 9-12 latch)	Indicates that strobe data has been captured by Inputs 9-12, respectively. Once acknowledged, the corresponding %Q command (Reset Strobe) should be sent to clear the strobe status for future strobe captures. *Following strobes will be locked out until this flag is cleared*.
Home Found (AQUADB only)	Indicates that the Home marker, after a Home command sequence, has been recognized and the AQUADB Input Counter has been set to the Home preload value.
Preload Latch Status (AQUADB only)	Indicates that the AQUADB input counter has been preloaded by a Preload Input. When acknowledged, this status indication should be cleared (by the Reset Preload Latch %Q bit). *This latch locks out the effect of the Preload Input, it will not be effective again until this bit is cleared. This latch does not apply to the %Q preload command bit.*
Home Switch Input (AQUADB only)	The status of the Home switch input. When this switch is closed during the Home cycle, the next encoder marker encountered will preload the counter with the configured Home value and set the Home Found %I indication. If a Home Switch is not used, this %I bit can be used as a general-purpose input reporting the status of faceplate Input 5.
IN6, IN7, IN8 (AQUADB only	The on/off status of Inputs 6, 7, & 8.
Module Ready	Powerup tests have all completed successfully and the module is ready for operation.
Error	An error condition has been detected by the module. The error code is reported in the the first %AI word. If the error was caused by a bad data command, the data has been ignored. Once acknowledged by the program, the %Q command (Clear error) must be toggled to clear the error status.

%AI Data Words

The following %AI Data words are transferred automatically to the CPU each sweep. The Starting Address of the Status Words is selected during configuration. The table below lists bit offsets from the Starting Address.

Offset	Description
000	Module Status Code
001	Counts per timebase
002	Gray Code Encoder Data*
003	Binary Data
004-005	Total Counts
006	Strobe Data 1 (Input 9)
007	Strobe Data 2 (Input 10)
008	Strobe Data 3 (Input 11)
009	Strobe Data 4 (Input 12)
010	Start/Stop Timer 1 Data
011	Start/Stop Timer 1 Data
012	Range Comparator 17-32 status (16 bits)
013, 014	reserved

* Not applicable for the AQUADB function selection.

%AI Data Word Descriptions

<table>
<tr><td rowspan="8">Module Status Code</td><td colspan="2">Indicates the Error identification code when an error has been detected. The error identified is the first error encountered. The error condition must be cleared before other errors will be reported.</td></tr>
<tr><td>Error Code</td><td>Description</td></tr>
<tr><td>0010</td><td>Encoder Position Offset out of range (ABS Encoder Function only)</td></tr>
<tr><td>xx11</td><td>ON Preset xx is out of range</td></tr>
<tr><td>xx12</td><td>OFF Preset xx is out of range</td></tr>
<tr><td>0015</td><td>Home Position out of range (AQUADB Function only)</td></tr>
<tr><td>0016</td><td>Preload Position out of range (AQUADB Function only)</td></tr>
<tr><td>001E</td><td>AQUADB Input Quadrature error (AQUADB Function only)</td></tr>
<tr><td>Counts per Timebase</td><td colspan="2">Indicates the number of input counts received in the last time interval defined by the Timebase configuration parameter. With the default Timebase (1000 ms), this indicates counts per second.</td></tr>
<tr><td>Gray Code Encoder Data</td><td colspan="2">Indicates the Gray code value presently being received by the module inputs from the Encoder parallel outputs (ABS Encoder only)</td></tr>
<tr><td>Binary Data</td><td colspan="2">The binary equivalent of the Gray code value being received by the module inputs from the Encoder parallel outputs, or the input counter Binary count value for the AQUADB selection.</td></tr>
<tr><td>Total Counts</td><td colspan="2">The total input counts received by the module. This total counts register can be initialized (preloaded) by a %AQ data command from the CPU. It is initialized to 0 at powerup. For AQUADB operation, it is also initialized to 0 at the Home position marker. In AQUADB mode, the Preload Input does not affect Total Counts.</td></tr>
<tr><td>Strobe Data 1-4</td><td colspan="2">The captured input binary data value recorded when the strobe input occurred. Inputs 9-12 correspond to Strobe inputs 1-4, respectively. Either input edge may be configured to trigger the strobe data capture.</td></tr>
<tr><td>Start/Stop Timer 1 Data</td><td colspan="2">The time (in ms) between the input edges of Input 10 (default) or the input edges of Inputs 9-10 depending upon the configuration. To start the capture of this timing data, the strobe latch for Input 10 must be cleared, and if the strobe 2 enable configuration is RCOMP–6, the output range comparator 6 must be on when the Input 10 strobe occurs. If Input 9 is used to stop the time measurement and the strobe 1 enable configuration is RCOMP–5, output range comparator 5 must be on (when strobe input occurs) before the timing will stop.</td></tr>
<tr><td>Start/Stop Timer 2 Data</td><td colspan="2">The time (in ms) between the input edges of Input 12 (default) or the input edges of Inputs 11-12 depending upon the configuration. To start the capture of this timing data the strobe latch for Input 12 must be cleared, and if the strobe 4 enable configuration is RCOMP–8, output range comparator 8 must be on when the Input 12 strobe occurs.

If Input 11 is used to stop the time measurement and the strobe 3 enable configuration is RCOMP–7, output range comparator 7 must be on (when strobe input occurs) before the timing will stop.</td></tr>
<tr><td>Range Comparator 17-32 status (16 bits)</td><td colspan="2">Indicates the ON/OFF state for range comparator outputs 17-32 based solely on the ON and OFF presets defined for each output.</td></tr>
</table>

%Q Control Bits

The following %Q Control Bits are transferred automatically to the CPU each sweep. The Starting Address of the Control Bits is selected during configuration. The table below lists bit offsets from the Starting Address.

Offset	***Description***	***Offset***	***Description***
00	Enable Output 1	16 - 19	reserved
01	Enable Output 2		
02	Enable Output 3		
03	Enable Output 4		
04	Enable Output 5 (only if cfg = enabled)	20	Reset Strobe 1 (Input 9 latch)
05	Enable Output 6 (only if cfg = enabled)	21	Reset Strobe 2 (Input 10 latch)
06	Enable Output 7 (only if cfg = enabled)	22	Reset Strobe 3 (Input 11 latch)
07	Enable Output 8 (only if cfg = enabled)	23	Reset Strobe 4 (Input 12 latch)
08 - 15	reserved	24	Home Command*
		25	Reset Preload Latch*
		26	Preload Command*
		27 - 30	reserved
		31	Clear Error

* Applies to AQUADB function only.

%Q Control Bit Descriptions

Enable Output 1-8	Enables each hardware Output (ON = Enable). If the configuration for Outputs 5-8 is DISABLED, these corresponding output bit commands have no effect.
Reset Strobe 1-4 (Input 9-12 Latch)	Clears the respective strobe latch condition so the next strobe can be captured and reported via the corresponding %I bits. If this %Q bit is held ON, the %I status bit will stay OFF and every strobe input pulse will cause new strobe data to be captured in the associated %AI strobe register.
Home Command (AQUADB only)	Initiates the Home command sequence. When the Home Marker Input is recognized, the input counter will be preloaded with the configured home value, and the Home Found %I indication will be set.
Reset Preload Latch (AQUADB only)	Clears the Preload Latch status after it has been set by the Preload switch Input. If this command is left on, it will allow all Preload switch inputs to be effective.
Preload Command (AQUADB only	Preloads the input counter with the configured preload value. The Preload Latch status %I indication will not be set by this command since it only applies to the Preload faceplate input.
Clear Error	Toggling this command ON clears the module status error condition reported by the %I Error bit and the %AI module status word and thus allows another error condition to be reported.

%AQ Immediate Commands

Six %AQ words are sent automatically from the CPU to the I/O Processor Module during each sweep. These words can be used to transfer immediate command data to the module for temporarily altering configuration parameters or to initialize counter data. Configuration parameter changes made in this manner do not affect the module configuration data (stored in the CPU) which will again become effective if the module is power cycled.

Each immediate command requires three sequential %AQ words. Two immediate commands are always sent during each PLC sweep. The first word of each command set contains the identifying command number and the other two words contain the data. The actual address of each command word depends on the starting address configured for the %AQ references.

Even though the commands are sent each sweep, the module will act on a command *only* if the command has changed since the last sweep. When any of the three–word data changes, the module accepts the data as a new command and responds accordingly.

When these commands are sent, all three %AQ words should be loaded on the same PLC sweep. If they cannot be loaded on the same sweep (for example, when entering data from the programmer), the steps below must be followed to ensure that no wrong or incomplete data is momentarily sent.

Step 1) Set Word 1 to Null Command (0000).

Step 2) Set correct data in Words 2 and 3.

Step 3) Set command in Word 1.

The following immediate commands may be sent by %AQ data to the I/O Processor:

Command	**Data**		**Command # (hex)Word 1**
	Word 3	**Word 2**	
Null	(not used)	(not used)	0000
Load Home Position (AQUADB) [1]	(not used)	Home Position	0101
Load Preload Position (AQUADB) [1]	(not used)	Preload Position	0102
Load Timebase	(not used)	Timebase (ms)	0106
Load Encoder Position Offset [2]	(not used)	Offset	0107
Load Total Counts	(not used)	Counts	0109
Load ON/OFF Preset Pairs 1-32	OFF preset	ON preset	0140 - 015F
Load Output Timer 1.1-8.1	(not used)	Time (ms)	01C0 - 01C7
Load Output Timer 1.2-8.2	(not used)	Time (ms)	01D0 - 01D7

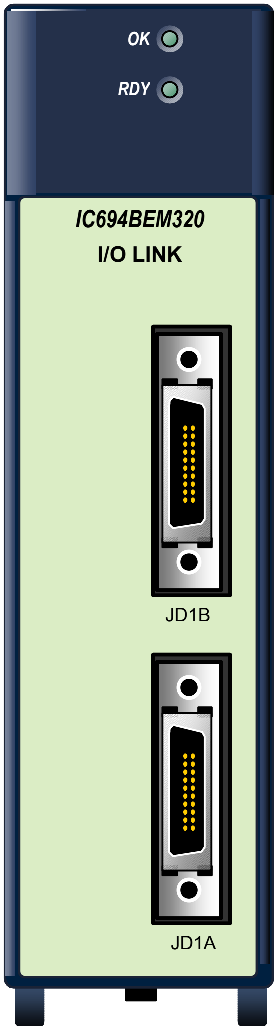
[1] AQUADB function only

[2] ABS Encoder function only

%AQ Immediate Command Descriptions

Null	The default %AQ Immediate command. Since the %AQ words are transferred each PLC sweep, you should always enter the Null command to avoid inadvertent execution of another immediate command.
Load Home Position (AQUADB)	The Home reference position value that will be preloaded into the Input counter at the marker location after a Home command.
Load Preload Position (AQUADB)	The position value that will be preloaded into the Input Counter when a Preload Switch Input is recognized or the %Q Preload command is set.
Load Timebase	The timebase to be used for determining the Counts per Timebase value returned in the second %AI word assigned to the module.
Load Encoder Position Offset (ABS Encoder Function only)	The Encoder offset value. The Input Count Value is shifted relative to the Encoder Input by this amount as follows: Input Count Value = Encoder Input - Offset
Load Total Counts	The Total Count value reported in the fifth and sixth %AI words assigned to the module
Load ON/Off Preset Pairs 1-32	The ON and OFF preset value for the specified range comparator output.
Load Output Timer 1.1-8.1	The Output Timer 1 value for the specified range comparator output 1-8.
Load Output Timer 1.2-8.2	TShe Output Timer 2 value for the specified range comparator output 1-8.

I/O Link Interface Module: IC694BEM320



The RX3i I/O Link Interface Module operates as a slave on a Fanuc I/O Link network. It can exchange either 32 or 64 inputs and outputs with the master. Typical masters on the I/O Link include all modern FANUC CNCs and Power Mates, PACSystems controllers and Series 90 PLCs equipped with an I/O Link Master Module.

An I/O Link Interface Module occupies one module slot in an RX3i backplane. It can be installed in any available backplane slot.

The maximum number of I/O Link Interface Modules that can be installed in the backplane depends on the power that is available from the power supply. To determine the exact number of modules allowed in your system, see the information on power supplies in chapter 3.

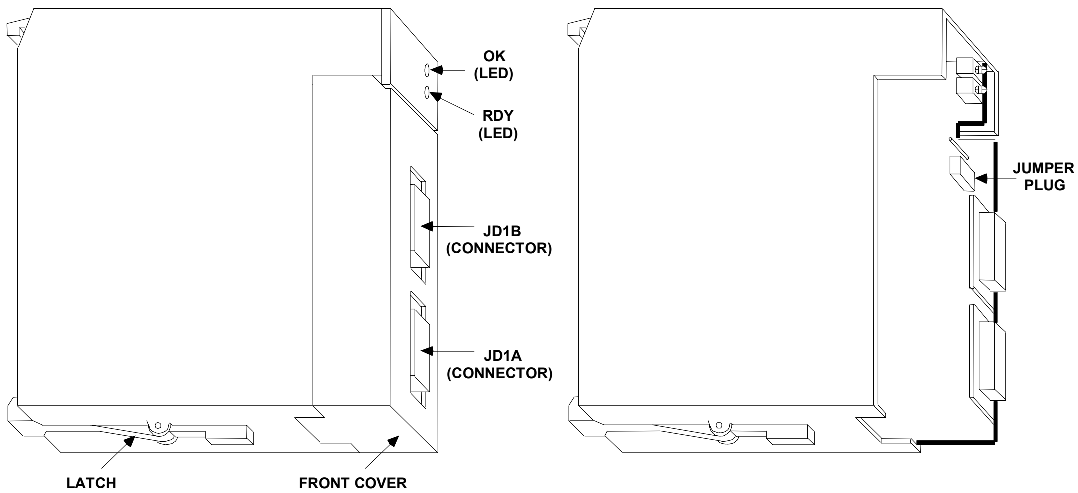
Usually, when there are multiple I/O Link Interface Modules in the same RX3i system, they are on separate I/O Links. However, it is possible to have more than one I/O Link Interface Module in the system connected to the same link, if that suits the needs of the application.

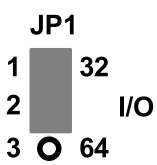
Module Specifications

Module type	Series 90–30 PLC module, providing I/O Link communications with I/O master.
LEDs	OK, RDY
I/O Points	32 or 64, jumper selectable
+5V current	without Optical Adapter connected: 205mA with Optical Adapter: 405 mA
User Manual	*RX3i I/O Link Interface Modules User's Manual*, GFK-2358

Module Description

The module's front cover is removable. A jumper plug inside the front cover is used to set up the module as a 32–point or 64–point I/O module. The factory default is 32.





To select 32 inputs and outputs, the jumper should be on the top and middle pins as shown at left.

To select 64 inputs and outputs, the jumper should be on the middle and bottom pins.

LEDs

The module has two LEDS that show its operating, and communications status.

OK: indicates the module's operating status.

RDY: indicates the module's communications status.

After power–up, the OK LED should remain ON. The RDY LED turns ON after the I/O Link master has established communications with the module.

Serial Ports

The front of the module has two 20–pin connectors that are used to attach the I/O Link cable. One connector is for the cable to the previous device on the link—either the master or another slave. The other connector is for the cable to the next slave on the link, if there is one. See the *RX3i I/O Link Modules User's Manual*, GFK-2358 for more information. Signal levels are RS422/485 compatible.

I/O Link Master Module: IC694BEM321

The RX3i I/O Link Master module (IC694BEM321) allows a PACSystems RX3i controller to act as a master on a proprietary Fanuc I/O Link. The master can receive 1024 discrete inputs from slaves, and send up to 1024 discrete outputs. Typical items running under the control of an I/O Link Master can include clusters of I/O (such as I/O Model A and Connector Panel I/O), PACSystems and Series 90 PLCs with I/O Link Interface (slave) modules, and Operator Panels that are I/O Link-compatible.

An I/O Link Master Module can be installed in any available slot in any RX3i backplane. For best performance, it should be installed in the Main Backplane or in an Expansion Backplane. The maximum number of I/O Link Master Modules that can be installed in the backplane depends on the power that is available from the power supply. To determine the exact number of modules allowed in your system, see the information on power supplies in chapter 3.

If there are multiple I/O Link Master Modules in the same RX3i system, they must be on separate I/O Links.

Specifications: IC694BEM321

Module type	PACSystems RX3i controller module, providing I/O Link communications with up to 16 slaves.
I/O Points	Up to 1024 inputs and 1024 outputs
+5V current required	without Optical Adapter connected: 415mA with Optical Adapter: 615mA
Host CPUs	▪ PACSystems RX3i CPUs ▪ Series 90-30 CPUs (models 311, 313, 321, 323, 331, and 341): release 4.4 or later, and all versions of the CPU models 350, 351, 352, 360, 363, and 364 ▪ Series 90-30 Hand-held Programmer (HHP)
User Manual	*RX3i I/O Link Interface Modules User's Manual*, GFK-2358

LEDs

The module has three LEDS that show its operating and communications status.

OK	*CFG*	*ACTV*	*Meaning*
off	off	off	No power to module, or powerup in progress
on	off	off	Module powered up but not configured
on	on	off	Module powered up and configured with minimum configuration (input status reference assigned and output status reference assigned), but link is not yet active, or has been activated but has gone down
on	on	on	Normal operation with active link

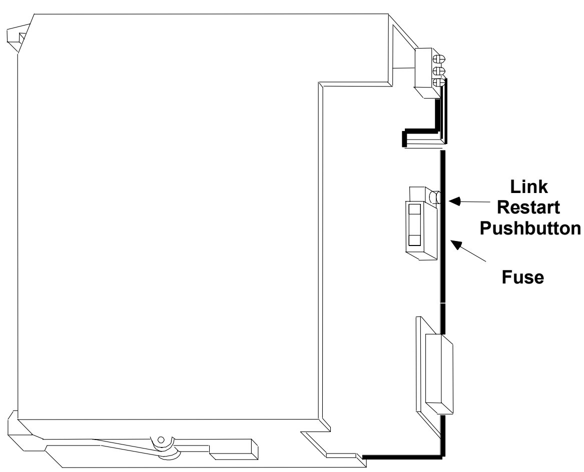
After power–up, the OK LED should stay ON. The CFG LED goes on after the CPU supplies the module configuration. The ACTV LED goes on when link communications have been established.

Restart Pushbutton

The LINK RESTART pushbutton can be used to restart the operation of the link if a failure occurs.

Note

Pushing the LINK RESTART button while the link is operating has no effect. If the link stops operating, all slaves must be power–cycled before using the LINK RESTART pushbutton to restart operation of the link.



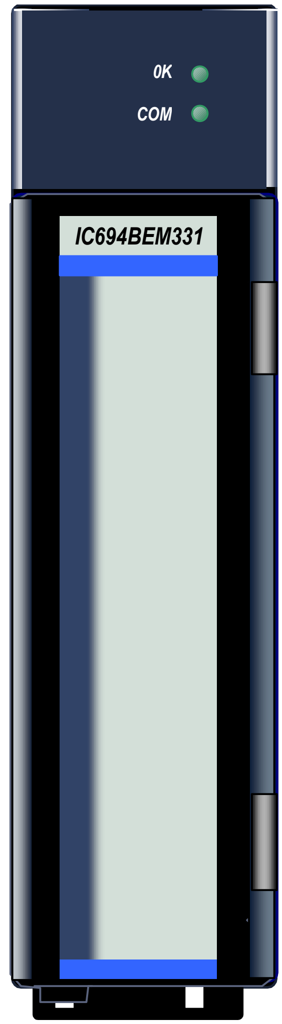
Fuse

The module's front cover is removable. A fuse located directly below the Restart pushbutton protects the +5 volt signal pins used by Optical Adapter cable. It is a replaceable 0.5A fast–blow fuse (5mm diameter x 20mm length).

Serial Port

The front of the module has one 20–pin, Honda–type connector, used for connection to the first slave on the I/O Link. Signal levels are RS422/485 compatible.

Genius Bus Controller: IC694BEM331



The Genius Bus Controller, IC694BEM331, interfaces a PACSystems RX3i and a Genius I/O serial bus. In addition to the Bus Controller, the bus can serve: Genius blocks, other PLCs with Genius Bus Controllers, Remote Drops, VersaMax and Field Control I/O Stations, Genius Hand-Held Monitor (HHM), Multiple hosts.

Features

- The Bus Controller can exchange up to 128 bytes with each device on the Genius I/O bus.
- Genius blocks and other devices on the bus automatically report faults, alarms and certain other predefined conditions to the Bus Controller. The Bus Controller stores any diagnostic messages it receives. They are read automatically by the CPU. Faults can then be displayed in the fault table using the programming software.
- The Bus Controller supports all Genius datagrams. Refer to chapter 3 of the Genius I/O System and Communications User's Manual, GEK-90486-1, for details on using datagrams.
- The Bus Controller can send up to 128 bytes of Global Data each bus scan. Global Data is data that is automatically and repeatedly broadcast by a Genius Bus Controller.
- The Bus Controller can receive up to 128 bytes of Global Data each bus scan from every other Bus Controller on its bus.

Up to eight Genius Bus Controllers can be included in an RX3i system.

LEDs

The LEDs on the front of the Genius Bus Controller indicate its operating status. Both LEDs should be On during normal operation.

OK Shows the status of the Bus Controller. This LED turns on after power up diagnostics are completed.

COM Shows the status of the Genius communications bus. This LED is on steadily when the bus is operating properly. It blinks for intermittent bus errors and is off for a failed bus. It is also off when no configuration has been received from the CPU.

Specifications: IC694BEM331

Current Consumption	
Diagnostics	Advanced diagnostics capabilities
Communications	Global Data and Datagrams
Data Length	128 bytes per message
Data Rates	Configurable: 153.5Kbaud standard/extended, 76.8Kbaud, or 38.4Kbaud
Genius Bus Specifications	
Bus Type	Daisy-chained bus cable; single twisted-pair plus shield or Twinax. Fiber optical cable and modems can also be used.
Bus Termination	75, 100, 120, or 150 Ohm resistor at both ends of electrical bus cable.
Maximum Bus Length	7800 feet at 38.4Kbaud, 4500 feet at 76.8Kbaud, 3500 feet at 153.6Kbaud extended, 2000 feet at 153.6Kbaud standard. Maximum length at each baud rate also depends on cable type, as listed in the *Genius System and Communications Manual*.
Maximum Number of Devices	32 devices at all baud rates except 38.4Kbaud. 16 devices at 38.4Kbaud.
Isolation	2000 volts Hi-Pot, 1500 volts transient common mode rejection.

Refer to Appendix A for product standards and general specifications.

Compatibility

Specific equipment or software versions required for compatibility with the Bus Controller are listed below.

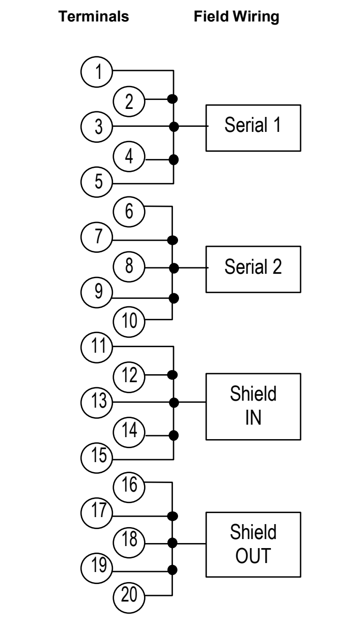
Series 90-30 PLC	If the RX3i Genius Bus Controller is installed in a Series 90-30 PLC, the CPU model can be: IC693CPU311K, 321K, 331L or later, or any version of the IC693CPU313, 323, 340, 341, 350, 351, 352, 360, 363, and 364. The CPU firmware must be release 5.0 or later.
Series Six PLC	To exchange global data with an RX3i Genius Bus Controller, a Series Six Bus Controller must be catalog number IC660CBB902F/903F (firmware version 1.5), or later.
Genius Hand-Held Monitor	There is no Hand-Held Monitor connector on the module, but a Hand-Held Monitor can communicate with the Bus Controller while connected to any other device on the bus. HHM version IC660HHM501H (revision 4.5) or later is required.
Genius Bus	The Genius bus is a shielded twisted-pair wire, daisy-chained between devices, and terminated at both ends. Proper cable selection is critical to successful operation of the system. Suitable cable types are listed in GEK-90486-1, the *Genius I/O System and Communications User's Manual*.

Genius System Documentation

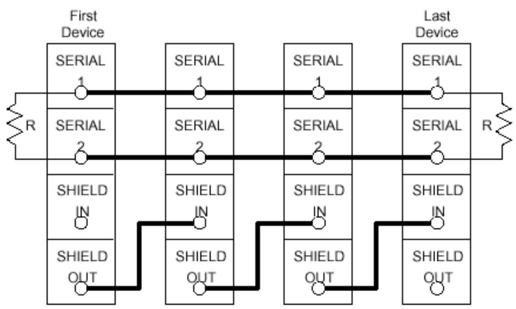
See the following manuals for detailed information on the Genius I/O system:

- GEK-90486-1, *Genius I/O System and Communications User's Manual*
- GEK-90486-2, *Genius I/O Discrete and Analog Blocks User's Manual*

Field Wiring: IC694BEM331



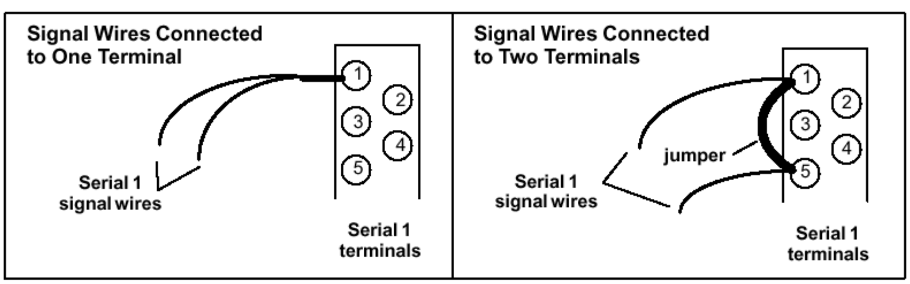
Using the cable type selected for the application, connect the devices as shown below. Each terminal accepts up to one AWG #14 (2.10mm^2) wire or two AWG #16 (1.32mm^2) wires using ring or lug-type connectors.



The bus shield wires are not insulated; do not permit them to touch other wires or terminals. Spaghetti tubing should be used to cover these wires.

1. Connect the Serial 1 terminals of adjacent devices and the Serial 2 terminals of adjacent devices.
2. Connect Shield In to the Shield Out terminal of the previous device. (For the first device on the bus, Shield In is not connected.)
3. Connect Shield Out to the Shield In terminal of the next device. (For the last device on the bus, Shield Out is not connected.)

The Serial 1 and Serial 2 terminals are interconnected *on the circuit boar*d, not on the terminal strip. Incoming and outgoing signal wire pairs can be connected to either one or two Serial 1 or Serial 2 terminals:



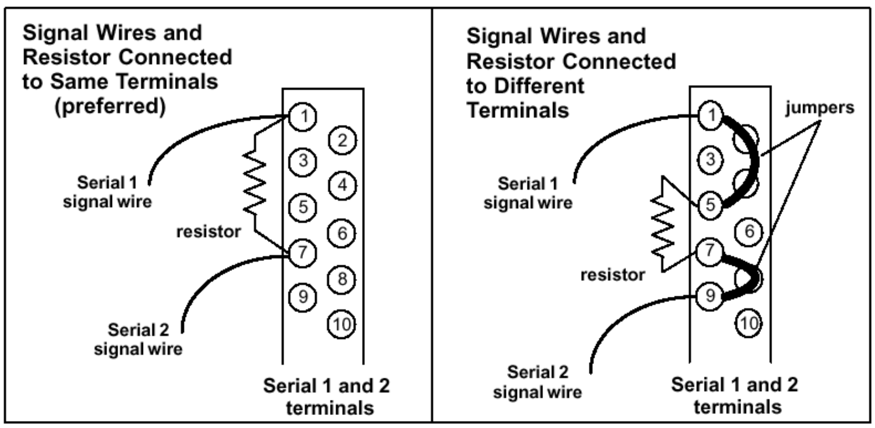
When connecting two signal wires to the same terminal, use spade or lug-type connectors, or twist the exposed ends of the wires together before inserting them. This will allow future removal of the Terminal Assembly without disrupting other devices on the bus.

When connecting two signal wires to separate terminals, install a jumper between the two terminals as shown on the right above. Failure to install the jumper will cause the entire bus to be disrupted whenever the faceplate is removed.

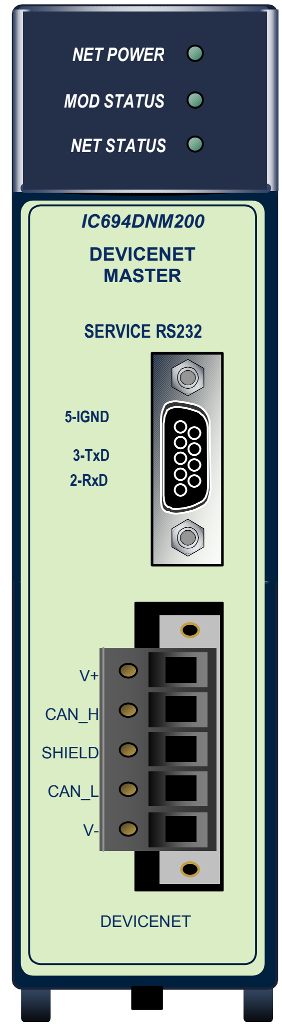
Terminating the Bus

The bus must be terminated at both ends by its characteristic impedance. The list of suitable cable types in *the Genius I/O System and Communications User's Manual* includes the termination requirements for each cable type. If the Bus Controller is at the end of the bus, install a resistor of the appropriate impedance across its Serial 1 and Serial 2 terminals as shown below.

If you need to install the terminating resistor across terminals different than those used for the signal wires, attach jumper wires between the signal wire terminals and the resistor terminals to prevent the bus from becoming unterminated if the Terminal Assembly is removed. Failure to do so will cause the entire bus to be disrupted whenever the faceplate is removed.



DeviceNet Master Module: IC694DNM200



The DeviceNet Master Module allows the CPU to send and receive data over a DeviceNet network. It can act as master for up to 63 slaves on the DeviceNet network. It can also be configured to simultaneously function as a slave to another master on the bus.

DeviceNet is a communications network that transmits data between control systems (for example: PLCs, PCs, VMEbus computers, and robot controllers) and distributed industrial devices such as switches, sensors, valve manifolds, motor starters, bar code readers, drives, displays, and operator interfaces.

This module can be installed in any available I/O slot in any RX3i or Series 90-30 backplane. It is compatible with PACSystems™ RX3i IC695CPU310 CPU, release 3.5 or later. It is also compatible with any Series 90-30 CPU except IC693CPU321 or IC693CPU340 with release 8.0 or later CPU firmware. Release 10 or later is recommended. Machine Edition Logic Developer PLC version 3.0 SP1 Special 2 or later is required. This module is not compatible with VersaPro™, Control, or Logicmaster™ programming software. A Series 90-30 Hand-Held Programmer (IC693PRG300) cannot be used for configuration.

Features

- Bus communications at all standard DeviceNet data rates (125k, 250k, 500k baud)
- Up to 255 bytes input data transfer and 255 bytes output data transfer per slave.
- Up to 3972 bytes of input data transfer and 3972 bytes of output data transfer per master.
- UCMM-capable Group 2 Server
- One or two I/O connections per Slave - Typically one connection is used for Polled and the other is used for Strobe, Cyclic, or COS
- Supports Unconnected Message Manager (UCMM) with one proxy connection per slave device
- Configurable global scan rate
- Supports Poll, Strobe, Cyclic and COS I/O connections, Fragmented I/O and Explicit Messaging
- Configurable update rates for Poll and COS/Cyclic on a connection basis.
- Configurable response to loss of communication
- Firmware update via service port on module

LEDs and Connectors

The module's three DeviceNet-compliant LEDS show its operating and communications status. The RS-232 serial port is used for a computer connection during firmware upgrades. The DeviceNet connector is a removable spring-clamp terminal. It provides bus continuity and can be removed from the module without disrupting bus operation.

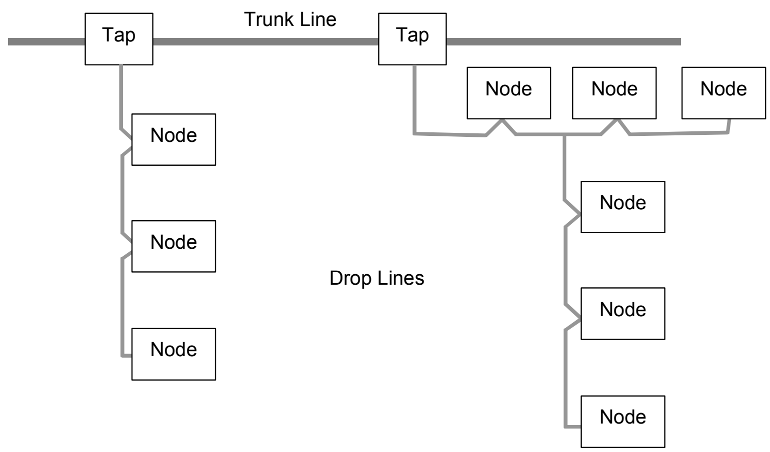
Specifications: IC694DNM200

Backplane Current Consumption	450mA at 5VDC (typical)
Thick Cable General Specifications	Two shielded pairs - Common axis with drain wire in center
	Overall braid shield - 65% coverage; 36 AWG or 0.12mm tinned Cu braid minimum (individually tinned)
	Drain wire- #18 Copper min.; 19 strands minimum (individually tinned)
	Outside diameter - 0.410 inches (min) to 0.490 inches (max.) roundness - radius delta to be within 15% of 0.5 O.D.
Thin Cable General Specifications	Two shielded pairs - Common axis with drain wire in center
	Overall braid shield - 65% coverage; 36 AWG or 0.12mm tinned Cu braid minimum (individually tinned)
	Drain wire - #22 Copper; 19 strands minimum (individually tinned)
	Outside diameter - 0.240 inches (min.) to 0.280 inches (max.) roundness - radius delta to be within 20% of 0.5 O.D.
Network Topology	Bus with limited branching (trunkline/dropline)
Redundancy	Not Supported
Network Power for Node devices	Nominal 24 VDC ±4%
Allowed Nodes (Bridging excluded)	64 nodes
Data Packet Size	0-8 bytes with allowance for message fragmentation
Duplicate Address Detection	Addresses verified at power-up
Error Detection / Correction	CRC - retransmission of message if validity not acknowledged by recipient

For product standards and general specifications, refer to Appendix A:

The DeviceNet Bus

Devices can be connected directly to the trunk cable, or to drop lines that are joined to the trunk cable with taps. Taps can be mounted in junction boxes or panels. Drop lines and daisy-chains are often used inside control panels where multiple devices are grouped together. When using drops with daisy-chains and branches, the maximum length from a tap to its farthest drop is 20 feet.



Bus Length

The maximum length of the trunk cable and drops both depend on the cable type and data rate. Individual drops may not exceed 6 meters and are limited to one network node per drop. However, the node may have multiple ports.

Data Rates	***125kbps***	***250kbps***	***500kbps***
thick cable, trunk length	500m (1640ft)	250m (820ft)	100m (328ft)
thin cable, trunk length	100m (328ft)	100m (328ft)	100m (328ft)
maximum drop length	6m (20ft)	6m (20ft)	6m (20ft)
total length of all drops	156m (512ft)	78m (256ft)	39m (128ft)

For each baud rate, the total drop length is the sum of all the drop lines of both cable types in the network.

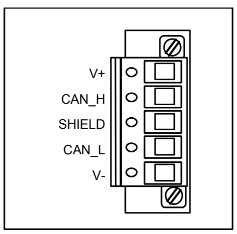
In addition, if the distance from a tap to the most distant device on its drop is longer than the distance from the tap to the nearest terminating resistor, the drop line length also counts as part of the trunk cable length (as well as the overall drop length).

DeviceNet Cable

Either DeviceNet thick cable or thin cable can be used. Thick cable permits greater cable lengths and higher current levels. Generally, thick cable is used for the trunk cable. Thin cable is normally used for shorter distances and is suitable for drop cables and for installations where more cable flexibility is needed. Both thick cable and thin cable are 5-wire, multi-conductor copper cable. Two wires form a transmission line for network communications. A second pair transmits network power. The fifth conductor forms an electromagnetic shield. Most cables have color coded leads which correspond to the color coding on the terminals on the DeviceNet Master Module.

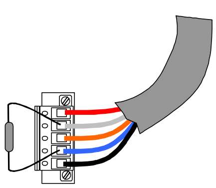
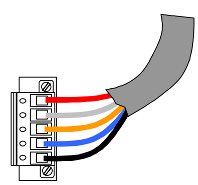
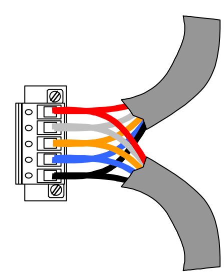
Bus Connector Pin Assignments

The DeviceNet connector on the RX3i DeviceNet Master module has five color-coded screw-clamp terminals.



Signal	***Pin***	***Wire Color***
V+	5	Red
CAN_H	4	White
Shield	3	Bare
CAN_L	2	Blue
V-	1	Black

Wiring to the DeviceNet Master module depends on its location on the network:

<table>
<tr>
<td>121 Ohm, 1% ¼ watt terminating resistors MUST be installed at both ends of the DeviceNet network. The terminating resistor is placed across the data communication signals at pin 2 (CAN_L) and pin 4 (CAN_H).

If the DeviceNet module is located at either end of the bus trunk, it is wired with one cable connection and a terminating resistor:</td>
<td>If the module is installed at the end of a drop or drop segment, it is wired with one cable connection only.
</td>
<td>If the module is installed directly on the trunk cable or as part of a daisy-chained drop cable, it has both an incoming and outgoing cable connected:
</td>
</tr>
</table>

Grounding

All DeviceNet cable shields must be tied to ground at each device connection. This is done by tying the bare wire of the cable to pin 3 (Shield) of the connector.

Power Requirements

The DeviceNet Master module consumes 450mA at 5VDC (typical) from the PLC backplane. This power is used for module operation, The DeviceNet Master powers its network transceiver from the 24VDC DeviceNet network power source. Linear power supplies are recommended for the DeviceNet power source. The DeviceNet power source should *not* also be used for device power. Transients caused by I/O devices can cause communications errors and even create bus-off conditions.

The DeviceNet specification recommends using a power tap to connect a power supply to the network. The power tap should be appropriately fused for the current capacity of the bus cables. The maximum current on the network depends on the cable type.

The DeviceNet network power supply must be grounded, but only at one point. The V- signal must be connected to protective earth ground at the power supply only. If multiple power supplies are used, only one power supply must have V- connected to earth ground.

Current Limit for Thick Cable

For thick cable, the maximum current on the network is 16 Amps. However, only 8 Amps is permitted on a single network segment. 16 Amps can be drawn from a single power supply by locating the power supply at the center point of two network segments, supplying 8 Amps to each segment.

Current Limit for Thin Cable

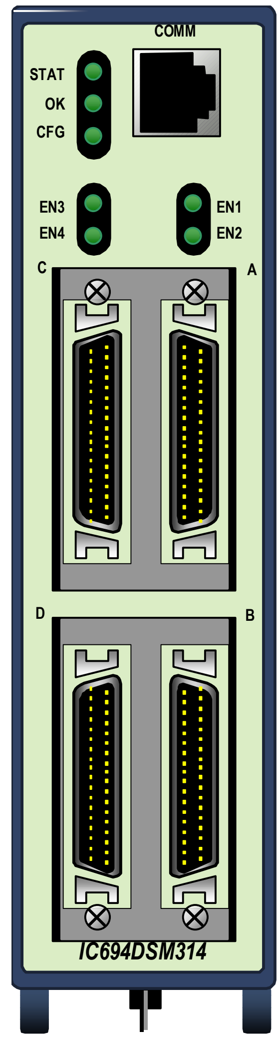
For thin cable, the maximum current permitted is 3 Amps.

Motion Mate Module: IC694DSM314

The Motion Mate Module, IC694DSM314, is a multi-axis motion control module. It supports two control loop configurations:

- Standard Mode (Follower Control Loop Disabled)
- Follower Mode (Follower Control Loop Enabled)

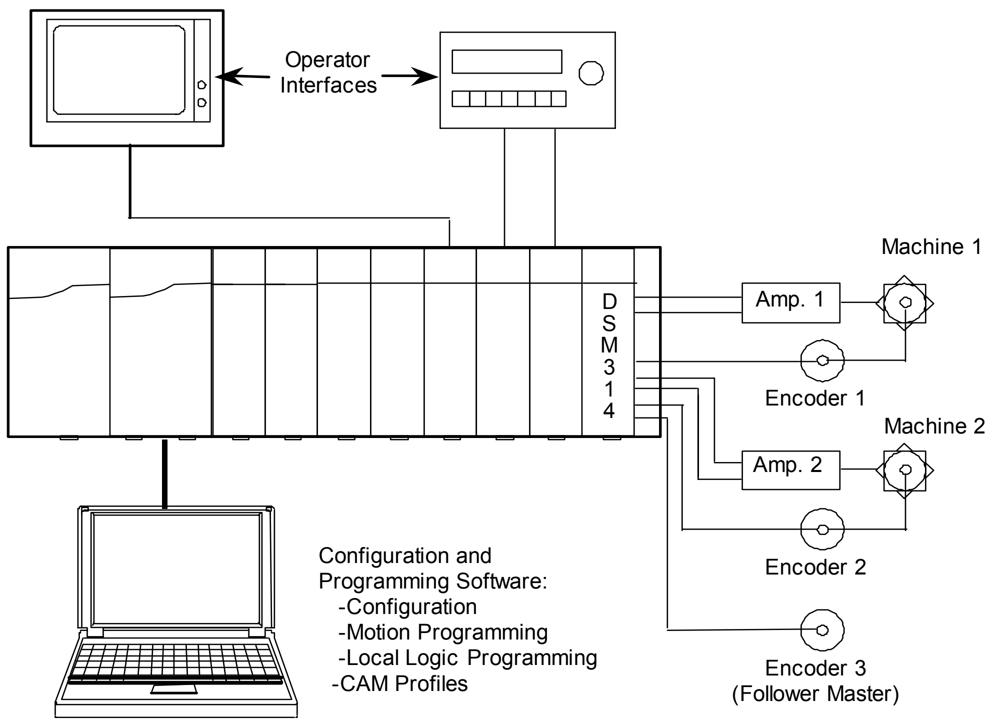
The DSM314 Module can be used with GE Fanuc α Series and β Series digital servo amplifiers and motors. It can also be used with analog GE Fanuc SL Series analog servos and third-party analog velocity command interface and analog torque command interface servos. Module features include:



- Velocity Feed forward and Position Error Integrator
- High resolution of programming units
- Simple and powerful motion program instruction set
- Simple 1 to 4-axis motion programs
- Non-volatile storage for 10 programs and 40 subroutines
- Single-point-of-connect for programming and configuration.
- Firmware is stored in flash memory and is updated via COMM port.
- Recipe programming using command parameters.
- Electronic CAM capability
- Home and overtravel switch inputs for each Servo Axis
- Two Position Capture Strobe Inputs for each axis
- 5v , 24v and analog I/O for use by PLC
- Incremental Quadrature Encoder input on each axis for Encoder/Analog mode
- 13 bit Analog Output can be controlled by PLC or used as Digital Servo Tuning monitor
- High speed digital output (four each 24V and four each 5V) via on-board Local Logic control

Overview

The DSM314 integrates high-performance motion control with the logic-solving functions of the RX3i PACSystem.



For more information about configuring and installing the DSM314 module, see the *Motion Mate User's Manual*, GFK-1742. For details about interfacing the DSM314 to the GE Fanuc SL Servo products, refer to the manual, *SL Series Servo User's Manual*, GFK-1581.

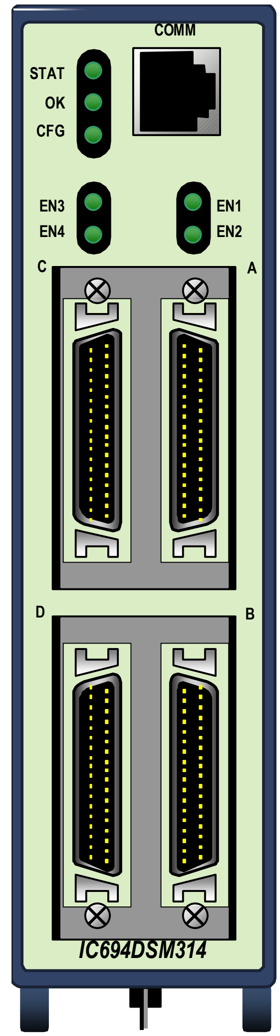
Specifications: DSM314

Power Supply Voltage Power Supply Current Draw by DSM	5 VDC from backplane 800 mA plus encoder supply current (see next item).
Available +5V Current/Module to supply external encoder, if used	500 mA (if used, must be added to module +5v current draw)
Number of DSM314 Modules in PACSystems RX3i Main Backplane	Up to 5 DSM314 modules in RX3i Main Backplane with Power Supply PWR040
Number of DSM314 Modules in PACSystems RX3i Expansion/Remote Backplane	▪ 3 DSM314 modules in expansion/remote backplane with PWR321 ▪ 6 DSM314modules in remote backplane with PWR330/331 ▪ 7 DSM314modules in expansion backplane with PWR330/331

Features: DSM314

LEDs

There are seven LED status indicators on the DSM314 module:



The **STAT** LED is normally On. When the LED is OFF, the DSM314 is not functioning. Slow blinking indicates status errors. Rapid blinking indicates errors that cause the servo to stop.

The **OK** LED indicates the current status of the DSM314 module. When the LED is steady On, the module is functioning properly. When the LED is Off, the module is not functioning.

The **CFG** LED is On when a module configuration has been received.

The **EN1** through **EN4** LEDs are On if the Axis 1 through Axis 4 Drive Enable relays are on.

COMM Connector

The COMM port is an RJ-11 connector, used to download firmware updates to the module.

I/O Connectors

The DSM314 is a two-axis digital servo/one axis analog velocity interface or four-axis analog servo (Torque Mode and/or Velocity Mode) controller with four 36-pin I/O connectors labeled A, B, C, and D. All four connectors provide similar analog and digital I/O circuits.

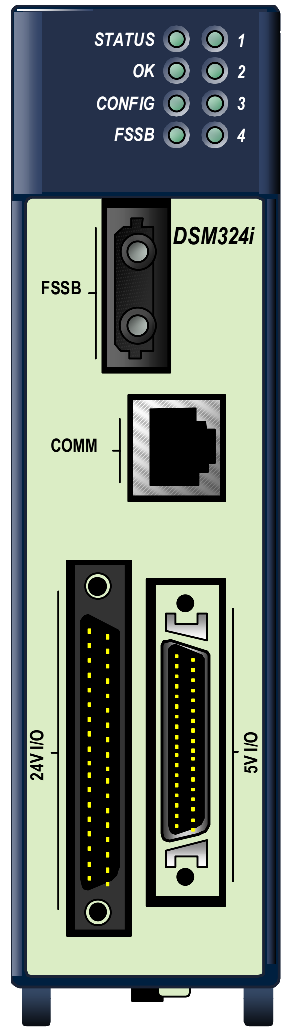
Shield Ground Connection

The DSM314 must be connected to frame ground via the ground terminal on the bottom of the module

Motion Controller Module: IC694DSM324

The Motion Controller Module, IC694DSM324, is a multi-axis motion control module. It supports two control loop configurations:

- Standard Mode (Follower Control Loop Disabled)
- Follower Mode (Follower Control Loop Enabled)



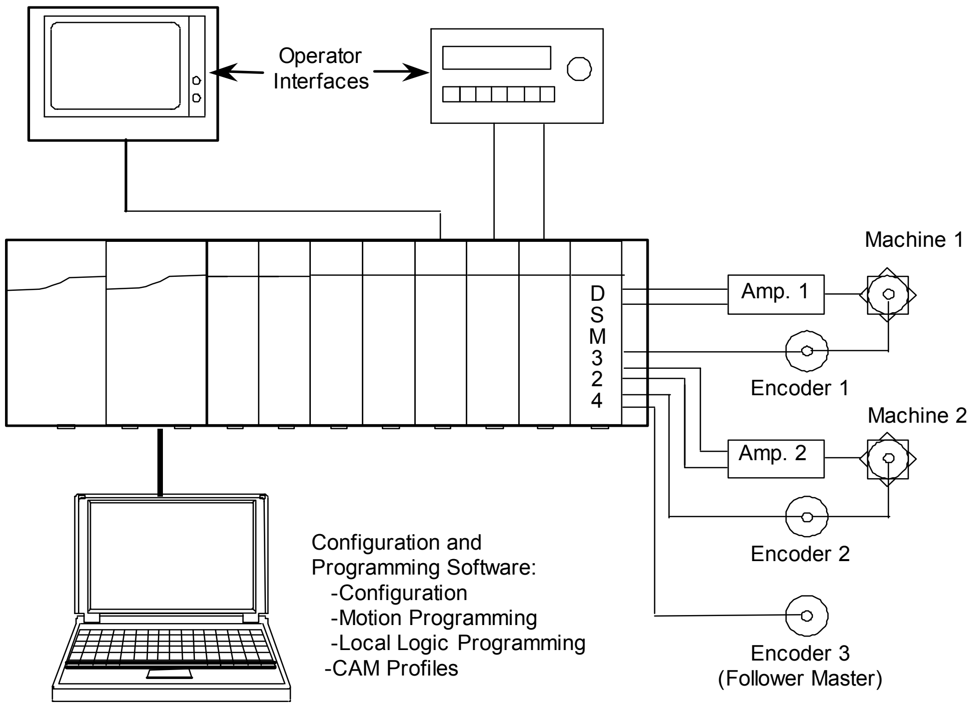
The DSM324 Module can be used with GE Fanuc β*i* Series digital servo amplifiers and motors. Module features include:

- Block Processing time under 5 milliseconds
- Velocity Feed forward and Position Error Integrator
- High resolution of programming units
- Simple and powerful motion program instruction set
- Simple 1 to 4-axis motion programs
- Non-volatile storage for 10 programs and 40 subroutines
- Single-point-of-connect for programming and configuration.
- Firmware is stored in flash memory and is updated via COMM port.
- Recipe programming using command parameters.
- Electronic CAM capability
- Home and overtravel switch inputs for each Servo Axis
- Two Position Capture Strobe Inputs for each axis
- 5v , 24v and analog I/O for use by PLC
- Incremental Quadrature Encoder input on each axis for Encoder/Analog mode
- 13 bit Analog Output can be controlled by PLC or used as Digital Servo Tuning monitor
- High speed digital output (four each 24V and four each 5V) via on-board Local Logic control

Please see the DSM324i Motion Controller for PACSystems RX3i and Series 90-30, *GFK-2347, for more information about the DSM324 module.*

Overview

The DSM324 integrates high-performance motion control with the logic-solving functions of the RX3i PACSystem.



For more information about configuring and installing the DSM324 module, see the *DSM324i Motion Controller for PACSystems RX3i and Series 90-30*, GFK-2347. For details about interfacing the DSM324 to the GE Fanuc SL Servo products, refer to the manual, *AC Servo Motor* β*i*s *Descriptions Manual*, GFZ-65302EN.

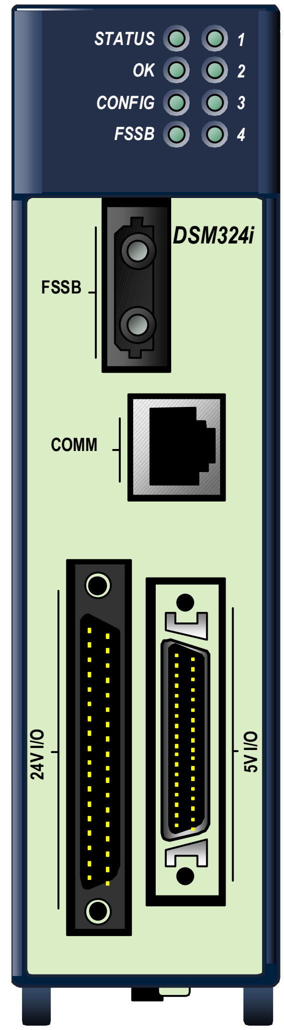
Specifications: DSM324

Power Supply Voltage Power Supply Current Draw by DSM	5 VDC from backplane 860 mA plus encoder supply current (see next item).
Available +5V Current/Module to supply external encoder, if used	500 mA (if used, must be added to module +5v current draw)
Number of DSM324i Modules in PACSystems RX3i Main Backplane	Up to 5 DSM324i modules in RX3i Main Backplane with Power Supply PWR040
Number of DSM324i Modules in PACSystems RX3i Expansion/Remote Backplane	▪ 2 DSM324i modules in expansion/remote backplane with PWR321 ▪ 6 DSM324i modules in remote backplane with PWR330/331 ▪ 6 DSM324i modules in expansion backplane with PWR330/331

Features: DSM324

LEDs

There are eight LED status indicators on the DSM324 module:



The **STATUS** LED is normally On. When the LED is OFF, the DSM324 is not functioning as the result of a status error. Flashing signals an error condition.

The **OK** LED indicates the current status of the DSM314 module. When the LED is steady On, the module is functioning properly. When the LED is Off, the module is not functioning.

The **CONFIG** LED is On when a module configuration has been received.

The **FSSB** LED is On when FSSB communications are active. It blinks during FSSB setup. This LED is Off if FSSB communications are inactive or if FSSB setup has failed.

The Axis Enable LEDS, 1 through 4, are On if the Axis 1 through Axis 4 Drives are enabled.

FSSB Connector

The FSSB connector provides optical fiber connection to Servo Amplifiers for the exchange of command, feedback, and diagnostics data. This connector has a removable protective cap.

COMM Connector

The COMM port is an RJ-11 connector, used to download firmware updates to the module.

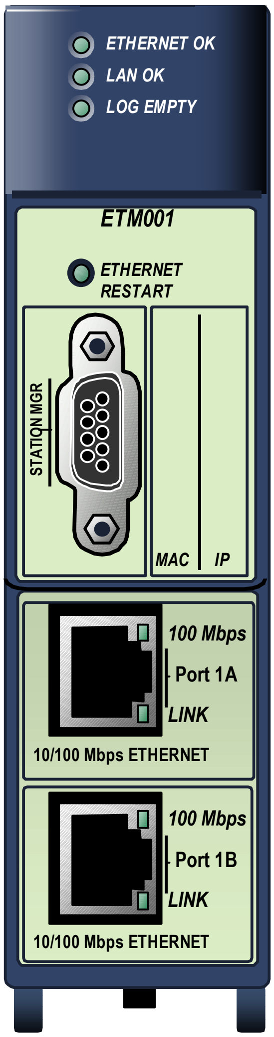
I/O Connectors

The DSM324 provides two connectors for 5VDC and 24VDC I/O. Pre-manufactured cables are available in 1-meter and 3-meter lengths for both I/O cpnnectors.

Shield Ground Connection

The DSM324 must be connected to frame ground via the ground terminal on the bottom of the module. The grounding resistance of the system ground should be 100 ohms or less (class 3 grounding).

Ethernet Interface Module: IC695ETM001



The Ethernet Interface Module, IC695ETM001, is used to connect a PACSystems RX3i controller to an Ethernet network. It enables the RX3i controller to communicate with other PACSystems equipment and with Series 90 and VersaMax controllers. The Ethernet Interface provides TCP/IP communications with other PLCs, host computers running the Host Communications Toolkit or programmer software, and computers running the TCP/IP version of the programming software. These communications use the GE Fanuc SRTP and Ethernet Global Data (EGD) protocols over a four-layer TCP/IP (Internet) stack.

Features of the RX3i Ethernet Interface include:

- Full PLC programming and configuration services
- Periodic data exchange using Ethernet Global Data (EGD)
- EGD Commands to read and write PLC and EGD exchange memory over the network.
- TCP/IP communication services using SRTP
- Comprehensive station management and diagnostic tools
- Extended PLC connectivity via IEEE 802.3 CSMA/CD 10Mbps and 100Mbps Ethernet LAN port connectors.
- Network switch that has Auto negotiate, Sense, Speed, and crossover detection.
- Direct connection to BaseT (twisted pair) network switch, hub, or repeater without an external transceiver.

For more information about this module, please refer to the following publications:

- *TCP/IP Ethernet Communications for PACSystems*, GFK-2224
- *PACSystems TCP'IP Communications, Station Manager Manual*, GFK-2225

Specifications: IC695ETM001

Ethernet processor speed	200 MHz
Connectors	- Station Manager (RS-232) Port: 9-pin female D-connector - Two 10BaseT / 100BaseTX Ports: 8-pin female shielded RJ-45
LAN	IEEE 802.2 Logical Link Control Class I IEEE 802.3 CSMA/CD Medium Access Control 10/100 Mbps
Number of IP addresses	One
Number of Ethernet Port Connectors	Two, both are 10BaseT / 100BaseTX with auto-sensing RJ-45 connection.
Embedded Ethernet Switch	Yes – Allows daisy chaining of Ethernet nodes.
Serial Port	Station Manager Port: RS-232 DCE, 1200 - 115200 bps.

Refer to Appendix A for product standards and general specifications.

Ethernet Interface Ports

The Ethernet Interface module has two auto-sensing 10Base T / 100Base TX RJ-45 shielded twisted pair Ethernet ports for connection to either a 10BaseT or 100BaseTX IEEE 802.3 network. The port automatically senses the speed (10Mbps or 100Mbps), duplex mode (half duplex or full duplex) and cable (straight-through or crossover) attached to it with no intervention required.

Ethernet Media

The Ethernet Interface can operate directly on 10BaseT/100BaseTX media via its network ports.

10BaseT: 10BaseT uses a twisted pair cable of up to 100 meters in length between each node and a switch, hub, or repeater. Typical switches, hubs, or repeaters support 6 to 12 nodes connected in a star wiring topology.

100BaseTX: 100BaseTX uses a cable of up to 100 meters in length between each node and a switch, hub, or repeater. The cable should be data grade Category 5 unshielded twisted pair (UTP) or shielded twisted pair (STP) cable. Two pairs of wire are used, one for transmission, and the other for collision detection and receive. Typical switches, hubs, or repeaters support 6 to 12 nodes connected in a star wiring topology.

Station Manager

The built-in Station Manager function of the Ethernet Interface provides on-line supervisory access to the Ethernet Interface, through the Station Manager port or over the Ethernet cable. Station Manager services include:

- An interactive set of commands for interrogating and controlling the station.
- Unrestricted access to observe internal statistics, an exception log, and configuration parameters.
- Password security for commands that change station parameters or operation.

Refer to the *PACSystems TCP/IP Ethernet Communications Station Manager Manual*, GFK-2225 for complete information on the Station Manager.

Firmware Upgrades

The Ethernet Interface receives its firmware upgrades indirectly from the PLC CPU using the WinLoader software utility. WInLoader is supplied with any updates to the Ethernet Interface software.

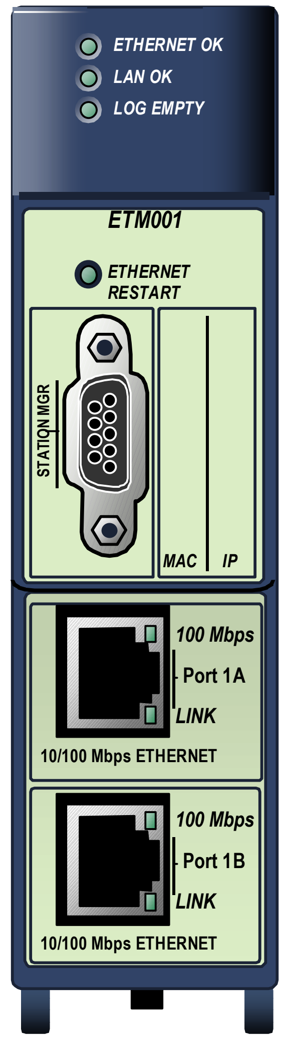
Ethernet Global Data (EGD)

Each PACSystems CPU supports up to 255 simultaneous Ethernet Global Data (EGD) exchanges. EGD exchanges are configured using the programmer and stored into the PLC. Both Produced and Consumed exchanges can be configured. PACSystems Ethernet Interfaces support both selective consumption of EGD exchanges and EGD exchange production and consumption to the broadcast IP address of the local subnet.

The Ethernet Interface can be configured to use SNTP to synchronize the timestamps of produced EGD exchanges.

The Ethernet Interface implements the capabilities of a Class 1 and Class 2 device. COMMREQ-driven EGD Commands can be used in the application program to read and write data into the CPU or other EGD Class 2 devices.

Ethernet Interface Controls and Indicators



LEDs

- The **Ethernet OK** LED indicates whether the module is able to perform normal operation. This LED is On for normal operation and flashing for all other operations. If a hardware or runtime failure occurs, the EOK LED blinks a two-digit error.
- The **LAN OK** LED indicates access to the Ethernet network. The LAN LED blinks when data is being sent or received over the network directed to or from the Ethernet interface. It remains On when the Ethernet interface is not actively accessing the network but the Ethernet physical interface is available and one or both of the Ethernet ports is operational. It is Off otherwise unless software load is occurring.
- The **Log Empty** LED is On during normal operation. It is Off if an event has been logged.
- Two Ethernet network activity LEDS (**LINK**) indicate the network link status and activity.
- Two Ethernet network speed LEDS (**100Mbps**) indicates the network data speed (10 (off) or 100 Mb/sec (on)).

Ethernet Restart Pushbutton

This pushbutton is used to manually restart the Ethernet firmware without power cycling the entire system. It is recessed to prevent accidental operation.

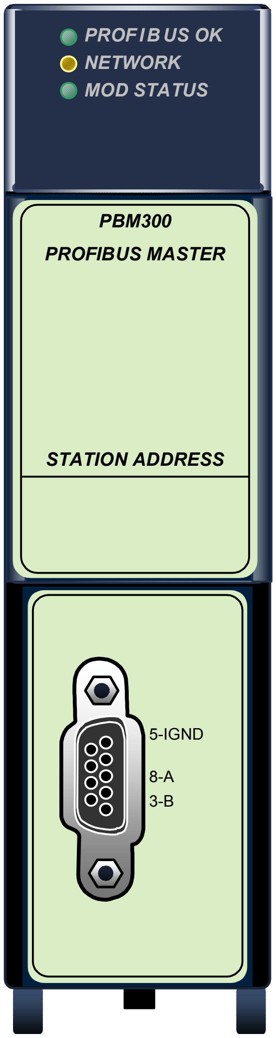
Connectors

The module has two 10BaseT/100BaseTX Ethernet Network Port Connectors. There is only one interface to the network (only one Ethernet MAC address and only one IP address).

It also has a Station Manager (RS-232) Serial Port.

Profibus Master Module, IC695PBM300

The RX3i PROFIBUS Master Module, IC695PBM300, allows the RX3i CPU to send and receive data on a PROFIBUS-DP network.



Features

The IC695PBM300 module provides the following features:

- supports up to 125 PROFIBUS-DP slaves
- supports up to 244 bytes of input data and 244 bytes of output data per slave
- Supports up to 3,584 bytes of input data and 3,584 bytes of output data total
- Supports all standard data rates
- Supports Sync and Freeze modes
- Supports DP-V1 Read, Write and Alarm messages
- PROFIBUS-compliant Module and Network Status LEDs

For more information about this module, please refer to the *PACSystems RX3i Profibus Module User's Manual,* GFK-2301.

Compatibility

The PROFIBUS Master module requires an RX3i CPU with firmware version 2.9 or later. This module must be located in an RX3i Universal Backplane.

The module requires Machine Edition Version 5.0 SP2 Logic Developer-PLC or later for configuration.

Specifications: IC695PBM300

Backplane Current Consumption	440 mA @ 3.3 VDC
Data rates	Supports all standard data rates (9.6 kBit/s, 19.2 kBit/s, 93.75 kBit/s, 187.5 kBit/s, 500 kBit/s, 1.5 MBit/s, 3 MBit/s, 6 MBit/s and 12 MBit/s)
Status Information Available	Slave Status Bit Array Table Network Diagnostic Counters DP Master Diagnostic Counters Firmware Module Revision Slave Diagnostic Address

Profibus Master Module Controls and Indicators

Network Connector

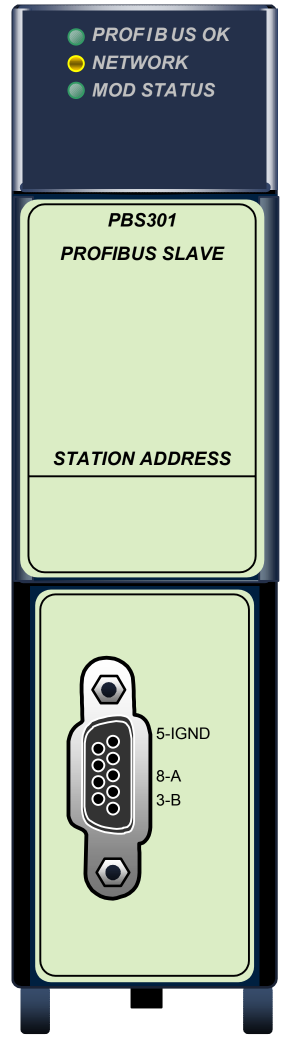
The Profibus Master module has a 9-pin sub-D connector for attaching the bus cable. For pin assignments, segment length, cable type and termination requirements, refer to the *RX3i PACSystems PROFIBUS Modules User's Manual,* GFK-2301.

LEDs

The PROFIBUS Master module provides three PROFIBUS-compliant LEDs that indicate module and network status.

- The green OK LED indicates the presence of power, and completion of backplane reset.
- The bicolor Network LED is steadily yellow when the module is holding the PROFIBUS token and able to transmit PROFIBUS telegrams. It flashes yellow if the module is sharing the network with another PROFIBUS master. The Network LED is red if a communications problem such as a connection timeout exists with at least one slave on the network.
- The bi-color Mod Status LED indicates module status. When this LED is steadily green, the module is configured and has established a connection with a least one device on the network. If it is flashing green, the module may be waiting for a configuration or may have a firmware problem. If it is flashing yellow, the module is in boot loader mode, downloading firmware, or has a non-recoverable error. The rate of LED flashing provides additional status information as described in the *RX3i Profibus Modules User's Manual.*

Profibus Slave Module, IC695PBS301



The IC695PBS301 provides slave communications on a PROFIBUS DP network. The slave module automatically exchanges data with a master device. The slave module has no bus access rights. It can only acknowledge received messages or transmit messages to a master upon request.

The PROFIBUS Slave module provides the following PROFIBUS communications features:

- Ability to read up to 244 bytes of input data from the network, and send up to 244 bytes of output data
- Support for all standard PROFIBUS data rates
- Support for DP-V1 Read, Write and Alarm messages
- PROFIBUS-compliant module and network status LEDs

Compatibility

The PROFIBUS Slave module requires an RX3i CPU with firmware version 3.0 or later. This module must be located in an RX3i Universal Backplane.

The Slave module requires Machine Edition Logic Developer-PLC, version 5.0 Service Pack 3 or later for configuration.

The PROFIBUS module receives its firmware upgrades indirectly from the host controller CPU using the WinLoader software utility. WinLoader is supplied with any updates to the PROFIBUS module software.

Specifications: IC695PBS301

Backplane current consumption	440mA @ 3.3VDC
Data rates	Supports all standard data rates (9.6 KBit/s, 19.2 KBit/s, 93.75 KBit/s, 187.5 KBit/s, 500 KBit/s, 1.5 MBit/s, 3 MBit/s, 6 MBit/s and 12 MBit/s)
Status information available	Slave Status Word

For product standards and general specifications, refer to Appendix A

Profibus Slave Module Controls and Indicators

Network Connector

The PROFIBUS Slave module has a 9-pin sub-D connector for attaching the bus cable. For pin assignments, segment length, cable type and termination requirements, refer to the *RX3i PACSystems PROFIBUS Modules User's Manual,* GFK-2301.

LEDs

The PROFIBUS Slave module provides three PROFIBUS-compliant LEDs that indicate module and network status.

- The green Profibus OK LED indicates the presence of power, and completion of backplane reset.
- The bicolor Network LED is yellow when the module is able to transmit PROFIBUS telegrams. It is red if a critical communications problem has occurred.
- The bi-color Mod Status LED indicates module status. When this LED is steadily green, the module is configured and has established a connection with the network master. If it is flashing green, the module may be waiting for a configuration or may have a firmware problem. If it is flashing yellow, the module is in boot loader mode, downloading firmware, or has a non-recoverable error. The rate of LED flashing provides additional status information as described in the *RX3i Profibus Modules User's Manual.*

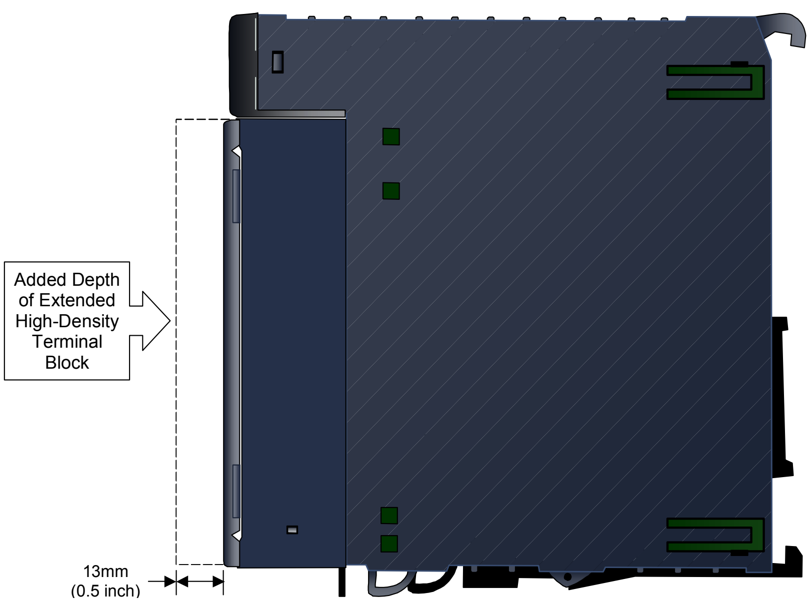
Chapter 15 High-density Terminal Blocks

This chapter describes Terminal Blocks for high-density RX3i modules.

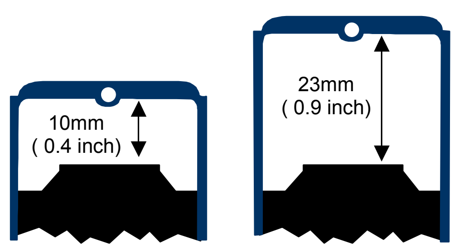
Terminal Block Type	***Catalog Number***
Box-style Terminal Block, 36 pins, One	IC694TBB032
Spring-style Terminal Block, 36 pins, One	IC694TBS032
Extended Box-style Terminal Block, 36 pins, One	IC694TBB132
Extended Spring-style Terminal Block, 36 pins, One	IC694TBS132

Extended High-Density Terminal Blocks

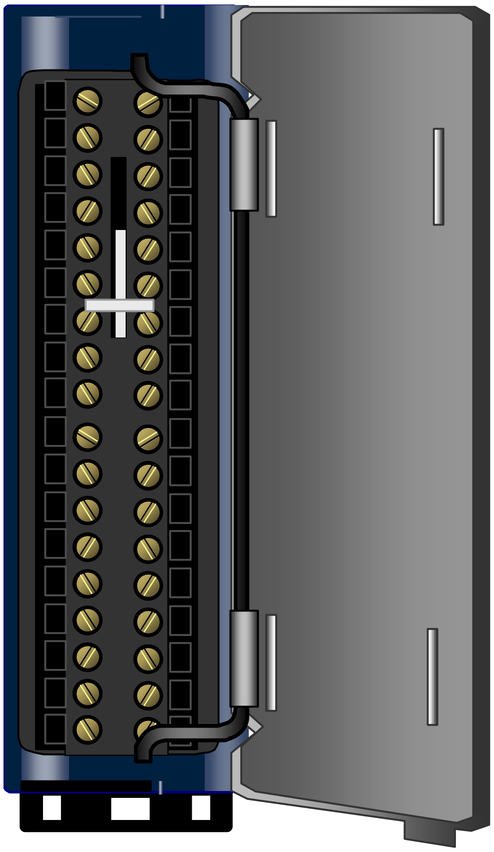
Extended High-Density Terminal Blocks IC694TBB132 and IC694TBS132 are functionally-identical to High-Density Terminal Blocks IC694TBB032 and IC694TBS032. The Extended High-Density Terminal Blocks have an outer cover that is approximately ½-inch (13mm) deeper, to accommodate wires with thicker insulation, such as that typically used with AC I/O modules.



The diagram below compares the space for wiring on a High-Density Terminal Block (left) and an Extended High-Density Terminal Block (right), seen from the bottom of the module.



Box-style Terminal Blocks, 36 Pins: IC694TBB032 and TBB132



Box-style Terminal Blocks, IC694TBB032 and IC694TBB132, are used with high-density PACSystems RX3i modules and equivalent Series 90-30 PLC modules. These terminal blocks provide 36 screw terminals for field wiring to the module.

Terminal Blocks IC694TBB032 and TBB132 are functionally identical. Terminal Block IC694TBB032 comes with a standard-depth outer cover. When installed, it is the same depth as most other PACSystems and Series 90-30 PLC modules.

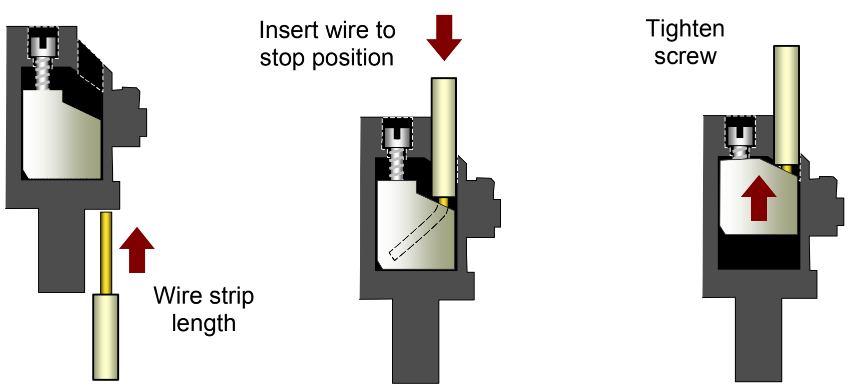
Extended Terminal Block IC694TBB132 comes with an outer cover that is approximately ½-inch (13mm) deeper than Terminal Block IC694TBB032, to accommodate wires with thicker insulation, such as that typically used with AC I/O modules.

Specifications: TBB032 and TBB132

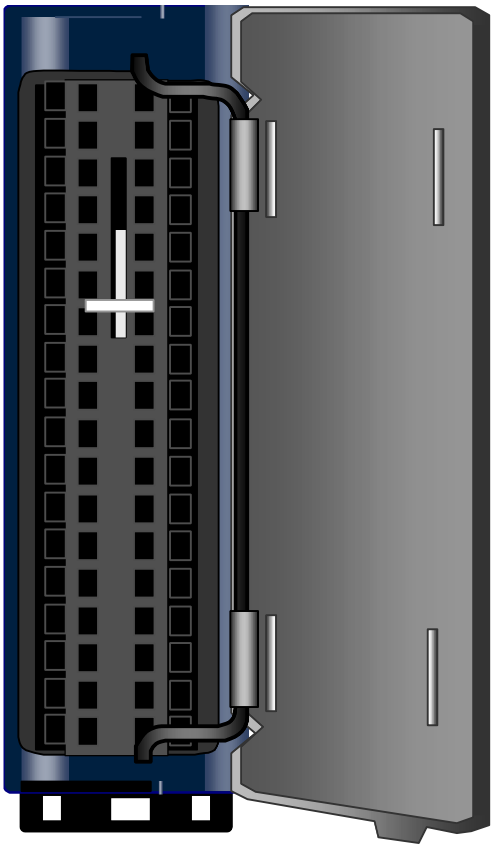
Torque	7 lb-in
Wire strip length	0.310 inches (7.87 mm)
Wire gauges supported	#14-26 AWG (solid or stranded)

Connecting Field Wiring to a Box-Style High-density Terminal Block

The bottom of the terminal block can be used as a gauge for the wire strip length, as shown below. The stripped wire must be fully-inserted into the terminal block so that the insulation meets the stop position inside the terminal, and the end of the wire is bent. Tightening the terminal screw raises the wire and clamps it in place.



Spring-style Terminal Blocks, 36 Pins: IC694TBS032 and TBS132



Spring-style Terminal Blocks, IC694TBS032 and IC694TBS132, are used with high-density PACSystems RX3i modules and equivalent Series 90-30 PLC modules. These terminal blocks provide 36 spring-style terminals for field wiring to the module.

Terminal Blocks IC694TBS032 and TBS132 are functionally identical. Terminal Block IC694TBS032 comes with a standard-depth outer cover. When installed, it is the same depth as most other PACSystems and Series 90-30 PLC modules.

Extended Terminal Block IC694TBS132 comes with an outer cover that is approximately ½-inch (13mm) deeper than Terminal Block IC694TBS032, to accommodate wires with thicker insulation, such as that typically used with AC I/O modules.

Specifications: TBS032 and TBS132

Wire strip length	0.310 inches (7.87 mm)
Wire gauges supported	#14-28 AWG (solid or stranded)

Installing and Removing High-density Terminal Blocks

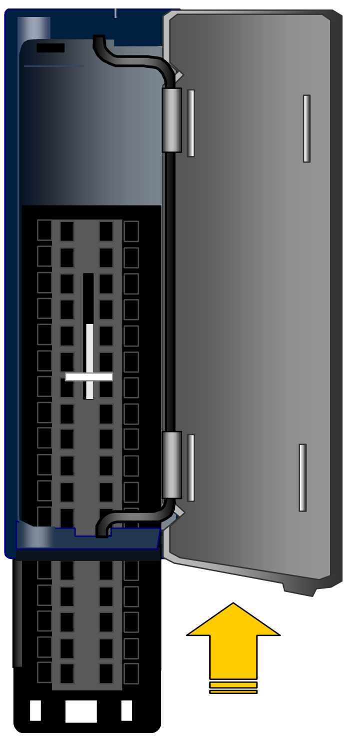
This section has special installation instructions for High-density Terminal Blocks. See chapter 2 for general installation information.

Warning

Field power must be turned off when installing or removing a Terminal Block assembly.

Installing or Removing a Module's Terminal Block Assembly

1. Install the small catalog number label (for example: "ALG600") supplied with the module in the slot on the top of the Terminal Block.
2. Complete the module wiring and secure the wire bundles to the tie-downs on the bottom of the Terminal Block



Inserting a Terminal Block in its Cover

1. Align the top of the Terminal Block with the bottom of the cover, making sure that the notches in the Terminal Block match up with the grooves in the cover.
2. Slide the Terminal Block upward until it clicks into place.

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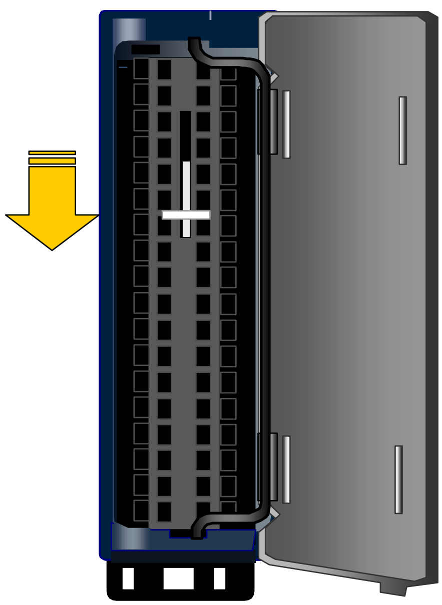
Installing a High-density Terminal Block Assembly

1. Press the terminal block assembly straight toward the module until it is partially seated.
2. Open the door on the front of the terminal block and push the latch (see below) up very firmly until it reaches the top of the slot and clicks into place.
3. Check to be sure the terminal block is fully seated.



Removing a High-density Terminal Block from the Module

1. Open the terminal block door.
2. Push the latch down as shown at left very firmly until the terminal block is released.
3. Pull the terminal block away from the module until the contacts have separated.

Removing a Terminal Block from its Cover

To remove a Terminal Block from its cover:

1. Grasp the sides of the Terminal Block cover.
2. Pull down on the bottom of the Terminal Block.

Appendix A Product Certifications and Installation Guidelines for Conformance

This appendix describes the compliance markings that appear on PACSystems RX3i products and the corresponding standards to which the products have been certified. This appendix also provides installation requirements for conformance to standards and additional safety guidelines for installing in the European Union.

RX3i Agency Approvals

Description	***Agency Standard or Marking***	***Comments***
N.A. Safety for Industrial Control Equipment	c UL US LISTED	Certification by Underwriter's Laboratories to UL508 standard and equivalent CSA C22.2 No 142 - M1987standard
N.A. Safety for Hazardous Locations Class I, Div. 2, Groups A, B, C, D	c UL US LISTED	Certification by Underwriter's Laboratories to UL1604 standard and equivalent CSA C22.2 No 213-M1987 standard
Low Voltage Directive European Safety for Industrial Control Equipment	CE	Self-Declaration in accordance with European Directives; Refer to Declaration of Conformity found at www.gefanuc.com for a complete list of approved products
Electromagnetic Compatibility Directive European EMC for Industrial Control Equipment	CE	Certification by Competent Body in accordance with European Directives; Refer to Declaration of Conformity found at www.gefanuc.com for a complete list of approved products
Explosive Atmospheres Directive European Safety for Hazardous Locations Equipment Group II, Category 3, Gas Groups A, B, C	Ex	Certification in accordance with European Directives and Independent 3rd Party Assessment Certificate; Refer to Declaration of Conformity found at www.gefanuc.com for complete list of approved products

Note: The agency approvals listed above and on the Declaration of Conformities are believed to be accurate, however, a product's agency approvals should be verified by the marking on the unit itself.

UL Class 1 Division 2 Hazardous Location Requirements

The following statements are required to appear for Class I Div 2 Hazardous Locations.

1. EQUIPMENT LABELED WITH REFERENCE TO CLASS I, GROUPS A, B, C, and D, DIV. 2 HAZARDOUS LOCATIONS IS SUITABLE FOR USE IN CLASS I, DIVISION 2, GROUPS A, B, C, D OR NON–HAZARDOUS LOCATIONS ONLY.
2. WARNING – EXPLOSION HAZARD – SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.
3. WARNING – EXPLOSION HAZARD – DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON–HAZARDOUS.

ATEX Class 1 Zone 2 Hazardous Location Requirements

In order to maintain compliance with the ATEX Directive, a RX3i system located in a Class 1 Zone 2 area (Category 3) must be installed within a protective enclosure meeting the criteria detailed below:

- IP54 or greater, and
- Mechanical strength to withstand an impact energy of 3.5 Joules

Standards Overview

PACSystems RX3i Environmental Specifications

Vibration	**IEC60068-2-6, JISC0911**	10 - 57 Hz, 0.012" displacement peak-peak 57 - 500 Hz, 1.0g acceleration
Shock	**IEC60068-2-27, JISC0912**	15G, 11ms
Operating Temperature		0°C to 60°C: [inlet] (32° to 140°F)
Storage Temperature		-40°C to +85°C (-40° to 185°F)
Humidity		5% to 95%, non-condensing

Additional RX3i Specifications

Standards for EMC Emissions, and Immunity, for RX3i products are given on the following pages. Refer to the listing of module catalog numbers below to determine which set of standards applies to a specific module: Specifications Group 1 or Group 2.

Module	***Group***	***Module***	***Group***	***Module***	***Group***
IC694ACC300	1	IC694BEM341		IC694MDL740	1
IC694ALG220	1	IC694DSM314	1	IC694MDL741	1
IC694ALG221	1	IC694DSM324	2	IC694MDL742	1
IC694ALG222	1	IC694MDL230	1	IC694MDL752	1
IC694ALG223	1	IC694MDL231	1	IC694MDL753	1
IC694ALG390	1	IC694MDL240	1	IC694MDL754	2
IC694ALG391	1	IC694MDL241	1	IC694MDL930	1
IC694ALG392	1	IC694MDL310	1	IC694MDL931	1
IC694ALG442	1	IC694MDL330	1	IC694MDL940	1
IC695ALG600	2	IC694MDL340	1	IC695CHS012	2
IC695ALG608	2	IC694MDL390	1	IC695CHS015	2
IC695ALG616	2	IC694MDL632	1	IC695CPU310	2
IC695ALG704	2	IC694MDL634	1	IC695ETM001	2
IC695ALG708	2	IC694MDL645	1	IC695LRE001	2
IC694APU300	1	IC694MDL646	1		
IC694APU305	1	IC694MDL654	1		
IC694BEM320	1	IC694MDL655	1	IC695PSA040	2
IC694BEM321	1	IC694MDL660	2	IC695PSD040	2
IC694BEM320	1	IC694MDL732	1	IC695PSD140	2
IC694BEM340	1	IC694MDL734	1		

Specifications Group 2

EMC EMISSIONS		
Radiated, Conducted	**CISPR 11/EN 55011**	"Industrial Scientific & Medical Equipment" (Group 1, Class A)
	CISPR 22/EN 55022	"Information Technology Equipment" (Class A)
	47 CFR 15	referred to as FCC part 15, "Radio Devices" (Class A)
Harmonic	**EN61000-3-2**	Class A
EMC IMMUNITY		
Electrostatic Discharge	**EN 61000-4-2**[1]	±8KV Air, ±4KV Contact
RF Susceptibility	**EN 61000-4-3**[1]	$10V_{rms}$ /m, 80Mhz to 1000Mhz, 80% AM, 1kHz sine wave
	ENV 50140/ ENV 50204	$10V_{rms}$ /m, 900 ± 5Mhz, 100% PM, 200Hz square wave
Fast Transient Burst	**EN 61000-4-4**[1]	AC/DC Input Power: ±2kV direct Signal: ±1kV cap coupled
Voltage Surge	**EN 61000-4-5**[1]	AC Input Power: ±2KV (12Ω) CM, ±1kV (2Ω) DM DC Input Power[2]: ±0.5KV (12Ω) CM, ±0.5kV (2Ω) DM Shielded Signal[3]: ±1kV (2Ω) CM Unshielded Communication Signal[3]: ±1KV (250Ω max.) CM Unshielded I/O Signal[3]: ±1kV (42Ω) CM, ±0.5KV (42Ω) DM
Damped Oscillatory Wave	**ANSI/IEEE C37.90a, EN61000-4-12**[1]	1Mhz, 400Hz rep rate AC/DC Input Power[2]: ±2.5KV CM & DM (200Ω) Signal[3]: ±2.5KV CM (200Ω)
Conducted RF	**EN 61000-4-6**[1]	AC/DC Input Power, Signal: $10V_{rms}$, 0.15 to 80Mhz, 80%AM
Voltage Dips & Interrupts	**EN 61000-4-11**[1]	AC Input Power: 30% Nominal (0.5 period); 60% Nominal (5,50 periods); >95% Nominal (250 periods)
Voltage Variation	**EN 61000-4-11**[1]	AC Input Power: ±10% (50,000 periods)
Voltage Flicker	**EN61000-3-3**	AC Input Power: $d_{max} \leq 4\%$

1) EN61000-4-x series of tests are technically equivalent to the IEC61000-4-x series.
2) Not applicable to ports limited to 10m or less.
3) Not applicable to RS232 ports and those ports limited to 30m (98ft.) or less

Specifications Group 2

EMC EMISSIONS		
Radiated, Conducted	**CISPR 11/EN 55011**	"Industrial Scientific & Medical Equipment" (Group 1, Class A)
	CISPR 22/EN 55022	"Information Technology Equipment" (Class A)
	47 CFR 15	referred to as FCC part 15, "Radio Devices" (Class A)
EMC IMMUNITY		
Electrostatic Discharge	**EN 61000-4-2**[1]	±8KV Air, ±4KV Contact
RF Susceptibility	**EN 61000-4-3**[1]	$10V_{rms}$ /m, 80Mhz to 1000Mhz, 80% AM, 1kHz sine wave
Fast Transient Burst	**EN 61000-4-4**[1]	AC/DC Input Power: ±2kV direct Discrete I/O, Communication: ±1kV (clamp) [1] Analog I/O: ±0.25kV (clamp)
Damped Oscillatory Wave	**ANSI/IEEE C37.90a, EN61000-4-12**[1]	AC/DC Input Power: +2.5KV I/O, Communication: +2.5KV [2]
Voltage Surge	**EN61000-4-5**[1]	AC/DC Input Power: ±2kV (12Ω) CM I/O, Communication: ±1kV (42Ω) CM [2]
Conducted RF	**EN 61000-4-6**[1]	Communication: $10V_{rms}$, 0.15 to 80Mhz, 80%AM [3]
Voltage Dips & Interrupts	**EN 61000-4-11**[1]	AC/DC Input Power: 30% & 100% Nominal (10ms)
Voltage Variation	**EN 61000-4-11**[1]	AC Input Power: ± 10% (10s) DC Input Power: ± 20% (10s)

*Although a few modules were tested according to the Voltage Surge test, modules were primarily tested to the Damped Oscillatory Wave test.

Note:

1) EN61000-4-x series of tests are technically equivalent to the IEC61000-4-x series.
2) Not applicable to communication or I/O lines whose maximum installed length is less than 30m.
3) Not applicable to communication lines whose maximum installed length is less than 30m.
4) Not applicable to communication or I/O lines whose maximum installed length is less than 3m.

Government Regulations

U.S., Canadian, Australian, and European regulations are intended to prevent equipment from interfering with approved transmissions or with the operation of other equipment through the AC power source.

The PACSystems RX3i family of products has been tested and found to meet or exceed the requirements of U.S. (47 CFR 15), Canadian (ICES-003), Australian (AS/NZS 3548), and European (EN55022) regulations for Class A digital devices when installed in accordance with the guidelines noted in this manual. These various regulations share commonality in content and test levels with that of CISPR 22 and based on this commonality testing to the each individual standard was deemed inappropriate.

The FCC requires the following note to be published according to FCC guidelines:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Industry Canada requires the following note to be published:

Note: This Class A digital apparatus complies with Canadian ICES-003.

Installation Guidelines for Conformance to Standards

To meet U.S., Canadian, Australian, and European regulations for Class A digital devices and maintain CE Mark compliance, RX3i installations that include the products listed below must be installed in a metal enclosure with external wiring routed in metal conduit as described in this appendix. Modules not listed below must still be installed in a protective enclosure as described in chapter 2, Installation.

Description	***Catalog Number***
RX3i 10-Slot Serial Expansion Backplane	IC694CHS392
RX3i Input 120VAC 8Pt Isolated	IC694MDL230
RX3i Input 240VAC 8Pt Isolated	IC694MDL231
RX3i Input 120VAC 16Pt	IC694MDL240
RX3i Input 24VAC 16Pt	IC694MDL241
RX3i Output 120 VAC 0.5 A 12 Point	IC694MDL310
RX3i Output 120/240 VAC 2 A 8 Point	IC694MDL330
RX3i Output 120 VAC 0.5 A 16 Point	IC694MDL340
RX3i Output 120/240 VAC 2 A 5 Point Isolated	IC694MDL390
RX3i Input 125VDC 8Pt Pos/Neg Logic	IC694MDL632
RX3i Input 5/12VDC (TTL) 32Pt Pos/Neg	IC694MDL654
RX3i Output 12/24 VDC 0.5 A 8 Point Positive Logic	IC694MDL732
RX3i Output 125 VDC 1 A 6 Point Isolated Pos/Neg	IC694MDL734
RX3i Output 5/24 VDC (TTL) 0.5 A 32 Point Negative Logic	IC694MDL752
RX3i Output Relay N.O. 4 A 8 Point Isolated	IC694MDL930
RX3i Input Analog 16sgl Current	IC694ALG223
RX3i Output Analog 2pt Voltage	IC694ALG390
RX3i Output Analog 2pt Current	IC694ALG391
RX3i Analog Combination Current/Voltage 4in/2out	IC694ALG442
RX3i I/O Link Interface Module	IC694BEM320
RX3i I/O Link Master Module	IC694BEM321
RX3i DSM314 Motion Controller	IC694DSM314
RX3i DSM324 Motion Controller	IC694DSM324
Series 90-30 10-Slot Expansion Backplane	IC693CHS392
Series 90-30 Remote Baseplate, 10 Slots	IC693CHS393
Series 90-30 Remote Baseplate, 5 Slots	IC693CHS399
Series 90-30 Input 120VAC 8Pt Isolated	IC693MDL230
Series 90-30 Input 240VAC 8Pt Isolated	IC693MDL231
Series 90-30 Input 120VAC 16Pt	IC693MDL240
Series 90-30 Input 24VAC 16Pt	IC693MDL241
Series 90-30 Input 125VDC 8Pt Pos/Neg Logic	IC693MDL632
Series 90-30 Input 5/12VDC (TTL) 32Pt Pos/Neg	IC693MDL654
Series 90-30 Output 120VAC 0.5 12Pt	IC693MDL310
Series 90-30 Output 120/240VAC 2A 8Pt	IC693MDL330
Series 90-30 Output 120VAC 0.5A 16Pt	IC693MDL340
Series 90-30 Output 120/240VAC 2A 5Pt Isolated	IC693MDL390
Series 90-30 Output 12/24VDC 0.5A 8Pt Positive Logic	IC693MDL732
Series 90-30 Output 12/24VDC 0.5A 8Pt Negative Logic	IC693MDL733
Series 90-30 Output 125vdc 1A 6Pt Isolated Pos/Neg	IC693MDL734
Series 90-30 Output 5/24VDC (TTL) 0.5A 32Pt Negative Logic	IC693MDL752
Series 90-30 Solenoid Out 11Pt/24VDC Out 5Pt Positive Logic	IC693MDL760
Series 90-30 Output Relay 4A 8Pt Isolated	IC693MDL930

Description	Catalog Number
Series 90-30 Mixed I/O 8Pt 120VAC In / 8Pt Relay Out	IC693MAR590
Series 90-30 Mixed I/O 8Pt 24VDC In / 8Pt Relay Out	IC693MDR390
Series 90-30 Input Analog 4pt Voltage	IC693ALG220
Series 90-30 Input Analog 16sgl/8diff Current	IC693ALG223
Series 90-30 Output Analog 2pt Voltage	IC693ALG390
Series 90-30 Output Analog 2pt Current	IC693ALG391
Series 90-30 Analog Combination Current/Voltage 4in/2out	IC693ALG442
Series 90-30 Fanuc I/O Link Module (Slave)	IC693BEM320
Series 90-30 Fanuc I/O Link Module (Master)	IC693BEM321
Series 90-30 DSM314 Motion Controller	IC693DSM314

Requirements for Installation in a Metal Enclosure

- Backplanes must be mounted in a metal enclosure with a metal-on-metal connection around the door or the equivalent. All surfaces of the enclosure must be adequately grounded to adjacent surfaces to provide electrical conductivity.
- Wiring external to the enclosure must be routed in metal conduit or the equivalent. Using shielded cables and power line filtering, as detailed in "Shielded Cable Alternative to Conduit," is equivalent to using metal conduit.
- The conduit must be mounted to the enclosure using standard procedures and hardware to ensure electrical conductivity between the enclosure and conduit. The termination for the shielded cable alternative to conduit is detailed in "Shielded Cable Alternative to Conduit."

Shielded Cable Alternative to Conduit

This section describes the installation requirements for using shielded cable as an alternative to metal conduit for meeting radiated emissions requirements (EN 55022, 47CFR15, etc.). The following practices could be used in place of conduit for systems or cables that require conduit or the equivalent.

Communication Cables

All communication lines should be double-shielded. The outside braided shield (85% coverage) must be terminated at the entrance to the enclosure and not continue within the enclosure. The inside shield should be left intact since it shields the communication line from noise within the enclosure and is terminated to the connector shell. The RX3i communication port connector shells are directly tied to frame ground. To prevent ground loop currents, one cable end of the inside shield should be capacitively coupled to its shell. The outside shield is classified as an RF shield and should be insulated from the inside shield.

An alternative to double-shielded cable for Genius bus communications is Eupen* CMS cable, equivalent Genius cables with an RF-absorptive material outer coating. The shield should be terminated per standard Genius wiring guidelines.

*Telephone: 32 87 55 47 71 (Europe), 908-919-1100 (U.S.A.)

I/O Cables

All I/O lines leaving the enclosure must have at least 85% braided shield coverage terminated at the entrance to the enclosure. This 85% RF shield should not continue into the enclosure. Eighty-five percent braided shield is a standard cable available with various wire sizes and quantities from many cable manufacturers.

Analog/High Speed Cables

Analog or high-speed lines, which require shielded cable for immunity, should be double-shielded. The outside braided shield should be terminated at the entrance to the enclosure and not continue within the enclosure. The inside shield should be terminated per standard installation instructions. The outside shield is classified as an RF shield and should be insulated from the inside shield.

Power Input to Enclosure (for IC694 Power Supplies)

An alternative to shielded input cables is to use RF filters to minimize the noise coupled back onto the power supply inputs. If RF filters are used at the point of enclosure entry, unshielded wires may be used inside and outside the enclosure.

AC Power Input RF Filter Requirements

- Type: Common mode/Differential mode line filter
- Effective range: between 30–300 megahertz
- Leakage current: <0.8 milliampere
- Insertion loss >30 decibels @ 30 megahertz, >20 decibels @ 100 megahertz, >15 decibels @ 300 megahertz

DC Power Input RF Filter Requirements

- Type: Feed-through, π type EMI ceramic filter
- Capacitance: 1500 picofarads (minimum)
- WVDC: 100 volts
- Current rating: As needed for application
- Insertion Loss: >50 decibels at 100 megahertz

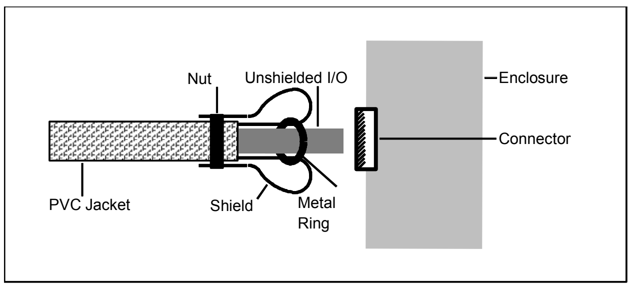
Shield Termination

Termination of RF shields is extremely important in the reduction of RF emissions. The RF shields should be terminated at the entrance to the enclosure with a 360 degree contact between the shield and the enclosure wall.

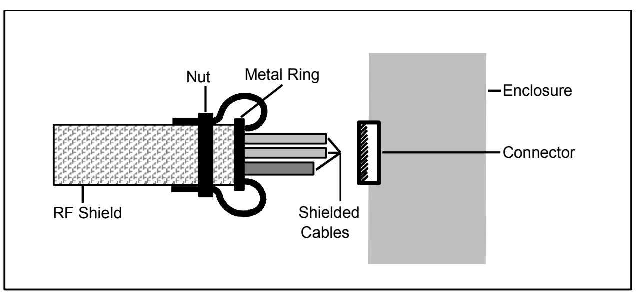
Compression Connectors

Compression connectors are standard hardware available for the termination of conduit. The diameter of the connectors is not of significant importance other than to make sure the wires can actually fit through them. The compression connector provides a metal ring for shield termination and compression.

The following figure shows an unshielded I/O cable with a single shield (side view):



The next figure shows multiple communication/high speed cables that share a single RF shield (side view):



Specialty Shielded Cable Vendors

Eupen specializes in RF-absorptive material outer coating cables (CMS cables). Ask for equivalent Genius cables.

Glenair, Inc. specializes in convoluted tubing (Series 72 & 74) and in flexible metal-core conduit (Series 75). They also carry various kinds of shield termination connectors.

Zippertubing Co. specializes in after installation zip-on shielding where different types of shielding can be selected. Recommended types of shielding are SHN-3, SH1, and SH3 to provide 85% coverage.

Safety-Related Guidelines for Installation in the European Union

This section provides safety-related guidelines specifically for control system products to be installed in the European Union. It is assumed that personnel who install, operate, and maintain automation systems that include GE Fanuc products are trained and qualified to perform those functions

1. ***General***:

   GE Fanuc product manuals provide information required for the intended use of GE Fanuc products. The product manuals are written for technically qualified personnel such as engineers, programmers, or maintenance specialists who have been specifically trained and are experienced in the field of automation control. Such personnel must possess the knowledge to correctly interpret and apply the safety guidelines provided in GE Fanuc product manuals. Should you require further information or face special problems that are not covered in sufficient detail in the product manuals, please contact your local GE Fanuc sales or service office or GE Fanuc authorized distributor.

2. ***Qualified Personnel***:

   Only qualified personnel should be allowed to specify, apply, install, operate, maintain, or perform any other function related to the products described in the product manuals. Examples of such qualified persons are defined as follows:

   - System application and design engineers who are familiar with the safety concepts of automation equipment.
   - Installation, startup, and service personnel who are trained to install and maintain such automation equipment.
   - Operating personnel trained to operate automation equipment and trained on the specific safety issues and requirements of the particular equipment.

3. ***Proper Usage***:

   The equipment/system or the system components may be used only as described in the product manuals. GE Fanuc control system products have been developed, manufactured, tested, and the documentation compiled in keeping with the relevant safety standards. Handling instructions and safety guidelines described for planning, installation, proper operation and maintenance must be followed to ensure safe application and use of the products.

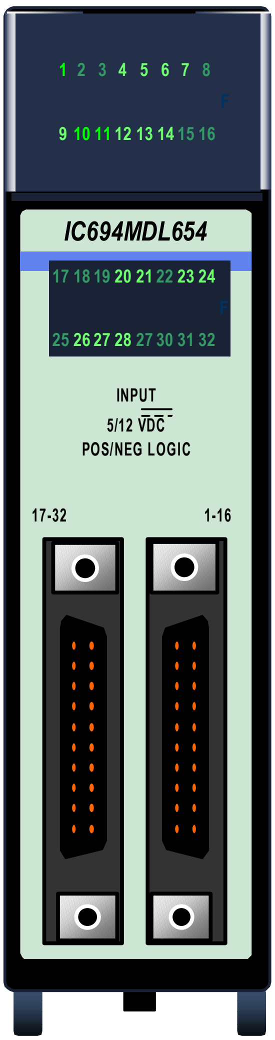
4. ***Guidelines for the Application Planning and Installation of the Product***:

   RX3i control system products generally form part of larger systems or installations. These guidelines are intended to help integrate GE Fanuc RX3i control system products into systems and installations without constituting a source of danger. The following precautions must be followed:

- Compliance with EN292-1 and EN292-2 (Safety of Machinery) as well as EN60204/IEC204 (Electrical Equipment of Industrial Machines) must be observed during the design phase.
- Opening the housing or the protective cover exposes certain parts of this equipment/system which could have a dangerously high voltage level.
- Only qualified personnel should be allowed access to this equipment/system. These persons must be knowledgeable of potential sources of danger and maintenance measures as described in the product manuals.
- Personnel must strictly adhere to applicable safety and accident prevention rules and regulations.
- A suitable isolating switch or fuses must be provided in the building wiring system. The equipment must be connected to a protective ground (PE) conductor.
- For equipment or systems with a fixed connecting cable but no isolating switch that disconnects all poles, a power socket with the grounding pin must be installed.
- Before switching on the equipment, make sure that the voltage range setting on the equipment corresponds to the local power system voltage.
- In the case of equipment operating on 24 VDC, make sure that proper electrical isolation is provided between the main supply and the 24 VDC supply. Use only power supplies that meet EN60204 (IEC204) requirements.
- The RX3i control system AC power supply must be supplied through an IEC-rated isolation transformer.
- Power supply to the RX3i control system must be controlled not to exceed overvoltage category II per EN60204-1 (IEC204).
- Do not exceed the input specifications of the power supply. Otherwise, functional failures or dangerous conditions can occur in the electronic modules/equipment.
- Emergency shutoff devices in accordance with EN60204/IEC204 must be effective in all operating modes of the automation equipment. Resetting the emergency off device must not result in any uncontrolled or undefined restart of the equipment.
- Automation equipment and its operating elements must be installed in such a manner as to prevent unintentional operation.
- Suitable measurements must be taken to ensure that operating sequences interrupted by a voltage dip or power supply failure resume proper operation when the power supply is restored. Care must be taken to ensure that dangerous operating conditions do not occur even momentarily. If necessary, the equipment must be forced into the “emergency off” state.

- Negative Logic Input and Output Modules cannot be used.
- Cable shielding and grounding are the responsibility of the machine builder. GE Fanuc's installation instructions and guidelines must be followed.
- Install the power supply and signal cables in such a manner as to prevent inductive and capacitive interference voltages from affecting automation functions.
- When interfacing the inputs and outputs of the automation equipment, measures must be taken to prevent an undefined state from being assumed in the case of a wire break in the signal lines.

Appendix B — I/O Cables for 32-Point Modules



This section describes the I/O Cables required for 32-point modules: IC694MDL654, MDL655, MDL752, and MDL753:

- Prefabricated I/O Cables: IC693CBL327/328 and IC693CBL329/330/331/332/333/334
- Terminal Block for 32-Point Modules: IC693ACC337
- Making Custom Cables

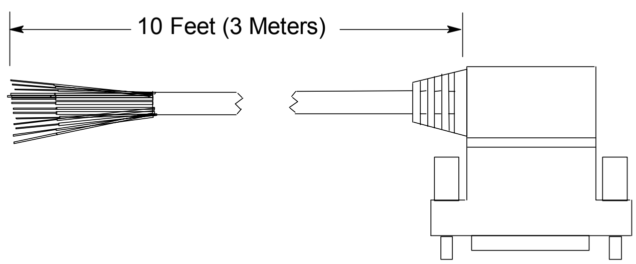
After installation, cables can be secured to the two tie-downs on the bottom of the module.

Prefabricated I/O Cables: IC693CBL327/328 and IC693CBL329/330/331/332/333/334

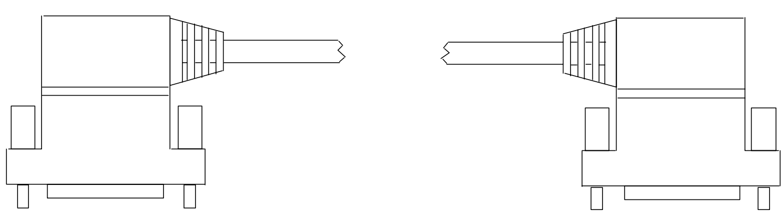
Prefabricated I/O Cables for 32-Point modules are available in several styles:

Catalog Number	Description	Length
IC693CBL327	Cable with one 24–pin, 90 deg. connector, Left Side	3.0 Meters (10 feet)
IC693CBL338	Cable with one24–pin, 90 deg. connector, Right Side	
IC693CBL329	Cable with two 24–pin, 90 deg. connectors, Left Side	1.0 Meter (39.37inches)
IC693CBL330	Cable with two 24–pin, 90 deg. connectors, Right Side	
IC693CBK002	One each: IC693CBL329 and -CBL330	
IC693CBL331	Cable with two 24–pin, 90 deg. connectors, Left Side	2.0 Meters (78.74 inches)
IC693CBL332	Cable with two 24–pin, 90 deg. connectors, Right Side	
IC693CBK003	One each: IC693CBL331 and -CBL332	
IC693CBL333	Cable with two 24–pin, 90 deg. connectors, Left Side	0.5 Meter (19.69 inches)
IC693CBL334	Cable with two 24–pin, 90 deg. connectors, Right Side	
IC693CBK004	One each: IC693CBL333 and -CBL334	

Cables –CBL327 and –CBL328 each have a right–angle 24–pin connector (Fujitsu FCN–365S024–AU) on one end and a set of stripped wire ends on the other.



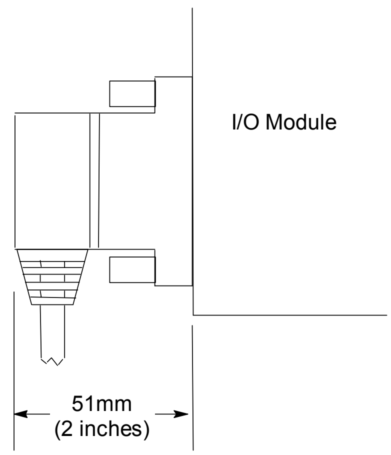
All of the other cables types have connectors (Fujitsu FCN–365S024–AU) on both ends. These cables are wired pin–to–pin (pin A1 to pin A1, pin A2 to pin A2, etc.).



Each pin on these connectors has a current rating of 1.2 Amp.

Connector Depth

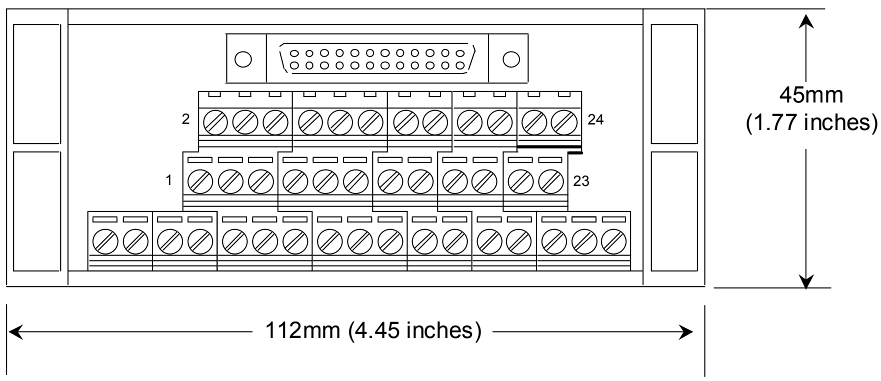
The prefabricated I/O cables extend 2” out from the face of the modules to which they are connected. The depth of the cabinet that the PLC is mounted in should allow for the 2” depth added by the connector.



Terminal Block for 32-Point Modules: IC693ACC337

Terminal Block IC693ACC337 can be used to wire field devices for 32-point discrete modules. Two Terminal Blocks are needed for each module (one per cable). They mount on a standard, user–supplied 35 mm DIN–rail.

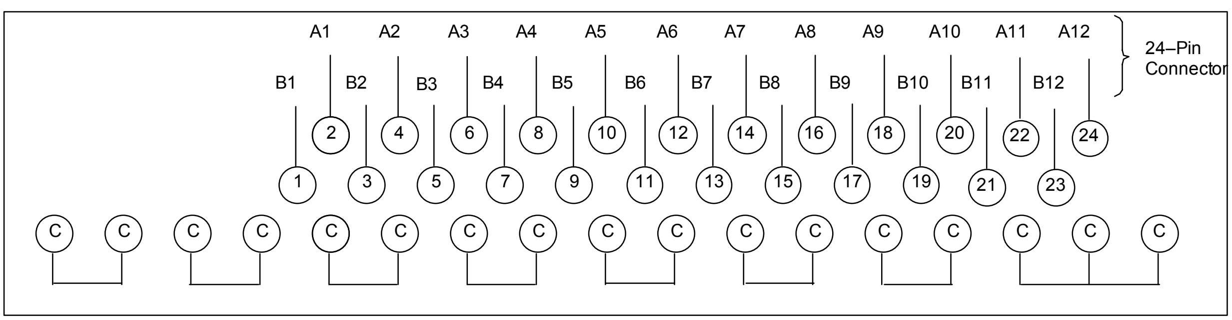
The depth of the Terminal Block, not counting the cable connector and DIN rail, is 57mm (2.12 inches).



The cable from the I/O module attaches to the connector on the Terminal Block.

Individual wires from input or output devices attach to the screw terminals. The diagram below shows how the screw terminals correspond to the connector pins.

The common row terminals (labeled with the letter C below) are provided for wiring convenience, as appropriate. They are electrically isolated from the numbered terminals.



Building Custom Length 24–pin Connector Cables

Cables connecting the 32-point module to field devices can be built to length as described below.

You must purchase the mating female (socket type) 24–pin connectors. The 24–pin connector kit can be ordered as an accessory kit from GE Fanuc. Catalog numbers for these connectors and their associated parts are listed in the following table. The list includes catalog numbers for three types of connectors: solder pin, crimp pin, and ribbon cable. *Each accessory kit contains enough components (D–connectors, backshells, contact pins, etc.) to assemble ten single–ended cables of the type specified for each kit.*

GE Fanuc Catalog Number	Vendor Catalog Number	Description
IC693ACC316 (Solder Eyelet Type)	FCN–361J024–AU	Solder eyelet receptacle
	FCN–360C024–B	Backshell (for above)
IC693ACC317 (Crimp Type)	FCN–363J024	Crimp wire receptacle
	FCN–363J–AU	Crimp pin (for above, 24 needed)
	FCN–360C024–B	Backshell (for above)
IC693ACC318 (Ribbon or IDC Type)	FCN–367J024–AUF	IDC (ribbon) receptacle, closed cover
	FCN–367J024–AUH	IDC (ribbon) receptacle, open cover

Additional tools from Fujitsu are required to properly assemble the crimped contact and ribbon cable type connectors. *The solder eyelet connectors (as provided in IC693ACC316) do not require any special tooling.*

Crimped Contact Connectors (as provided in IC693ACC317) require:

Hand Crimping Tool	FCN–363T–T005/H
Contact Extraction Tool	FCN–360T–T001/H

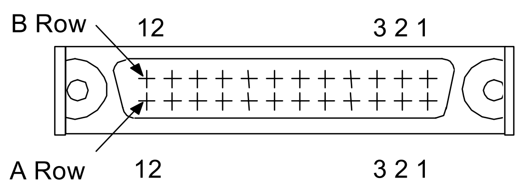
Ribbon Cable Connectors (as provided in IC693ACC318) require:

Cable Cutter	FCN–707T–T001/H
Hand Press	FCN–707T–T101/H
Locator Plate	FCN–367T–T012/H

These tools must be ordered from an authorized Fujitsu distributor.

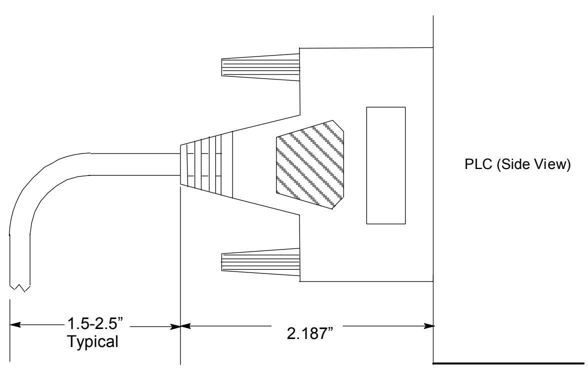
Pin connections with color codes are shown below. Cables are made of 12 twisted pairs; wire size is #24 AWG (0.22mm^2). Each pair has a solid color wire and the same color wire with a black tracer.

Pin Number	***Pair #***	***Wire Color Code***		***Pin Number***	***Pair #***	***Wire Color Code***
A1	1	BROWN		B1	7	VIOLET
A2	1	BROWN/BLACK		B2	7	VIOLET/BLACK
A3	2	RED		B3	8	WHITE
A4	2	RED/BLACK		B4	8	WHITE/BLACK
A5	3	ORANGE		B5	9	GRAY
A6	3	ORANGE/BLACK		B6	9	GRAY/BLACK
A7	4	YELLOW		B7	10	PINK
A8	4	YELLOW/BLACK		B8	10	PINK/BLACK
A9	5	DARK GREEN		B9	11	LIGHT BLUE
A10	5	DARK GREEN/BLACK		B10	11	LIGHT BLUE/BLACK
A11	6	DARK BLUE		B11	12	LIGHT GREEN
A12	6	DARK BLUE/BLACK		B12	12	LIGHT GREEN/BLACK



Connector Depth for Custom Built Cables

Because custom built cables use a straight connector, they require more space in front of the PLC than a prefabricated cable, which has a right–angle connector. The depth of the cabinet that the PLC is mounted in should allow for the depth added by this connector.



Appendix C Calculating Heat Dissipation

This section explains how to find the total heat dissipation of PACSystems RX3i equipment.

PACSystems RX3i equipment must be mounted in a protective enclosure. The enclosure must be able to properly dissipate the heat produced by all the devices mounted inside. This includes the modules, discrete output devices, and discrete input devices. Each device manufacturer publishes these values. If an exact value is not available for a device, you can make a close estimate by obtaining the value for a similar device.

Module Heat Dissipation

For each backplane and module except power supplies (discussed separately), look up the power in Watts from the table of Module Load Requirements in the Power Supplies chapter. If the module uses more than one voltage type (for example, 3.3V and 24V relay), find its total power requirement. Then, add together the heat dissipation values for all the modules in the enclosure.

Example:

The Load Requirements table shows that the 12-Slot Universal Backplane IC695CHS012 draws:

1.98 Watts from the 3.3 VDC supply

+1.20 Watts from the 5 VDC supply

=3.18 Watts total heat dissipation of backplane IC695CHS012

Power Supply Heat Dissipation

In general, power supplies are 66% efficient. The power supply dissipates approximately 1 Watt of power in the form of heat for every 2 Watts of power it delivers to the PLC.

After finding the total power requirement for all of the modules in the backplane served by a power supply above, divide the total by 2 to find the power supply dissipation value. Do not use the rating of the power supply (such as 30 Watts) for this calculation because the application may not use the full capacity of the power supply.

If the +24 VDC output on an Expansion Power Supply is being used, calculate the power drawn, divide the value by 2, and add it to the total for the power supply.

Heat Dissipation for Discrete Output Modules

In addition to the module power calculations done above, discrete solid-state output modules require a calculation for their output circuits, which are powered from another supply. (This calculation is not required for Relay Output modules.) To calculate output circuit power dissipation:

- In the module's specifications table, find the value for Output Voltage Drop.
- Using the manufacturer's documentation or other reference information, find the required current value for each device (such as a relay, pilot light, solenoid, etc.) connected to an output point on the module. Estimate the device's percent of "on-time" based on its intended use in the application.
- Multiply the Output Voltage Drop times the current value times the estimated percent of on-time to arrive at average power dissipation for that output.

Repeat these steps for all outputs on the module, and then for all discrete output modules in the backplane.

Example:

The specifications table for the IC694MDL340 16-Point Discrete 120 VAC Output Module lists its Output Voltage Drop as: 1.5 Volts maximum.

Use that value for all of the calculations for the module.

In this example, two output points drive solenoids that control the advance and retract travel of a hydraulic cylinder. The solenoid manufacturer's datasheet shows that each solenoid draws 1.0 Amp. The cylinder advances and retracts once every 60 seconds that the machine is cycling. It takes 6 seconds to advance and 6 seconds to retract.

Because the cylinder takes equal time to advance and retract, both solenoids are on for equal lengths of time: 6 seconds out of every 60 seconds, which is 10% of the time. Therefore, since both solenoids have equal current draws and on-times, one calculation can be applied to both outputs.

Use the formula *Average Power Dissipation = Voltage Drop x Current Draw (in Amps) x Percent (expressed as a decimal) of on-time*:

1.5 x 1.0 x 0.10 = 0.15 Watts per solenoid

Then multiply this result by 2 for two identical solenoids:

0.15 Watts x 2 Solenoids = 0.30 Watts total for the two solenoids

Also in this example, the other 14 output points on the 16-point module operate pilot lights on an operator's panel. Each pilot light requires .05 Amps of current. Seven of the pilot lights are on 100% of the time and seven are on an estimated 40%.

For the 7 lights that are on 100% of the time:

1.5 x .05 x 1.00 = 0.075 Watts per light

Then multiply this value by 7:

0.075 Watts x 7 lights = 0.525Watts total dissipation for the first 7 lights

For the 7 lights that are on 40% of the time:

1.5 x .05 x 0.40 = .03 Watts per light

Then multiply this value by 7:

0.03 Watts x 7 lights = 0.21 Watts total dissipation for the other 7 lights

Adding up the individual calculations, we get:

0.30 + 0.525 + 0.21 = 1.035 Watts for the module's total output calculation

Heat Dissipation for Discrete Input Modules

In addition to the module power calculations described above, a discrete input module requires another calculation for its input circuits, because the power dissipated by the input circuits comes from a separate power source. This calculation assumes that all input circuit power delivered to these modules is eventually dissipated as heat. The procedure is:

- In the module's specifications table find the value for Input Current.
- For DC input modules, multiply the input voltage times the current value times the estimated percent of on-time to arrive at average power dissipation for that DC input.
- For AC input modules only, multiply the input voltage times the current value times the estimated percent of on-time times 0.10 to arrive at average power dissipation for that AC input.

Repeat these steps for all inputs on the module, and then for all discrete input modules in the backplane.

Example:

The Specifications table for the IC693MDL240 16-Point Discrete 120 VAC Input Module gives the following information:

Input Current: 12 mA (typical) at rated voltage

Use this value for all of the input calculations for this module.

In this example, eight of the input module's points are used for switches that, for normal operation, stay on (closed) 100% of the time. These include the Emergency Stop, Over Temperature, Lube Pressure OK, and similar switches.

Use the formula *Average Power Dissipation = Input Voltage x Input Current (in Amps) x Percent (expressed as a decimal) of on-time:*

120 x .012 x 1.0 = 1.44 Watts per input

Then multiply this result by 8:

1.44 Watts x 8 inputs = 11.52 Watts total for the 8 inputs

Also in this example, two input points on this 16-point module are for the Control On and Pump Start pushbuttons. Under normal conditions, these pushbuttons are only pressed once per day for about one second – just long enough to start up the control and pump. Therefore, their effect on our power calculation is negligible:

0.0 Watts total for 2 inputs

For the remaining 6 inputs of the 16 point module, it is estimated that they will be on for an average of 20% of the time. So the following calculation is made for these 6 inputs:

Using the formula of *Average Power Dissipation = Input Voltage x Input Current (in Amps) x Percent (expressed as a decimal) of on-time:*

120 x .012 x 0.20 = 0.288 Watts per input

Then multiply this result by 6:

0.288 Watts x 6 inputs = 1.728 Watts total for the 6 inputs

Finally, addi up the individual calculations:

11.52 + 0.0 + 1.728 = 13.248 Watts for the module's total input calculation

Total Heat Dissipation

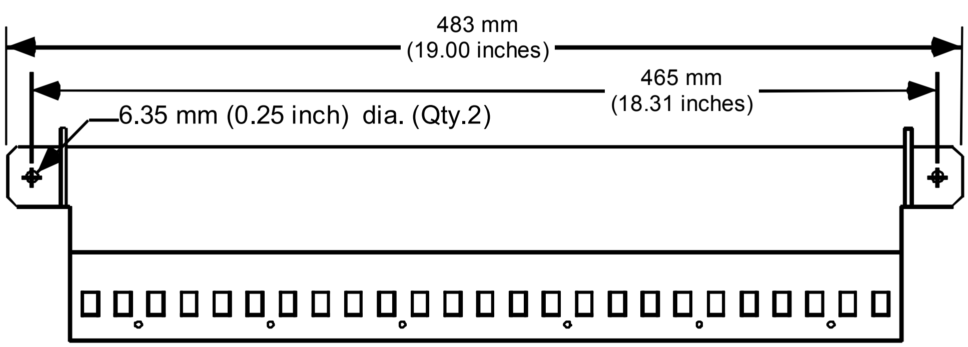
After the individual power dissipations have been calculated, add them together to obtain total PLC heat dissipation. It is usually not necessary to include analog modules because their power dissipation values are negligible when compared with the total.

Appendix D Cable Shield Clamping Assembly

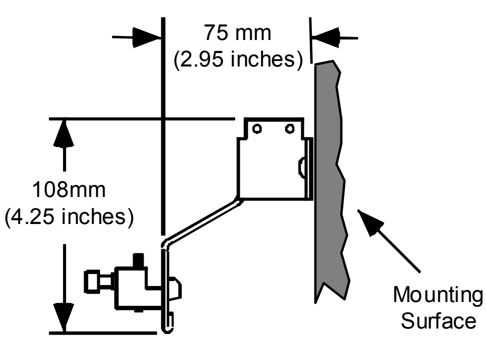
Cable Shield Clamping Assembly, IC697ACC736, contains the parts necessary for providing higher EMC immunity for shielded cables in severe industrial environments. Shield grounding is provided by the ground plate and cable clamps in the kit.

The Cable Shield Clamping Assembly package includes:

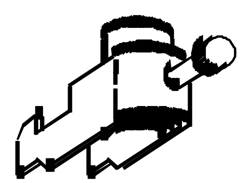
- One ground plate
- Six cable clamps
- Four #6 self-tapping screws



Front View with Mounting Dimensions



Side View with Spacing Requirements



(Six cable clamps included with assembly.)

* Additional cable clamps available (12 per package), catalog number IC697ACC737.

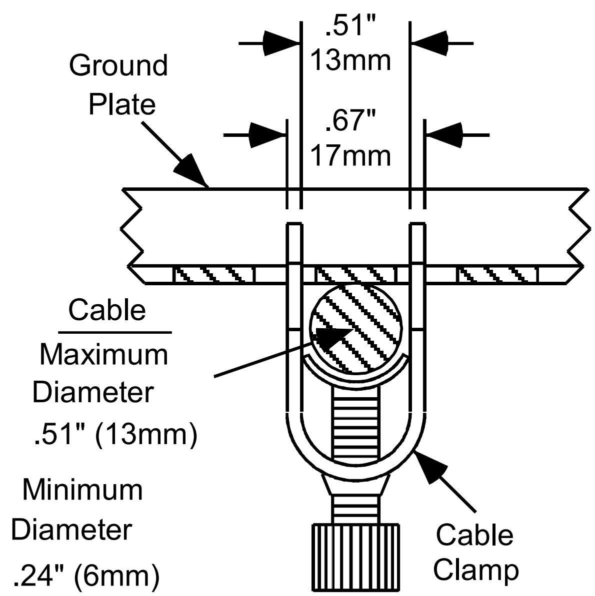
Installing the Cable Clamp Assembly

The ground plate should be mounted near the baseplate. The cable clamp provides mechanical relief as well as electrical grounding. The cable clamp attaches to the ground plate by sliding it into two adjacent slots at the selected cable location. The cable is inserted between the ground plate and the cable clamp after removing the required section of the cable's outer cover. Tighten the cable clamp by turning the thumbscrew clockwise. *Do not over-tighten the thumbscrew; hand-tighten or tighten lightly with a tool.*

If you are installing the ground plate on a painted surface, the paint must be removed where the ground plate is to be mounted to ensure a good ground connection between the plate and mounting surface.

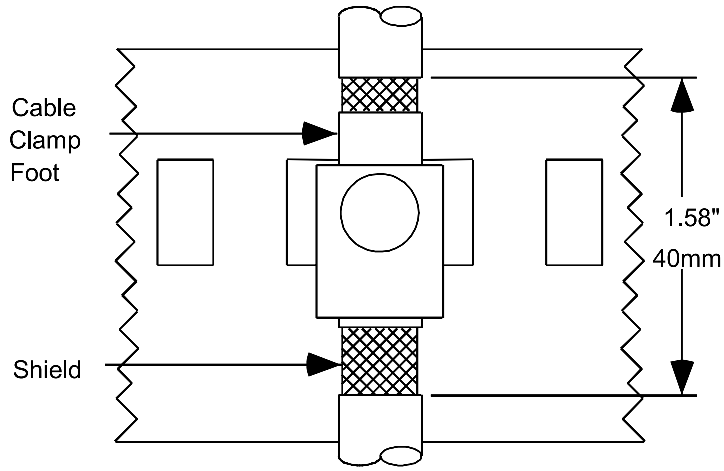
Cable Diameter

The largest diameter cable that can be used with the cable clamp is 0.51 inches (13mm). The smallest cable diameter that can be used with the clamp is 0.24 inches (6mm). Multiple cables can be placed in the clamp if the cable diameter is smaller than the minimum.



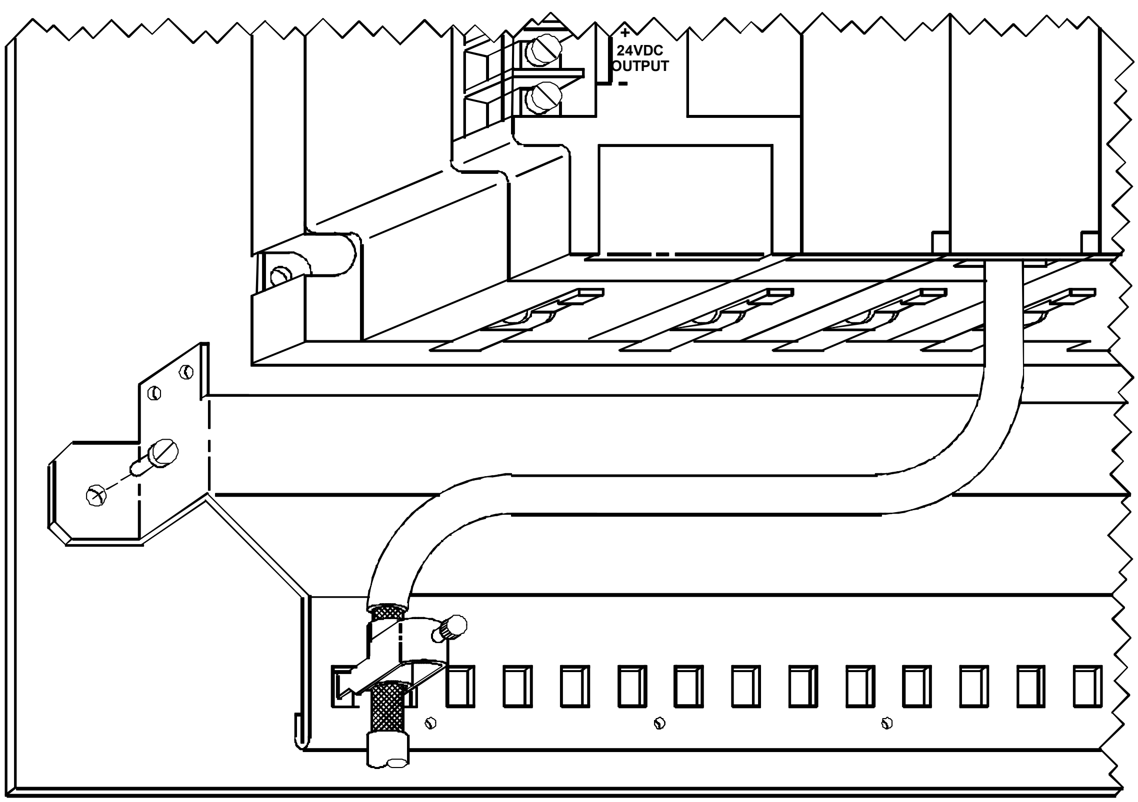
Removing the Insulating Cover

The insulating cover on the shielded cable must be removed to allow maximum contact between the cable shield and the cable clamp as shown below.



Typical Installation

A typical Cable Clamp Assembly installation with an Expansion Backplane is shown below.



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