



**Product Manual 26728**  
**(Revision A, 6/2018)**  
Original Instructions

**MicroNet™ Product Family**  
**“Kitted” Safety System Manual**

**Installation and Operation Manual**



### General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.



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## Warnings and Notices

### Important Definitions



This is the safety alert symbol used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER** - Indicates a hazardous situation, which if not avoided, will result in death or serious injury.
- **WARNING** - Indicates a hazardous situation, which if not avoided, could result in death or serious injury.
- **CAUTION** - Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury.
- **NOTICE** - Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT** - Designates an operating tip or maintenance suggestion.

#### **WARNING**

##### Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

#### **WARNING**

##### Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- Eye Protection
- Hearing Protection
- Hard Hat
- Gloves
- Safety Boots
- Respirator

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

#### **WARNING**

##### Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

## Electrostatic Discharge Awareness

### NOTICE

#### Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).
- Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.
- Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual **82715**, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
  - Do not touch any part of the PCB except the edges.
  - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
  - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

### IMPORTANT

External wiring connections for reverse-acting controls are identical to those for direct-acting controls.

## Electromagnetic Environment Recommendations

- Limited access
  - The access to the area is limited by an access regulation. All employees and visitors are well informed on the access limitations, use of mobile transmitters and other important rules to protect the environment against electromagnetic phenomena.
- Use of mobile transmitters
  - The use of mobile transmitters in sensitive areas is limited by access rules.
- Dedicated cables for PS and control, signal or communication lines
  - With regard to their potential in emitting or receiving disturbances, cable connections are divided into three different categories
    - - Signal/control cables (< 110 V)
    - - Low-voltage power cables (up to 1 kV)
    - - High-voltage Power cables (> 1 kV)
  - Different categories of cables are laid separately. The separation distance is a minimum of 30cm, or a metallic separating web is used in the cable duct/tray.
  - Wire pairs that belong together functionally are laid in the same cable/tray.
  - Control cables are separated from bus bars and power transformers.
- Overvoltage/lightning protection
  - For the factory/plant in areas with high risk for lightning strikes, an overvoltage/lightning protection concept exists. The installed overvoltage/lighting protection system limits overvoltage caused by lightning or switching actions between all conductors and the ground potential and limits the overvoltage to a defined and safe voltage level.
- Installation guidelines for equipment and systems
  - All installations (before placing into operation and during maintenance/replacement operations) are implemented according to the installation guidelines for the plant. The guidelines explain in detail the installation process, shielding, earth bonding, etc.
- Cabinet for SIL control system
  - Control is placed in an EMC metal cabinet per the installation guidelines for the factory/plant. Control is located in an environmental controlled environment which includes temperature, humidity, etc. and limits use of mobile transmitters.

# Chapter 1.

## General Information

### General

When used in conjunction with the MicroNet Safety Module (MSM), the MicroNet Plus and MicroNet TMR platforms have been certified by TUV as meeting SIL-1, SIL-2, or SIL-3 per IEC 61508 Parts 1-7, "*Function Safety of Electrical / Electronic / Programmable Electronic Safety Related Systems*". For applications requiring compliance with IEC 61508, the guidelines outlined in this manual must be followed.

Both the MicroNet Plus and MicroNet TMR platforms use configurable GAP/Coder software. The examples shown within this manual are intended to show only one possible typical configuration. The safety system design team will determine the final system/software architecture.

A safety based design review and functional testing are recommended to verify the overall system design.

See MicroNet Safety Module Manual 26547V1 and 26547V2 for proper configuration of the MSM to meet the requirements of IEC61508.

### Related Reference Documents

- MicroNet Plus Digital Control Manual 26166V1 & 26166V2
- MicroNet TMR Digital Control Manual 26167V1 & 26167V2
- MicroNet Safety Module Manual 26547V1 & 26547V2
- MicroNet Plus and MicroNet TMR Platforms IEC61508 SIL-3 Certification 51455
- GAP 3.14, Coder MicroNet 1.00 or TMR 1.00 Help

Table 1-1. Definitions and Abbreviations

DC	Diagnostic Coverage
PFDavg	Probability of failure on Demand
PFH	Probability of Failure Hourly
SFF	Safe Failure Fraction
SIL	Safety Integrity Level
SIF	Safety Instrumented Function(s)



The following list of modules has been reviewed by a third party for compliance with IEC 61508 Parts 1-7. At least two modules of each type are required for redundancy.

Table 1-2. SIL Approved MicroNet Plus and TMR Modules

Item #	Description	
5417-173	MicroNet High Density Analog/Discrete GRA 10 ft UL	Cable
5417-1105	MicroNet High Density Analog/Discrete GRA 10 ft UL (MIL Spec Connectors)	Cable
5453-277	MicroNet TMR Power Supply w/ Redundant Fans	Chassis
5453-279	MicroNet TMR	Chassis
5453-759	MicroNet Plus 14 Slot, Redundant with Smart Fans	Chassis
5453-829	MicroNet Plus 8 Slot, Redundant with Smart Fans	Chassis
5453-276	5009 F/T Discrete In	FTM
5501-372	High Density Analog I/O Triplex FTM	FTM
5441-694	High Density Discrete Relay Driver	FTM
5466-1000	MicroNet Plus, 24 Vdc Input, 2 Slot Power Supply	Module
5466-1001	MicroNet Plus, 110 Vac/125 Vdc Input, 2 Slot Power Supply	Module
5466-1002	MicroNet Plus, 220 Vac/250 Vac Input, 2 Slot Power Supply	Module
5466-1245	MicroNet Plus CPU5200 Enhanced Performance	Module
5466-1247	MicroNet TMR CPU5200 Shared RTN	Module
5466-1049	MicroNet TMR Plus Kernel PS	Module
5466-1050	MicroNet Simplex 48/24 HDDIO Smart-Plus	Module
5466-1051	MicroNet TMR 48/24 HDDIO Smart-Plus Module	Module
5466-5025	MicroNet High Density Analog A/O, 24 Analog Input, 8 Analog Outputs	Module
5501-380	5009/MicroNet TMR Power Supply (120 Vac/Vdc)	Module
9927-2490	Coder MicroNet 1.00	Software
9927-2623	Coder TMR 1.00	Software

Table 1-3. SIL Approved MicroNet Safety Modules (MSM)

Item #	Description
8237-2492	MicroNet Safety Module Bulkhead Mount HV/LV, Indep Relays, Voted Inputs MATH
8237-2493	MicroNet Safety Module Bulkhead Mount HV/HV, Indep Relays, Voted Inputs MATH
8237-2494	MicroNet Safety Module Bulkhead Mount HV/LV, Voted Relays/Inputs MATH
8237-2495	MicroNet Safety Module Bulkhead Mount HV/HV, Voted Relays/Inputs MATH
8237-2496	MicroNet Safety Module Panel Mount HV/LV, Indep Relays, Voted Inputs MATH
8237-2497	MicroNet Safety Module Panel Mount HV/HV, Indep Relays, Voted Inputs MATH
8237-2498	MicroNet Safety Module Panel Mount HV/LV, Voted Relays/Inputs MATH
8237-2499	MicroNet Safety Module Panel Mount HV/HV, Voted Relays/Inputs MATH

Table 1-4. SIL Approved ProTech TPS Devices

Item #	Description
8237-2602	ProTech TPS Bulkhead Mount HV/LV, Indep Relays, Voted Inputs MATH
8237-2603	ProTech TPS Bulkhead Mount HV/HV, Indep Relays, Voted Inputs MATH
8237-2604	ProTech TPS Bulkhead Mount HV/LV, Voted Relays/Inputs MATH
8237-2605	ProTech TPS Bulkhead Mount HV/HV, Voted Relays/Inputs MATH
8237-2606	ProTech TPS Panel Mount HV/LV, Indep Relays, Voted Inputs MATH
8237-2607	ProTech TPS Panel Mount HV/HV, Indep Relays, Voted Inputs MATH
8237-2608	ProTech TPS Panel Mount HV/LV, Voted Relays/Inputs MATH
8237-2609	ProTech TPS Panel Mount HV/HV, Voted Relays/Inputs MATH

Table 1-5. SIL Approved ProTech SX Devices

Item #	Description
8237-1242	ProTech SX, HV/LV
8237-1243	ProTech SX HV/HV

## SIL Parameters

$PFD_{avg} = 5.7 \times 10^{-3}$  (1 year)

$PFH = 9.9 \times 10^{-7}$  1/h

SFF = 94%

DC  $\geq$  90%

## SIL-3 MSM / MicroNet (Plus or TMR) System Overview

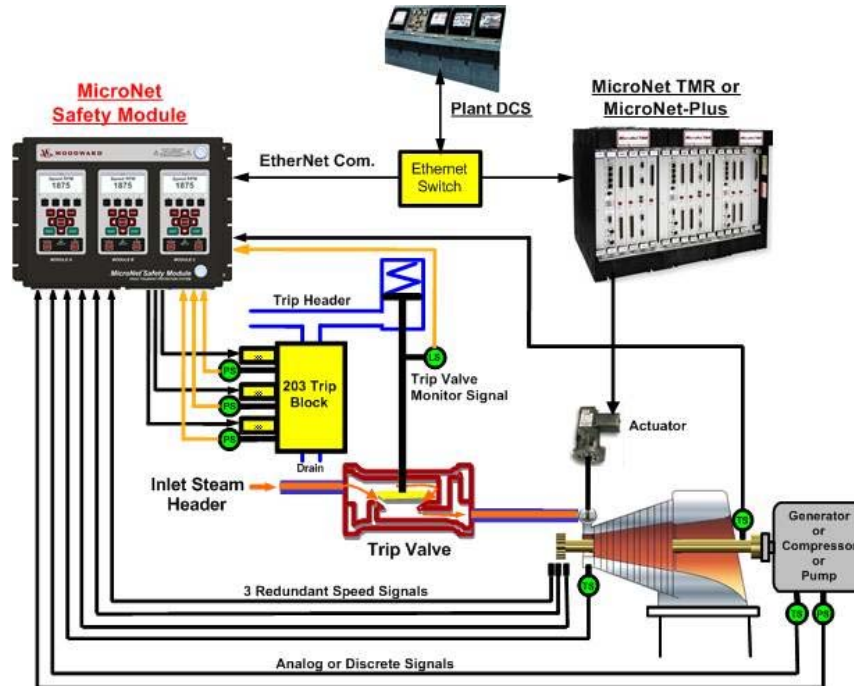


Figure 1-1. SIL-3 MSM / MicroNet (Plus or TMR) System Overview

### NOTICE

The "Kitted" MicroNet Safety system includes the SIL3 Certified ProTech/MSM and the SIL1 certified MicroNet Plus/TMR system.

### NOTICE

SIL-2 and SIL-3 based I/O must be routed through the independent MicroNet Safety Module.

### NOTICE

SIL1 I/O configuration requirements are included in this manual. For configuration information for SIL2 and SIL3 I/O, use the 26547V1 and 26547V2 safety manuals

System Configuration Block Diagram Examples

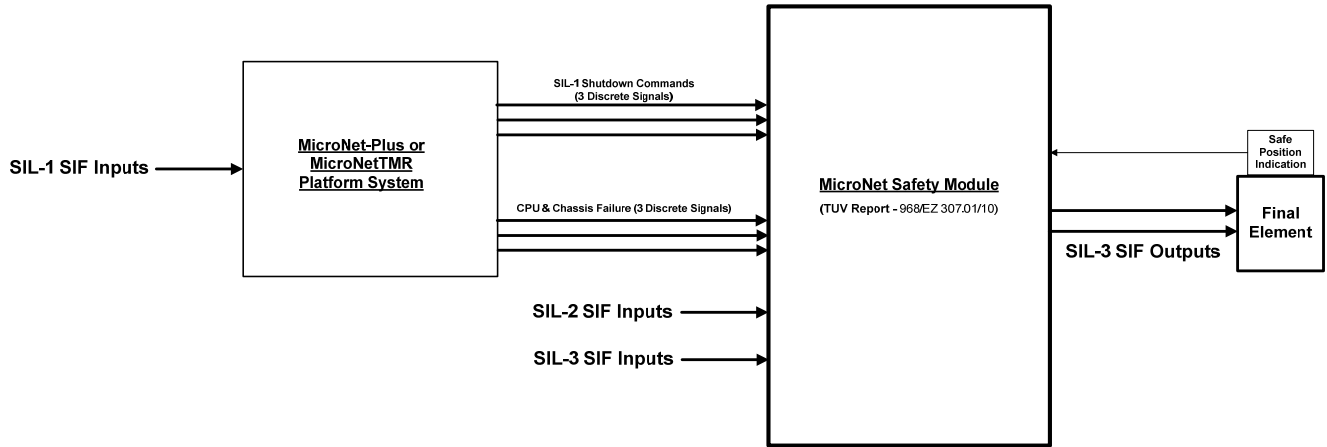


Figure 1-2. MicroNet (Plus or TMR) Safety System SIF Architecture

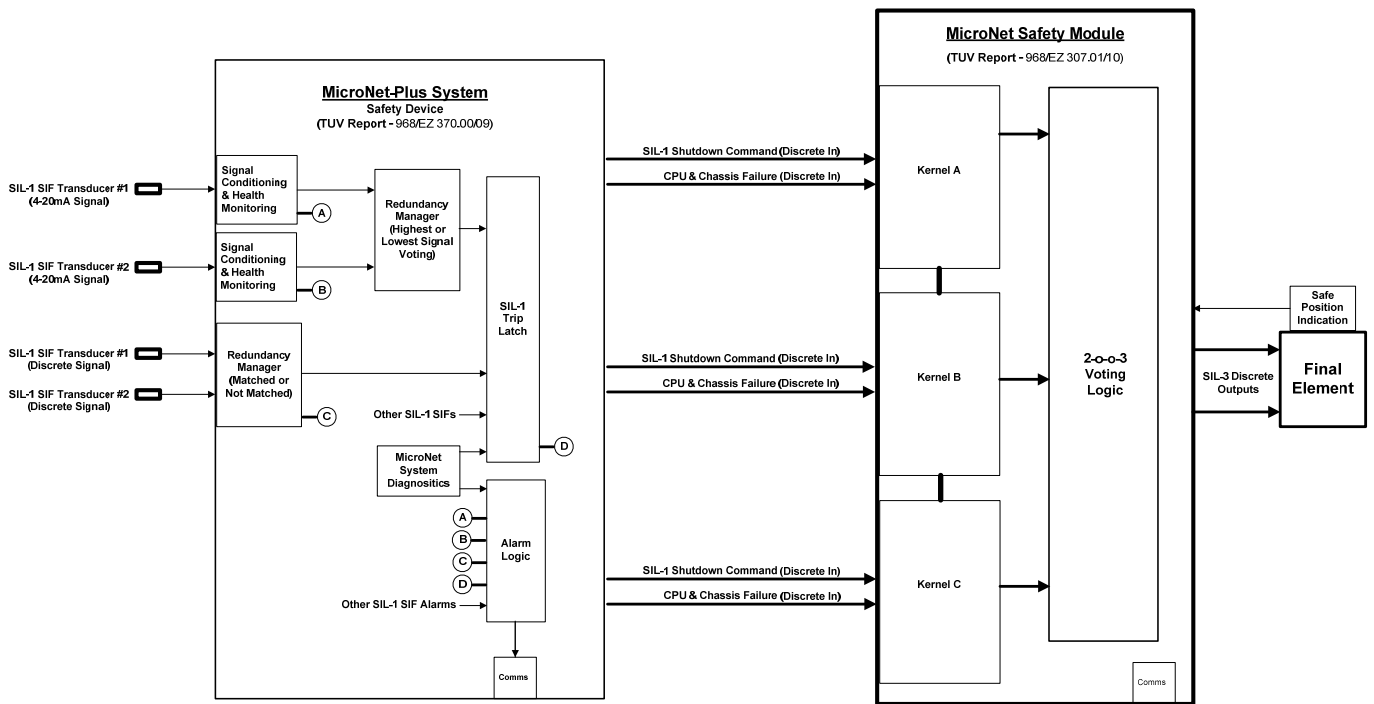


Figure 1-3. MicroNet-Plus Safety System SIL-1 SIF Architecture Connected to a SIL3 MSM

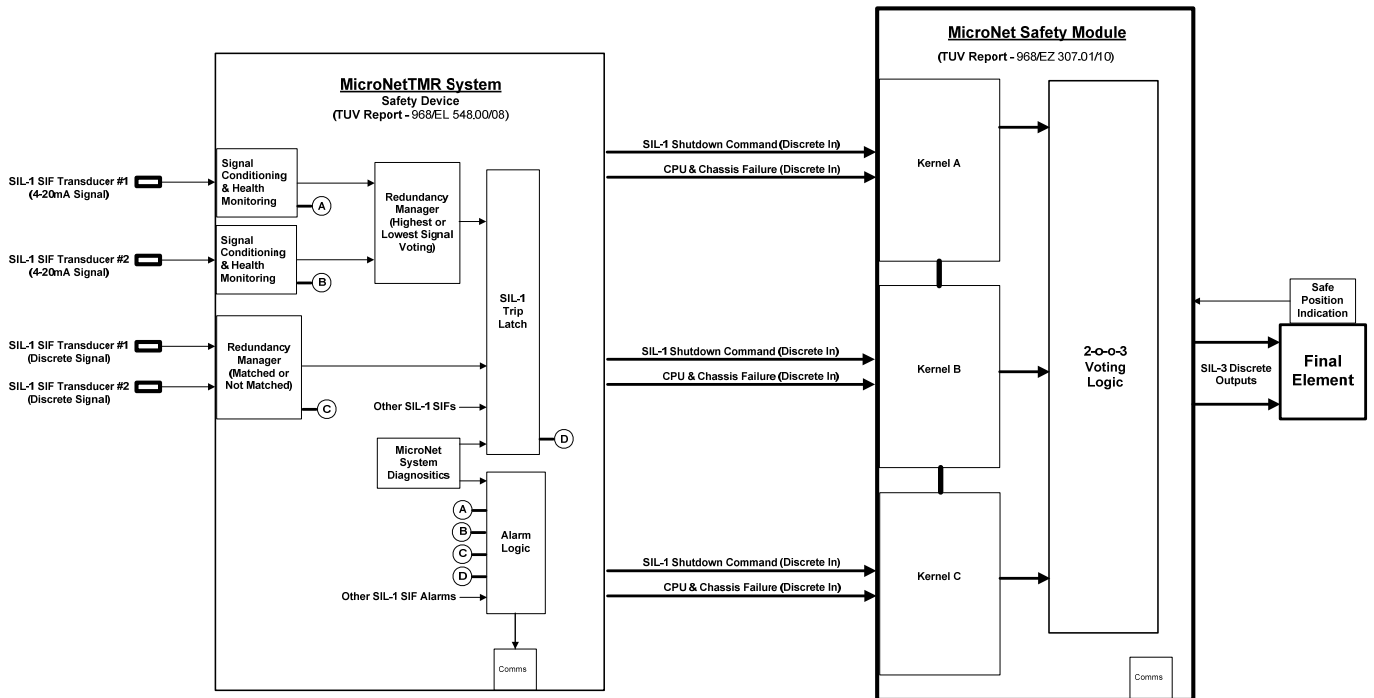


Figure 1-4. MicroNet TMR Safety System SIL-1 SIF Architecture Connected to a SIL3 MSM

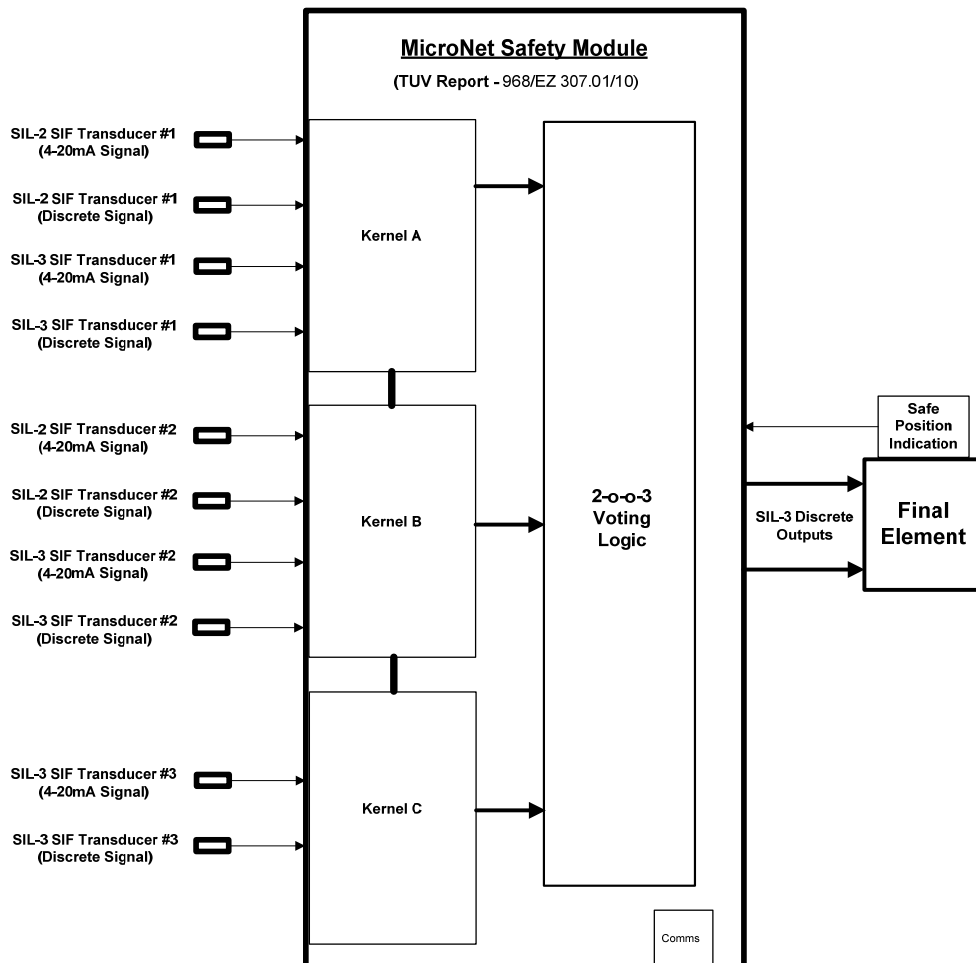


Figure 1-5. MicroNet Safety System SIL-2 and SIL-3 SIF Architecture

## Chapter 2. MicroNet Plus

### MicroNet Plus Redundant Hardware Configuration

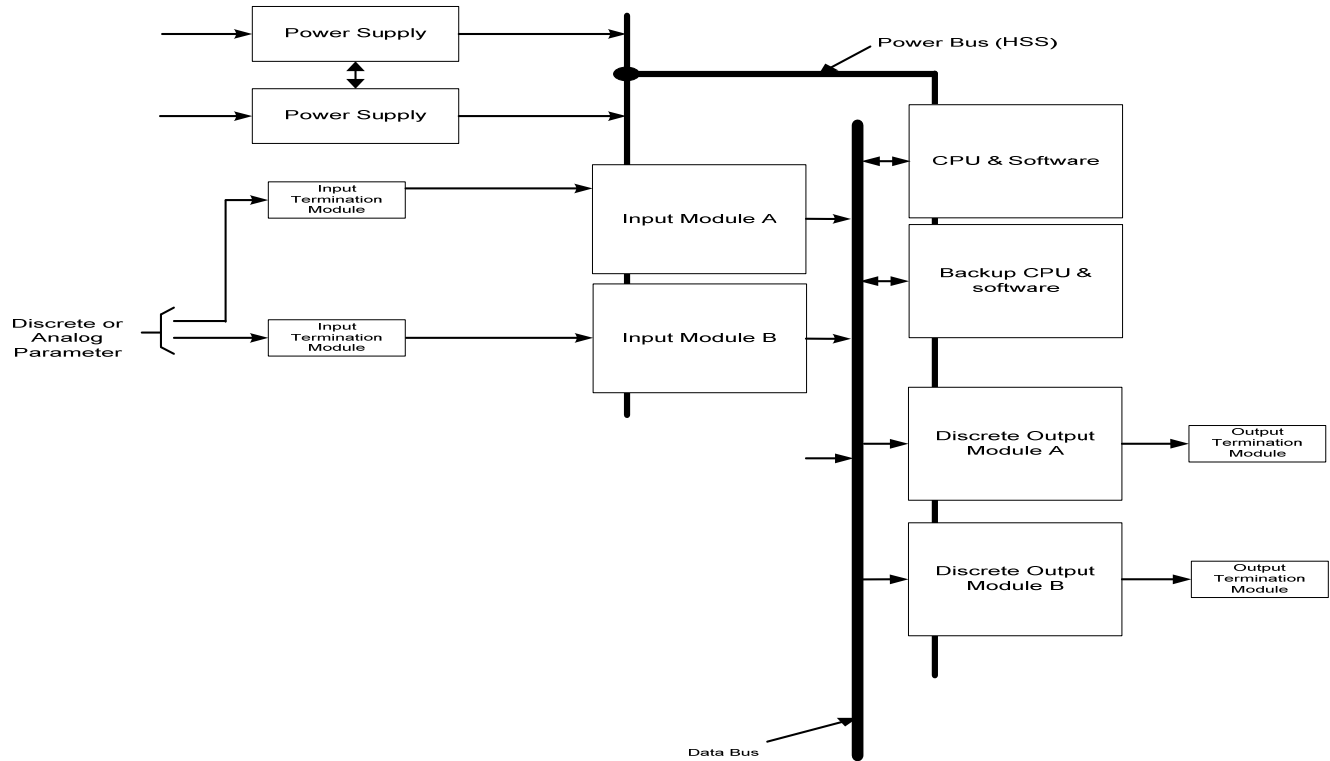


Figure 2-1. MicroNet Plus Redundant System Overview

#### MicroNet Plus Power Supply

For SIL applications, redundant power supplies are required. Follow installation instruction given in manual 26166V1.

#### MicroNet Plus CPU

For SIL applications redundant CPU modules configured as Master and Slave are required. Follow installation instruction given in manual 26166V1.

## Plus Boolean (Discrete) Inputs

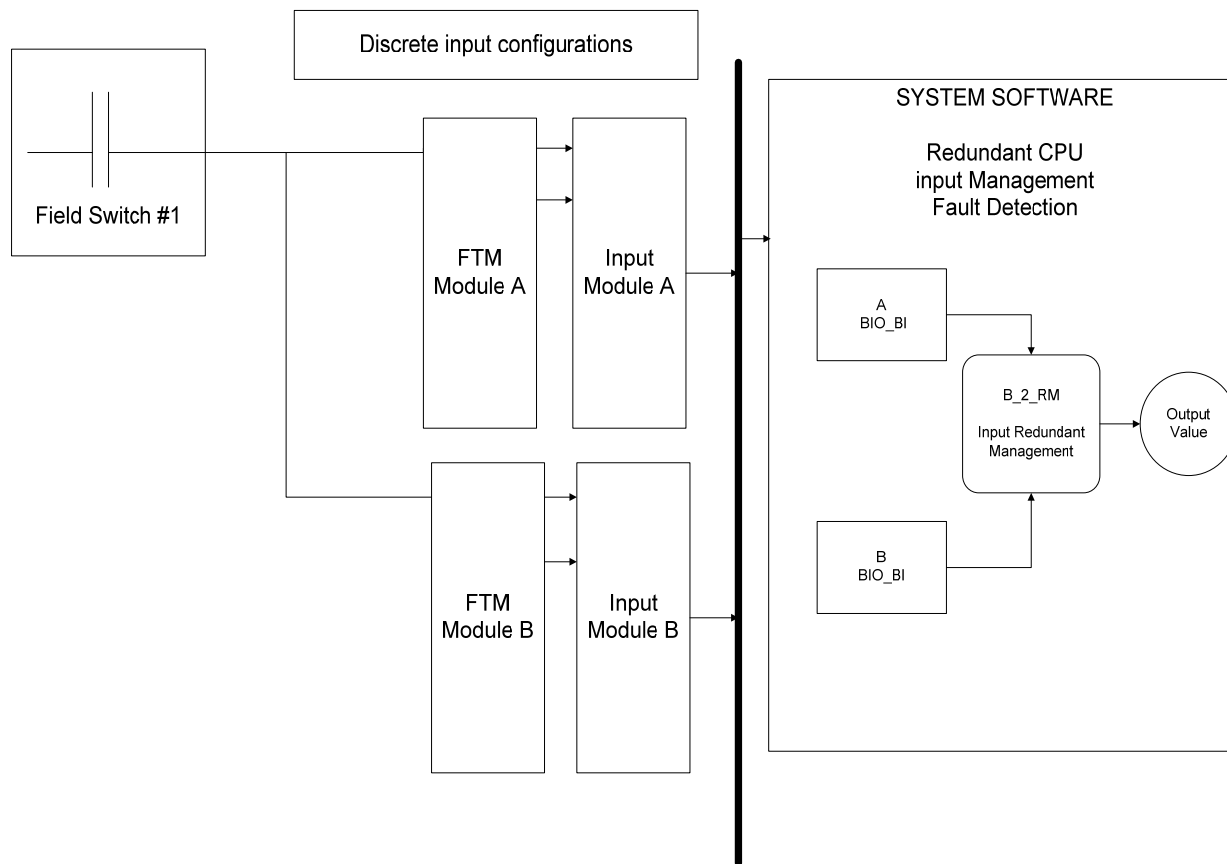


Figure 2-2. MicroNet Plus Boolean (Discrete) Inputs

See manual 26166V1 and 26166V2 for additional information.

See section "Application Software" for more details on System Software.

## Plus Analog Input

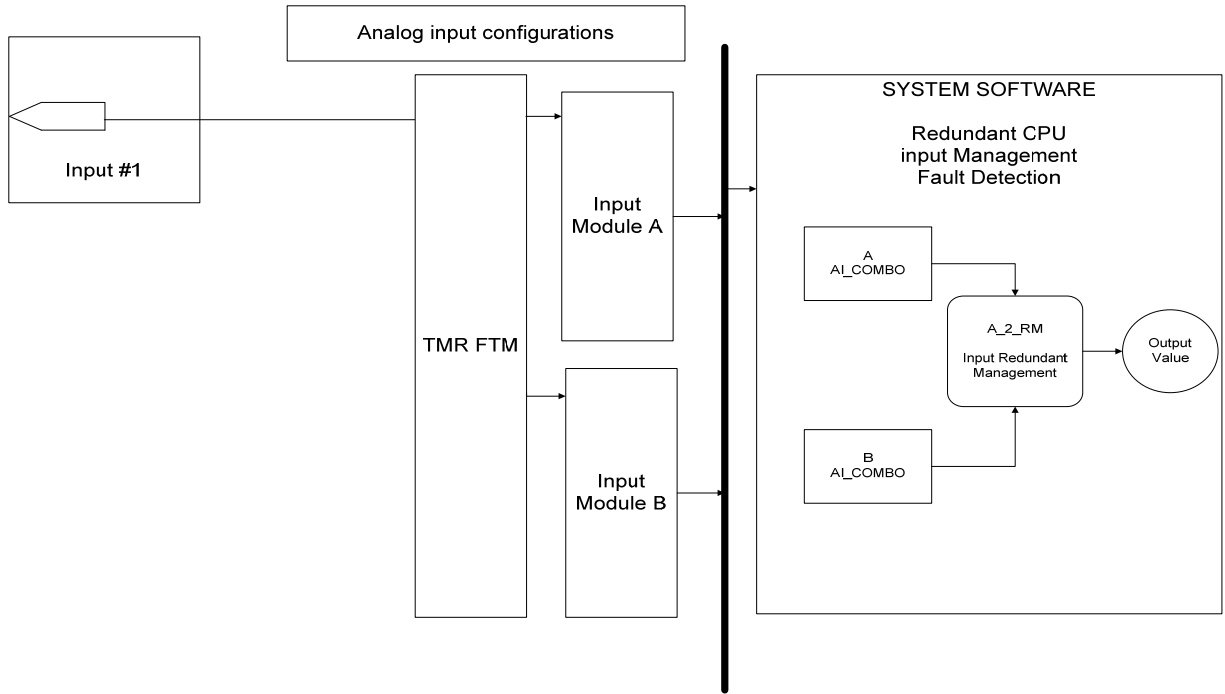


Figure 2-3. MicroNet Plus Analog Inputs

See manual 26166V1 and 26166V2 for additional information.

See section "Application Software" for more details on System Software.



## Plus Boolean (Relay) Outputs

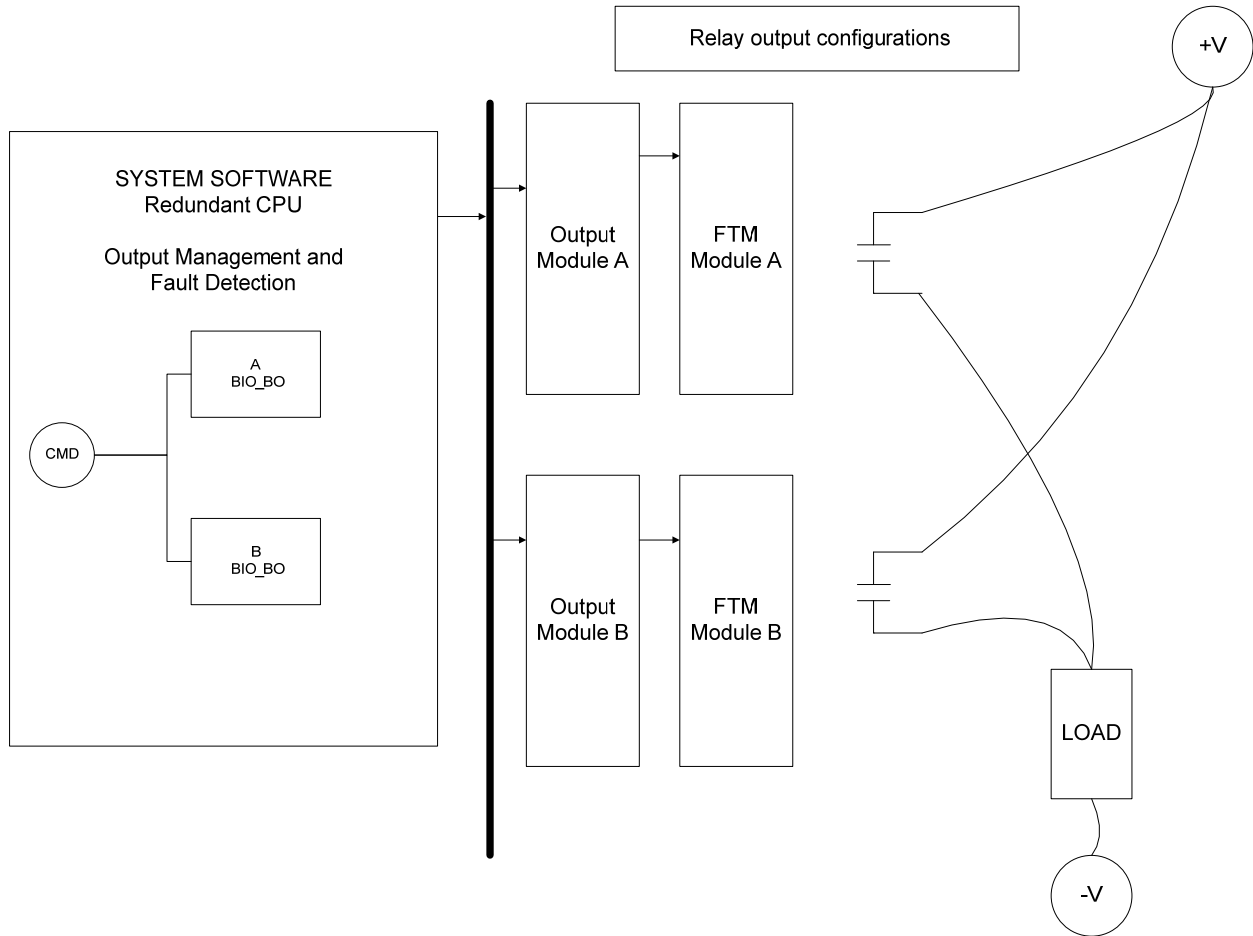


Figure 2-4. MicroNet Plus Boolean (Relay) Outputs

See manual 26166V1 and 26166V2 for additional information.

See section "Application Software" for more details on System Software.

## Plus Analog Outputs

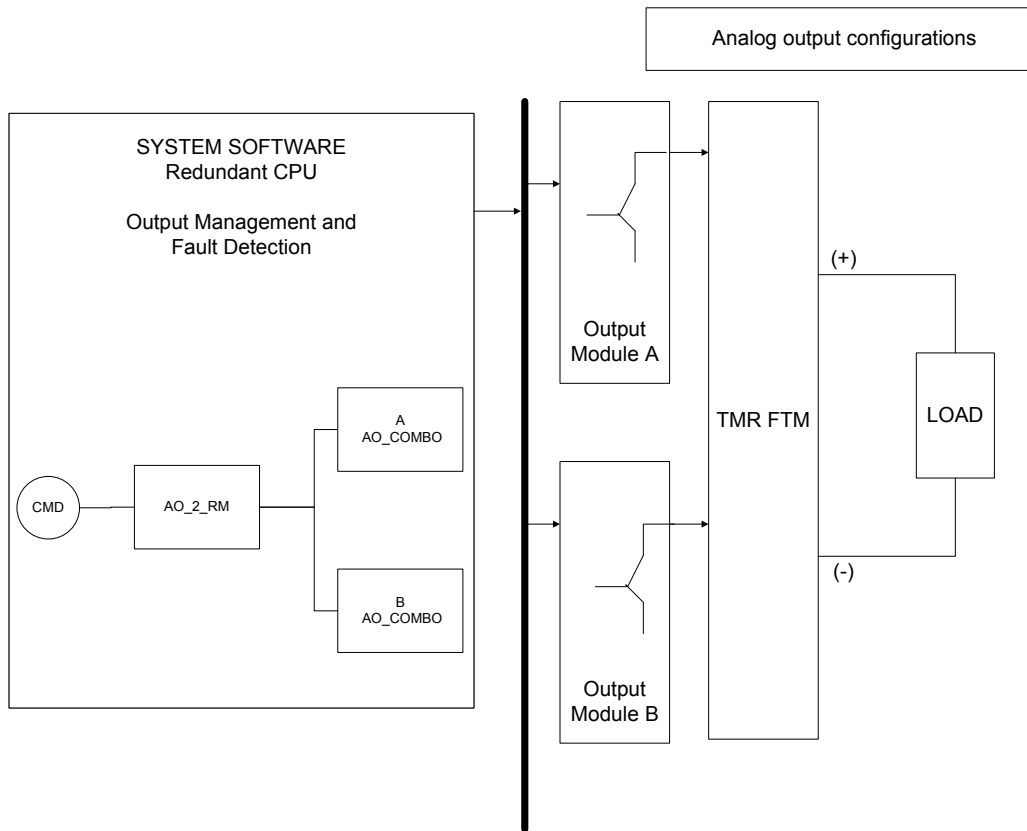


Figure 2-5. MicroNet Plus Analog Outputs

See manual 26166V1 and 26166V2 for additional information.

See section "Application Software" for more details on System Software.

## MicroNet Plus Application Software

### CPU

For SIL applications, redundant CPU modules configured as Master and Slave are required. See manual 26166V1 and 26166V2 for additional information.

### Plus Boolean (Discrete) Inputs Input Configuration

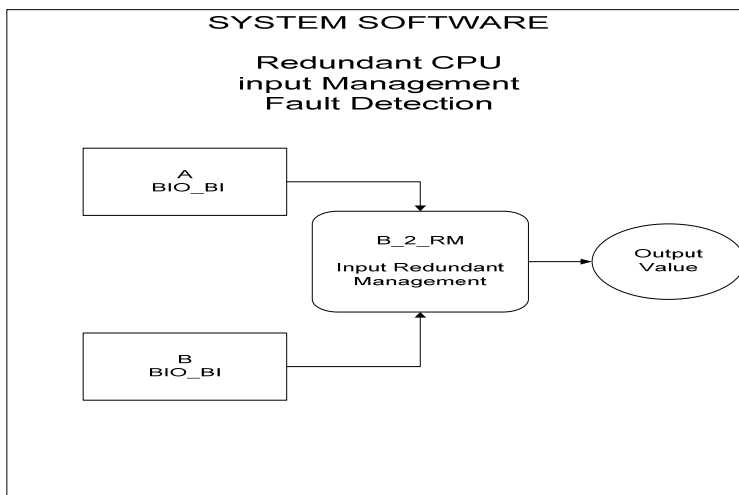


Figure 2-6. MicroNet Plus Boolean Input Block Diagram

The Boolean inputs shall be configured per Figures 2-7 and 2-8 below. See Appendix A for BIO\_BI description.

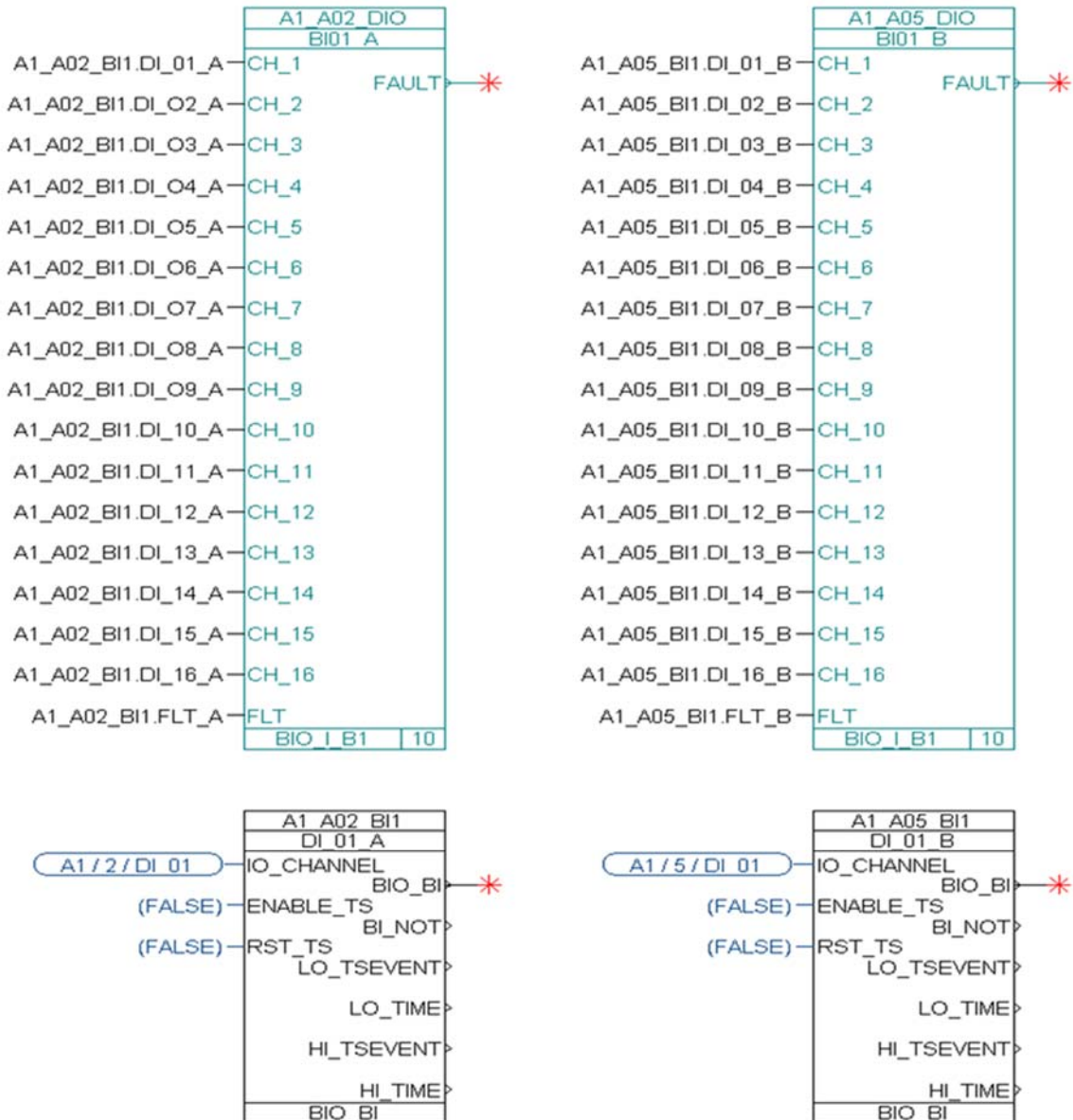


Figure 2-7. MicroNet Plus Boolean Input GAP Configuration

### Signal Processing

The signal processing required is accomplished using the B\_2\_RM block (Boolean Two Input Redundancy Manager) (see appendix A) per Figure 2-8. The B\_2\_RM monitors both Boolean input signals and compares the values. If the values match, the B\_2\_RM block sets the output the same as the two inputs. If the input values do not match, the output is set to the DFLT value of TRUE. This allows a hardware module to be replaced without disturbing the system functionality.

See Appendix A for B\_2\_RM and B\_NAME description.

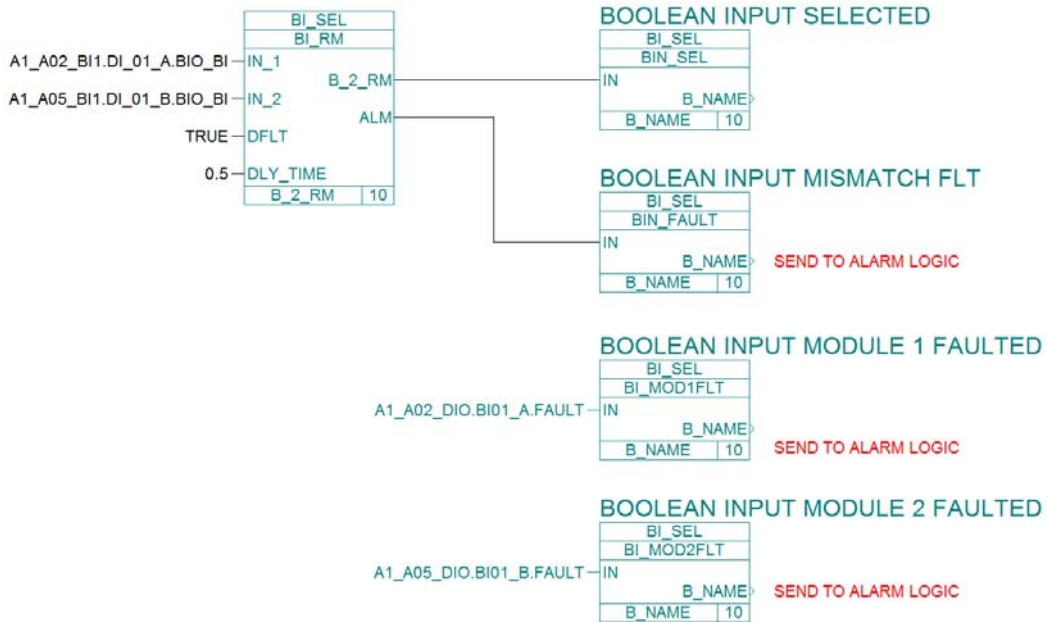


Figure 2-8. MicroNet Plus Boolean Input Redundant Manager GAP Configuration

### Alarm

The alarm output from the redundancy manager, “BIN\_FAULT.B\_NAME”, shall be sent to the alarm logic. In addition, the hardware module fault “BI\_MOD1FLT.B\_NAME” and “BI\_MOD2FLT.B\_NAME” shall be sent to the alarm logic.

### Plus Analog Input Input Configuration

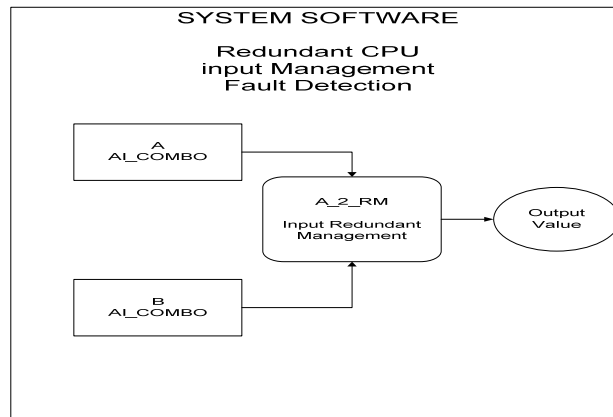


Figure 2-9. MicroNet Plus Analog Input Block Diagram

The analog inputs to the analog redundancy selection logic shall be configured per Figures 2-10 and 2-11 below.

See Appendix A for AI\_COMBO descriptions.

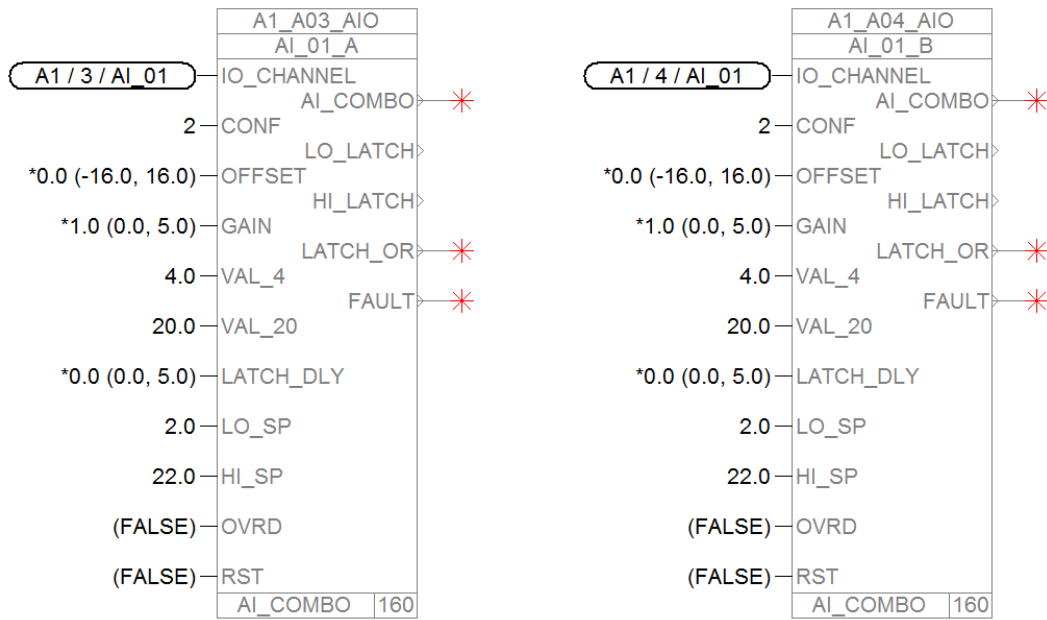


Figure 2-10. MicroNet Plus Analog Input GAP Configuration

The following adjustments are allowable for the AI\_COMBO analog input blocks:

The OFFSET and GAIN may be adjusted by the application engineer to calibrate the analog output.

The LATCH\_DLY is the delay (milliseconds) after a fault is detected before the fault is latched.

### Signal Processing

The signal processing required is accomplished using the A\_2\_RM (Analog Two Redundancy Manager) block per Figure 2-11. For each channel, the A\_2\_RM monitors both input analog signals for hardware faults detected in the Analog Input hardware blocks, as well as differences between the two signals. The A\_2\_RM latches hardware alarms and automatically selects the value to be used by the system. If there is a mismatch between the two input signals, the A\_2\_RM is configured to select the higher of the two signals.

See Appendix A for A\_2\_RM, A\_NAME and B\_NAME descriptions.

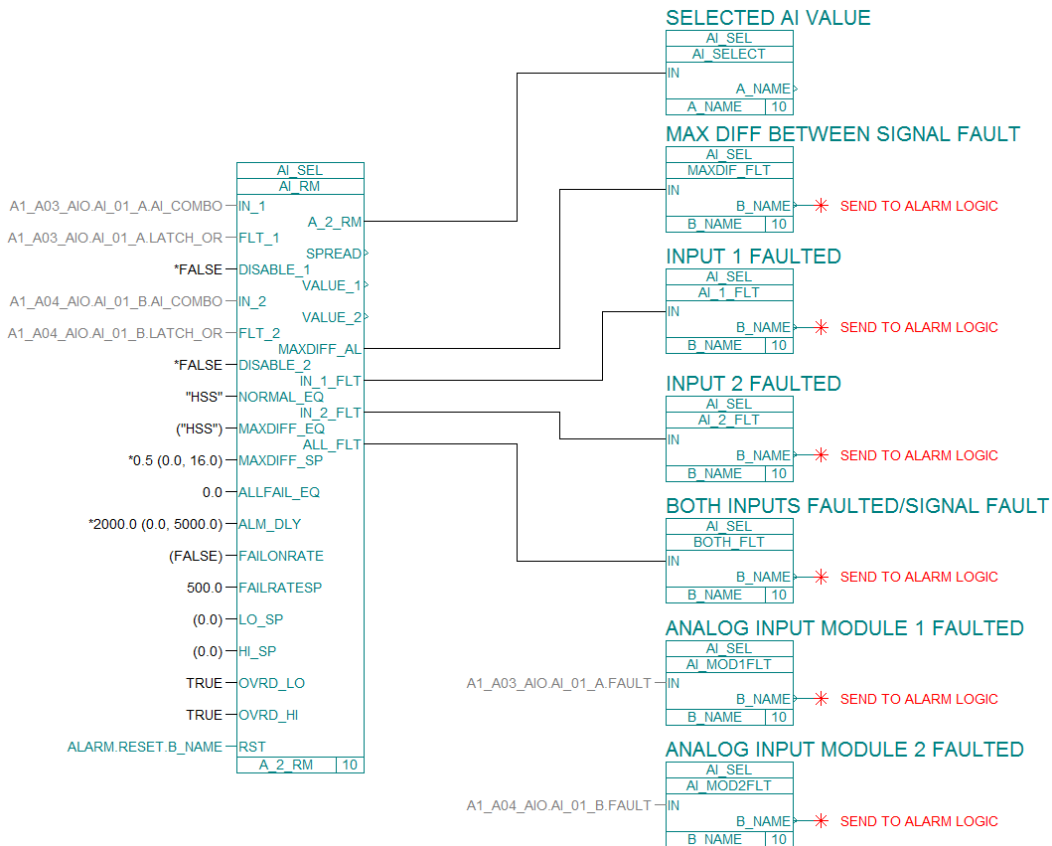


Figure 2-11. MicroNet Plus Analog Input Redundant Manager GAP Configuration

The A\_2\_RM (see Appendix A) must be configured per Figure 2-11 with the following allowable modifications. The modifications may be made by the application engineer or system designer to configure the applicable signal for safe operation of the system.

MAXDIFF\_SP (see Appendix A)

The MAXDIFF\_SP is the maximum allowable difference between the two input signals before a fault is latched.

ALM\_DLY set point: (see Appendix A)

The ALM\_DLY set point defines how long (ms) the IN\_1\_FLT, IN\_2\_FLT, & MAXDIFF\_AL alarm conditions must exist before being output as alarms.

### Alarms

The alarm output from the redundancy manager, “AI\_1\_FLT.B\_NAME”, “AI\_2\_FLT.B\_NAME”, “BOTH\_FLT.B\_NAME”, “MAXDIF\_FLT.B\_NAME”, “AI\_MOD1FLT.B\_NAME” and “AI\_MOD2FLT.B\_NAME” outputs shall be individually alarmed and shall be sent to the alarm logic.

## Plus Boolean (Relay) Outputs

### Output Configuration

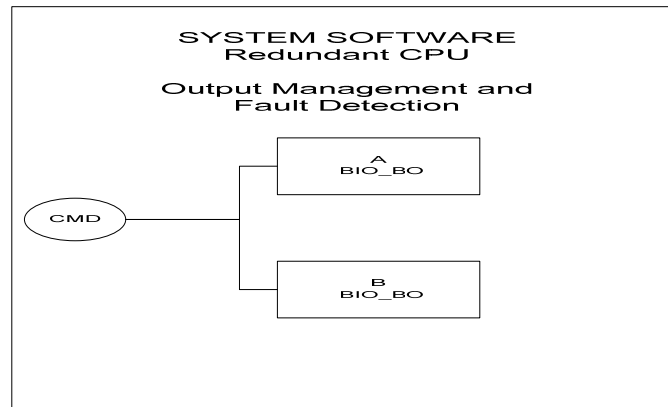


Figure 2-12. MicroNet Plus Boolean (Relay) Outputs Block Diagram

The Boolean outputs shall be configured per Figures 2-13 and 2-14.

See Appendix A for BIO\_BO and IO\_FLT descriptions.

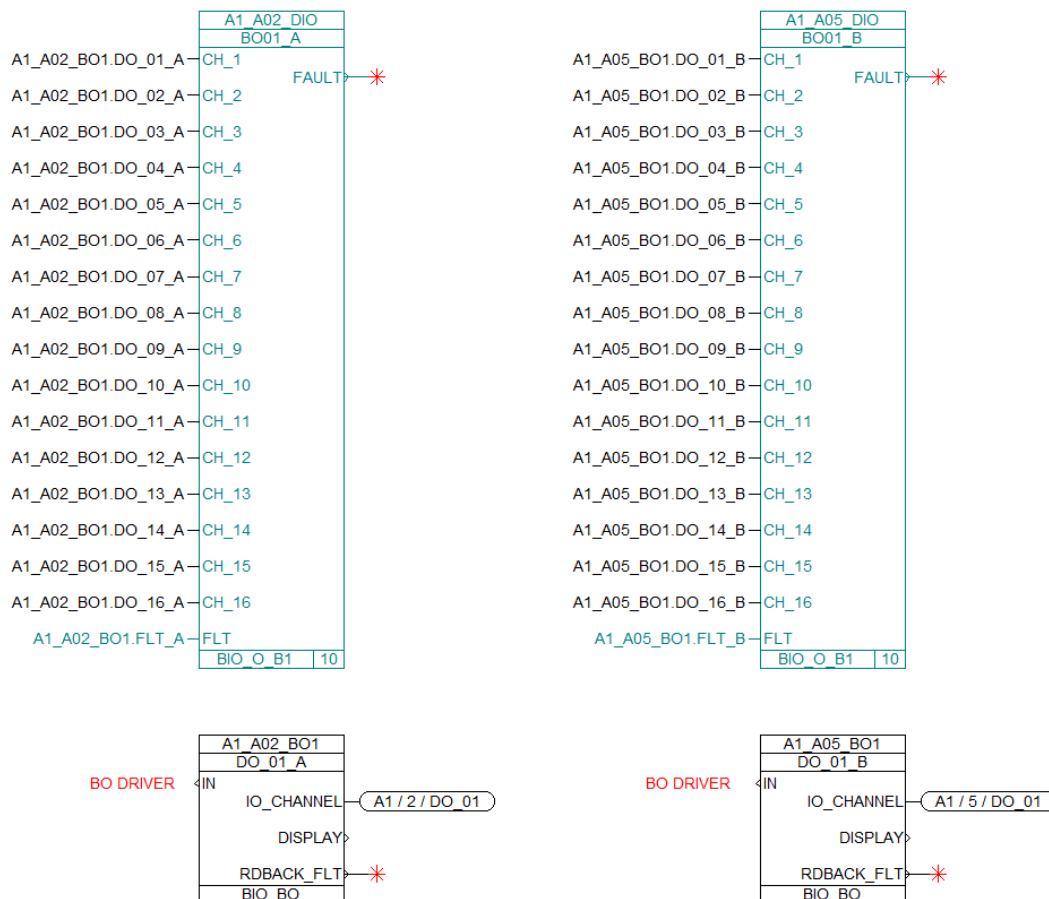


Figure 2-13. MicroNet Plus Analog Boolean (Relay) Output GAP Configuration



### Signal Processing

The signal processing required is accomplished per Figure 2-14. No specific redundancy software logic is required for dual Boolean outputs as the fail-safe operation is dependent on the system hardware. The Boolean output forcing function is configured to drive two relays, one of which must operate to drive the load.

See Appendix A for B\_NAME description.

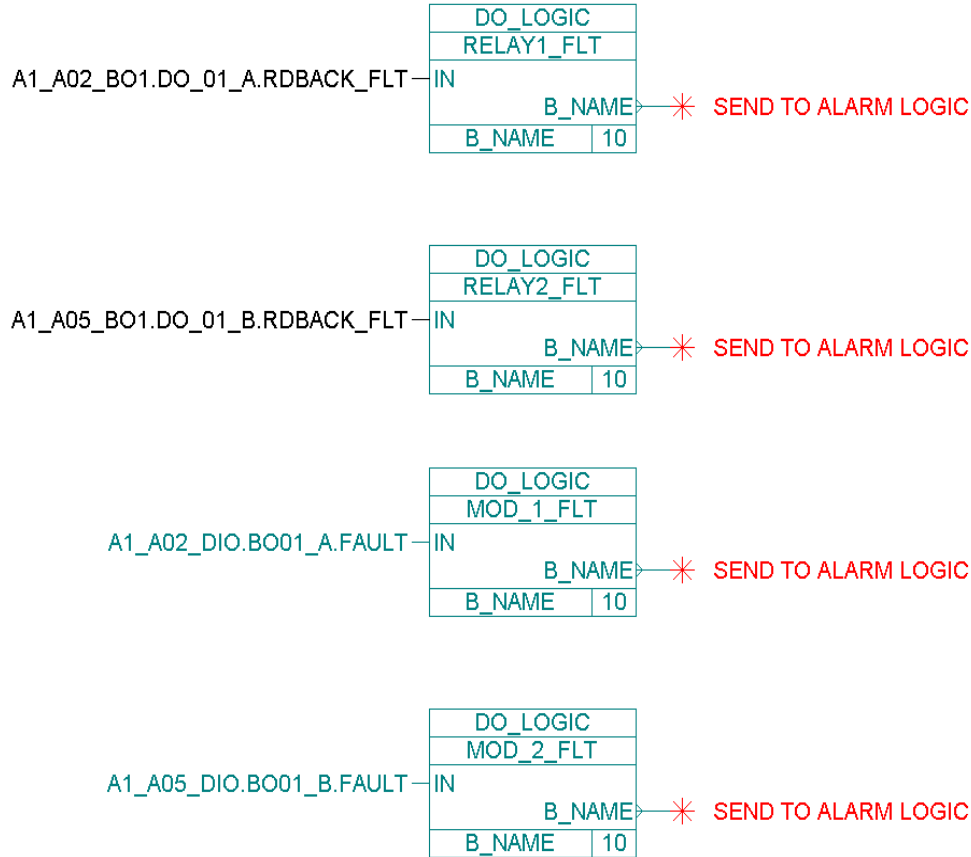


Figure 2-14. BO GAP Software Configuration

### Alarms

The RDBACK\_FLT output from the BIO\_BO block, “RELAY1\_FLT.B\_NAME” and “RELAY2\_FLT.B\_NAME”, shall be sent to the alarm logic. In addition, the hardware module fault “MOD\_1\_FLT.B\_NAME” and “MOD\_2\_FLT.B\_NAME” shall be sent to the alarm logic.

## Plus Analog Outputs Output Configuration

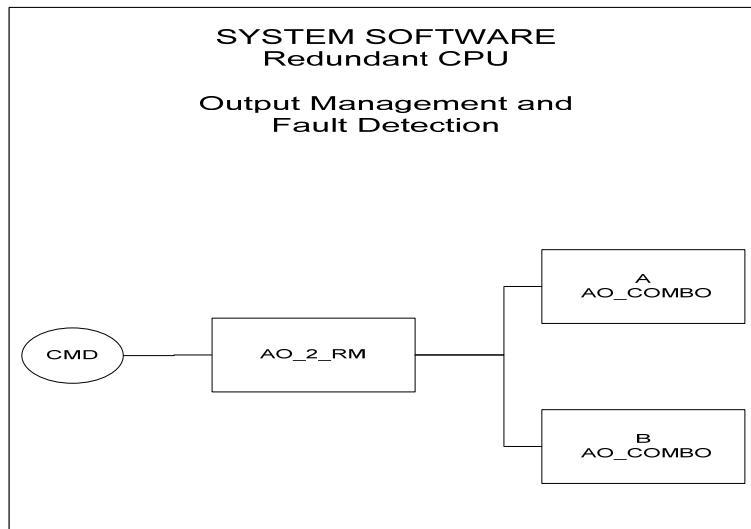


Figure 2-15. MicroNet Plus Analog Outputs Block Diagram

The analog outputs shall be configured per Figures 2-16 and 2-17.

See Appendix A for AO\_COMBO description.

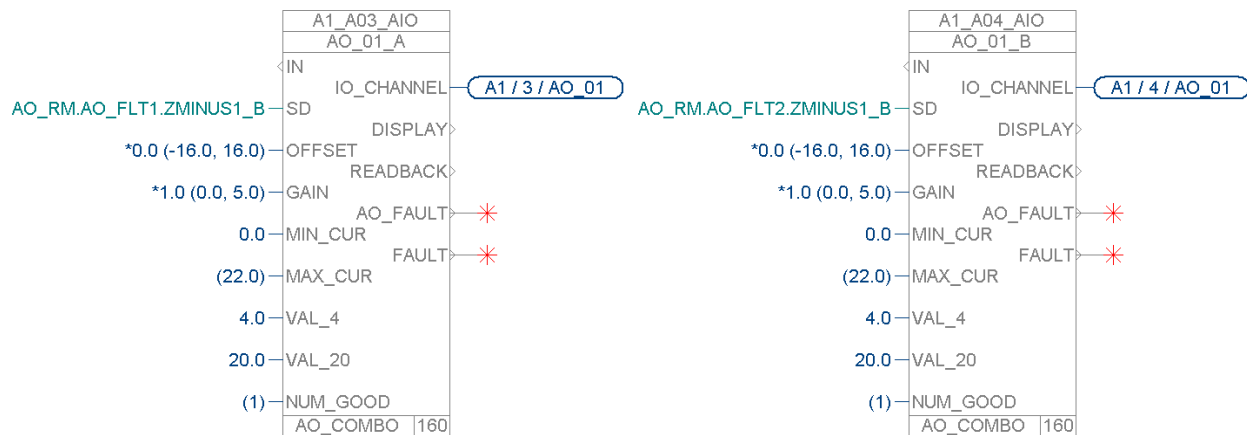


Figure 2-16. MicroNet Plus Analog Output GAP Configuration

The following adjustments are allowable for the AO\_COMBO analog output blocks:

The IN must be configured with the system driving function.

The OFFSET and GAIN may be adjusted by the application engineer to calibrate the analog output.

### Signal Processing

The software signal processing required is accomplished using the AO\_2\_RM (Analog Output Field redundancy manager) block per Figure 2-17. The AO\_2\_RM monitors both analog output signals for faults detected and automatically selects the output module to be used by the system by shutting down the faulted analog output. The system will continue to function with one of the Analog outputs faulted.

See Appendix A for OR, ZMINUS1\_B, AO\_2\_RM, and B\_NAME description.

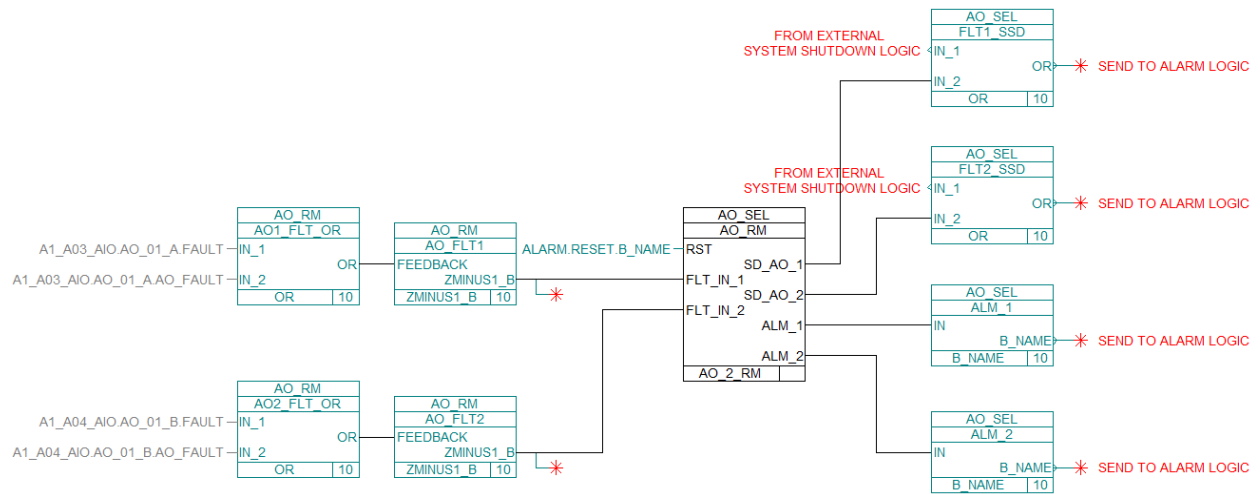


Figure 2-17. MicroNet Plus Analog Output Redundant manager GAP Configuration

### Alarms

The redundancy manager alarms “ALM\_1.B\_NAME”, “ALM\_2.B\_NAME”, “FLT1\_SSD.OR” and “FLT2\_SSD.OR” outputs shall be individually alarmed and sent to the alarm logic.

## Chapter 3. MicroNet TMR

### MicroNet TMR Hardware Configuration

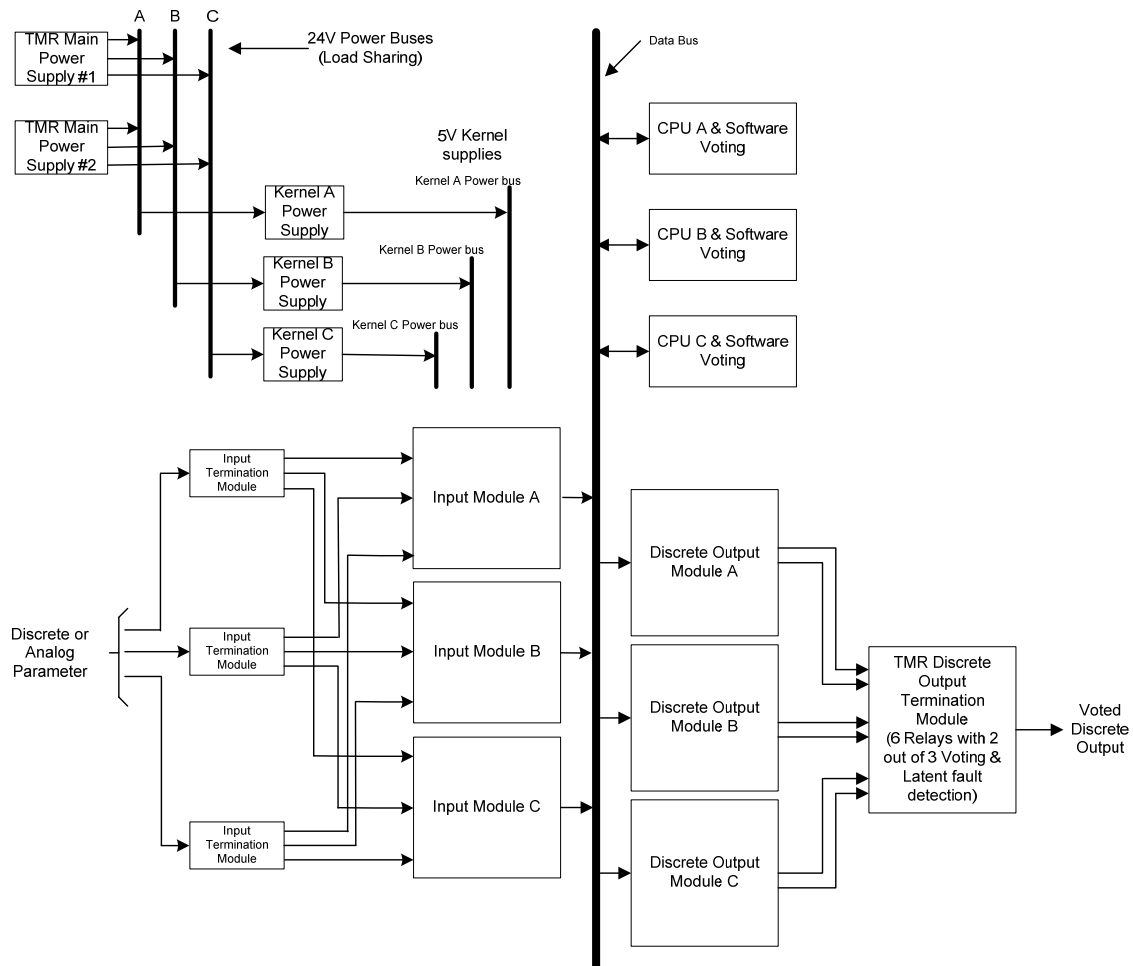


Figure 3-1. MicroNet Plus TMR System Overview

### MicroNet TMR System Overview

#### TMR Power Supply

For SIL MicroNet TMR applications, redundant main power supplies are required. See manual 26167V1 and 26167V2 for additional information.

#### TMR CPU

For SIL MicroNet TMR 2oo3 (2 out of 3) applications, three CPU modules are required. See manual 26167V1 and 26167V2 for additional information.

## TMR Boolean (Discrete) Input

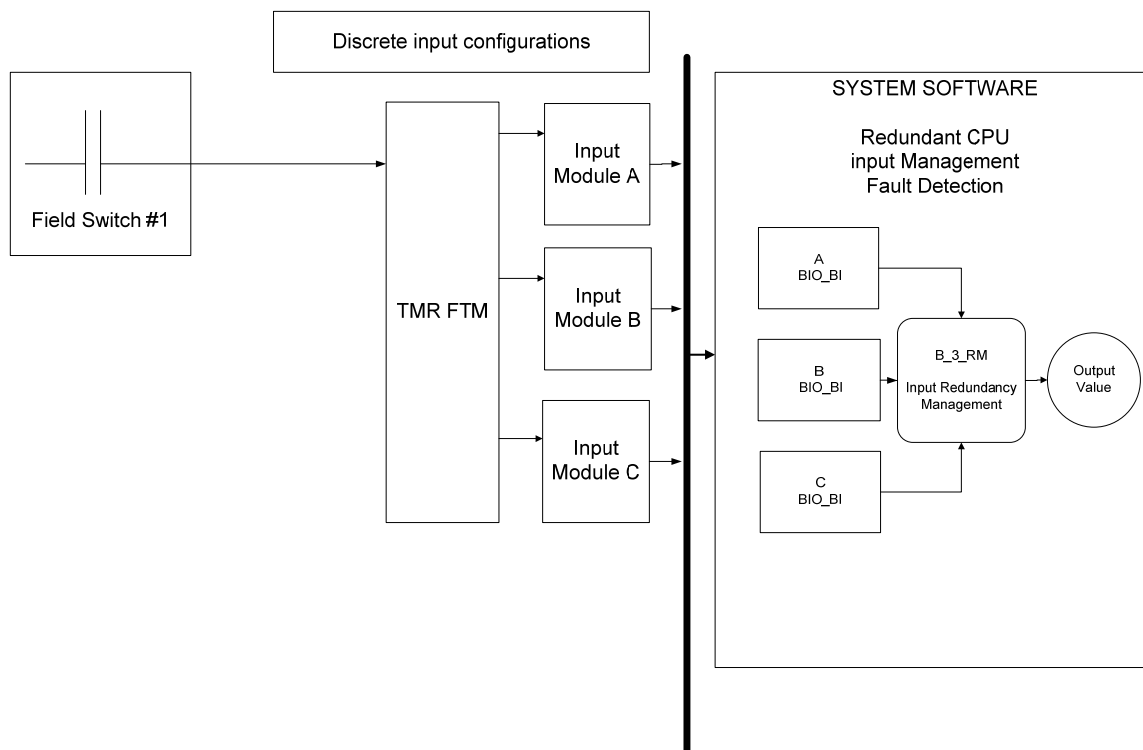


Figure 3-2. MicroNet TMR Boolean (Discrete) Inputs

See manual 26167V1 and 26167V2 for additional information.

See section "Application Software" for more details on System Software.

## TMR Analog Input

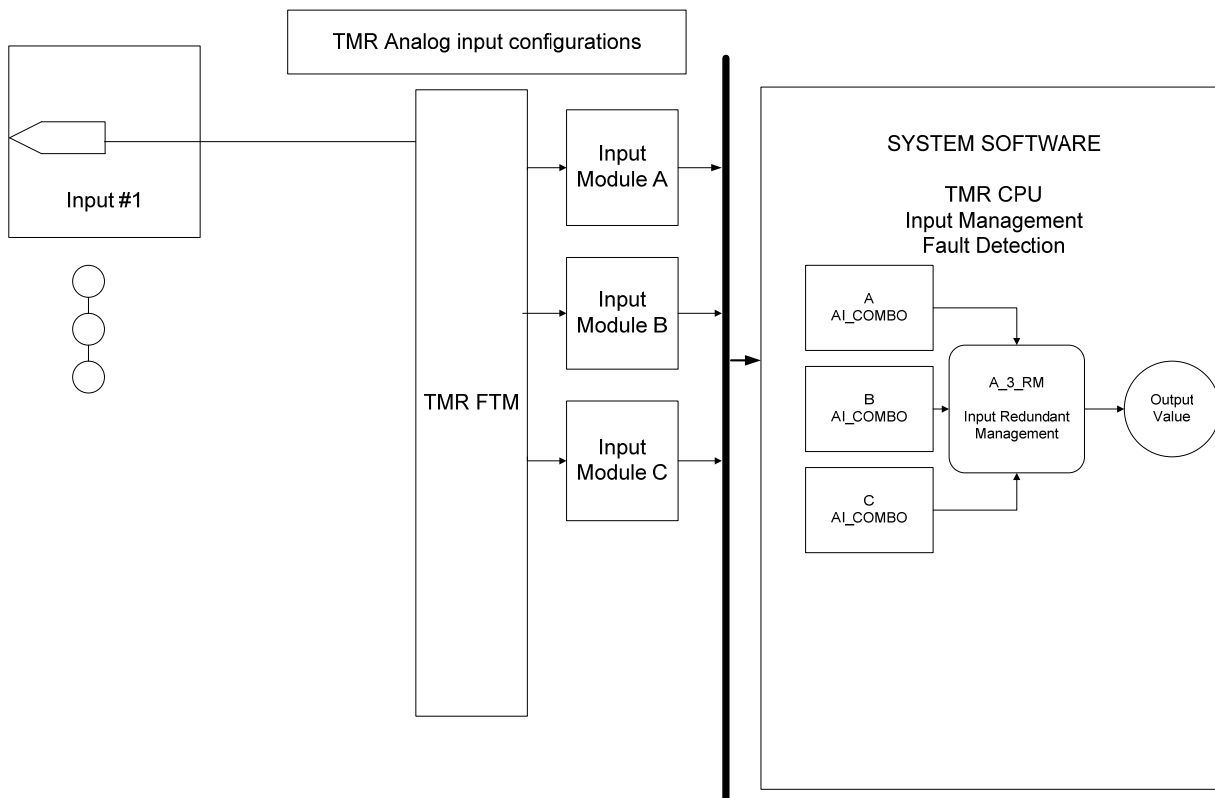


Figure 3-3. MicroNet TMR Analog Inputs

See manual 26167V1 and 26167V2 for additional information.

See section "Application Software" for more details on System Software.

## TMR Boolean (Relay) Output

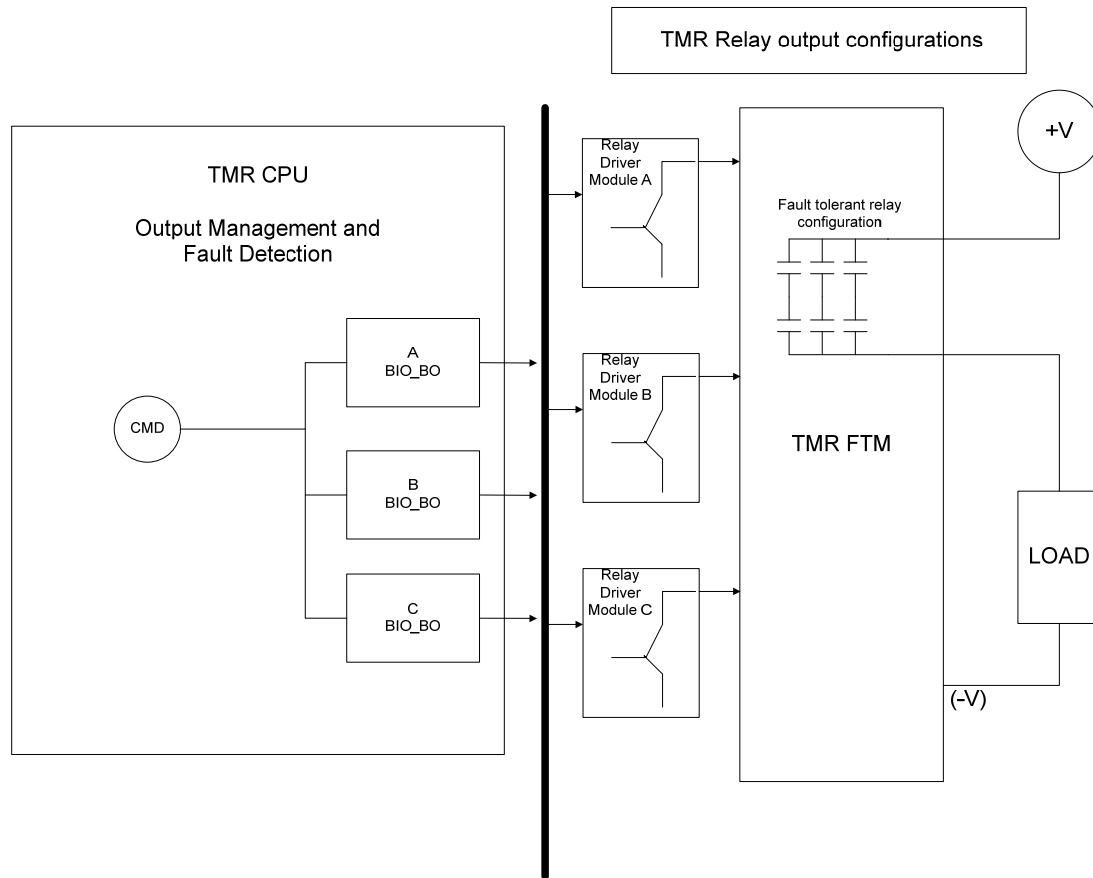


Figure 3-4. MicroNet TMR Boolean (Relay) Outputs

See manual 26167V1 and 26167V2 for additional information.

See section "Application Software" for more details on System Software.

## TMR Analog Output Example

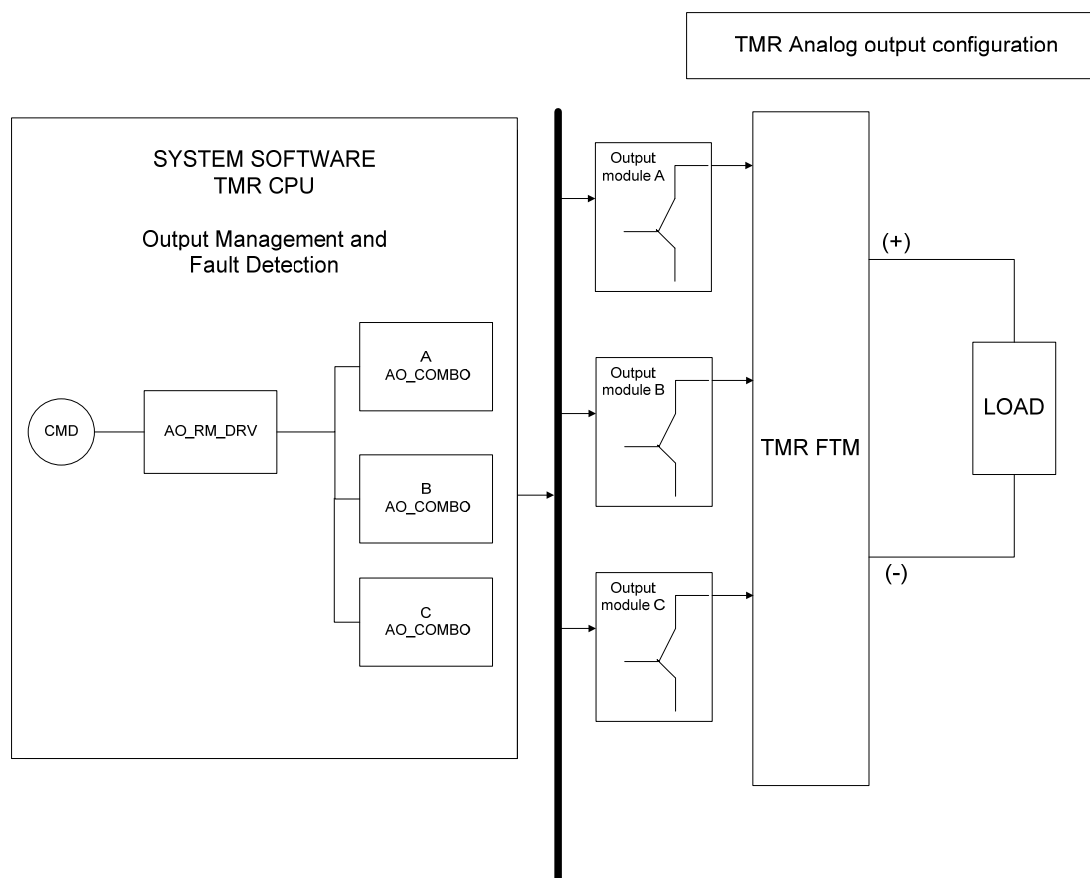


Figure 3-5. MicroNet TMR Analog Outputs

See manual 26167V1 and 26167V2 for additional information.

See section "Application Software" for more details on System Software.

## MicroNet TMR Application Software

### CPU

For SIL TMR applications, three TMR CPU modules are required. See manual 26167V1 and 26167V2 for additional information.



## TMR Boolean (Discrete) Inputs

### TMR Input Configuration

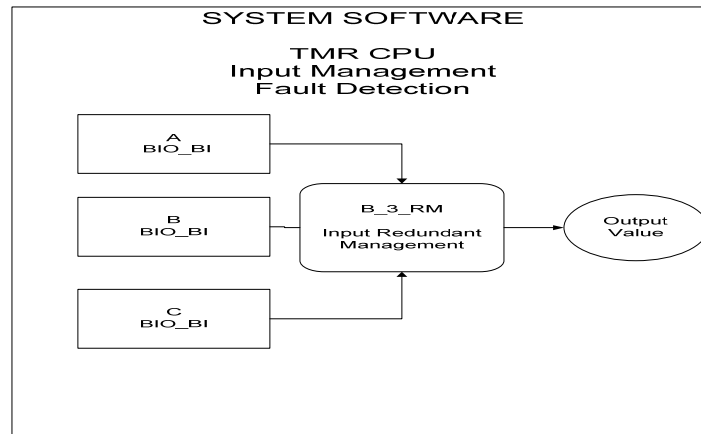


Figure 3-6. MicroNet TMR Boolean (Discrete) Input Block Diagram

The TMR Boolean inputs shall be configured per Figures 3-7 and 3-8.

See Appendix A for BIO\_BI description.

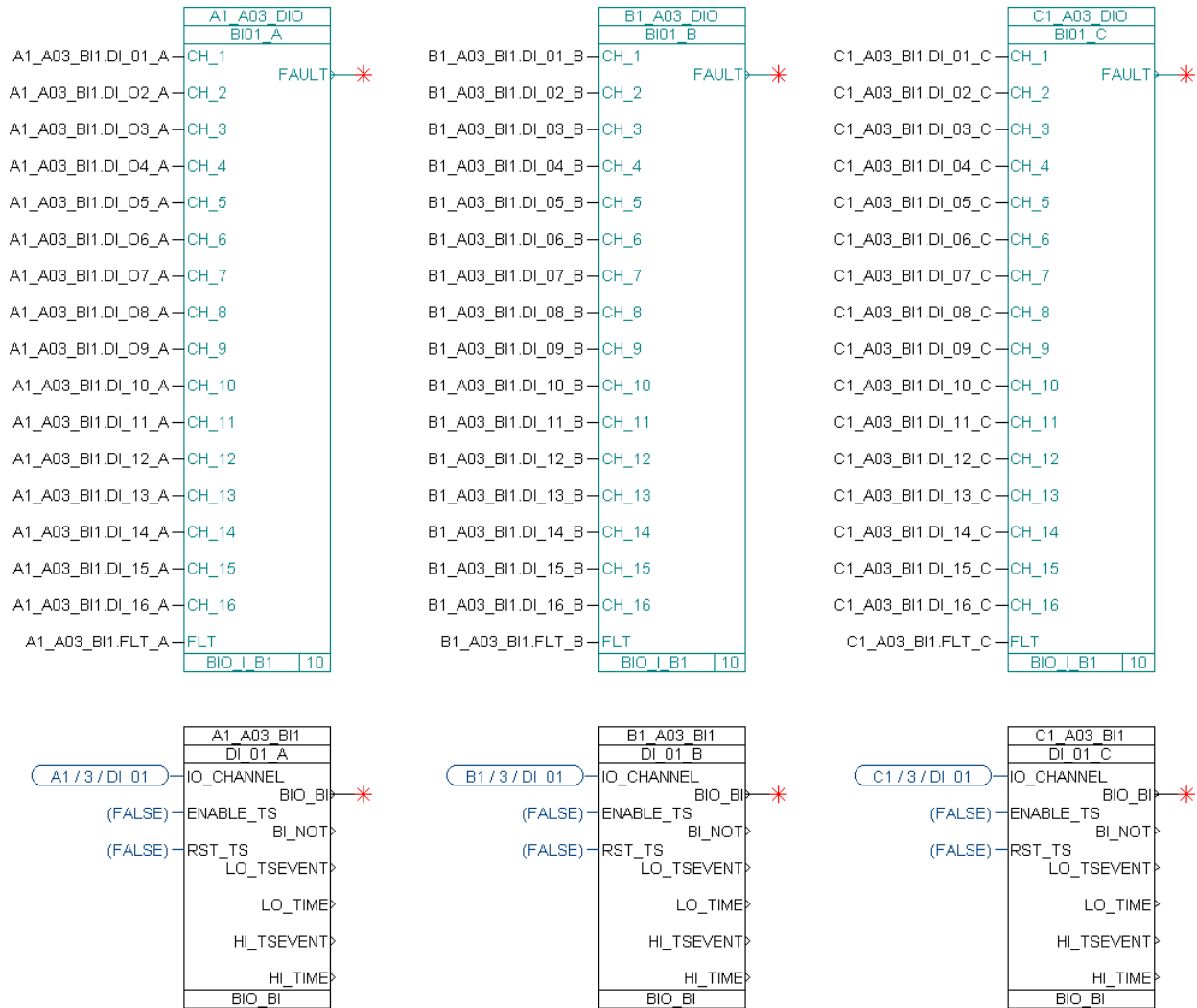


Figure 3-7. TMR Boolean input GAP Configuration

### Signal Processing

The signal processing required is accomplished using the B\_3\_RM (Boolean Three Input Triple Redundancy Manager) (see appendix A) block per Figure 3-8. The B\_3\_RM monitors all three Boolean input signals and compares the values. If the three values are the same the output is set to the same value as the inputs. If one of the inputs does not match the others, the fault output (FLT\_x) for that input is set to true and the output is set to the value of the two inputs that still match. The fault output will not go true if the mismatch does not last longer than the delay time (DLY\_TIME) and will never go true if the override for that input (OVRD\_x) is true. The fault outputs are latching and require a reset (RST) to clear them. See GAP help for more details.

See Appendix A for B\_3\_RM and B\_NAME description.

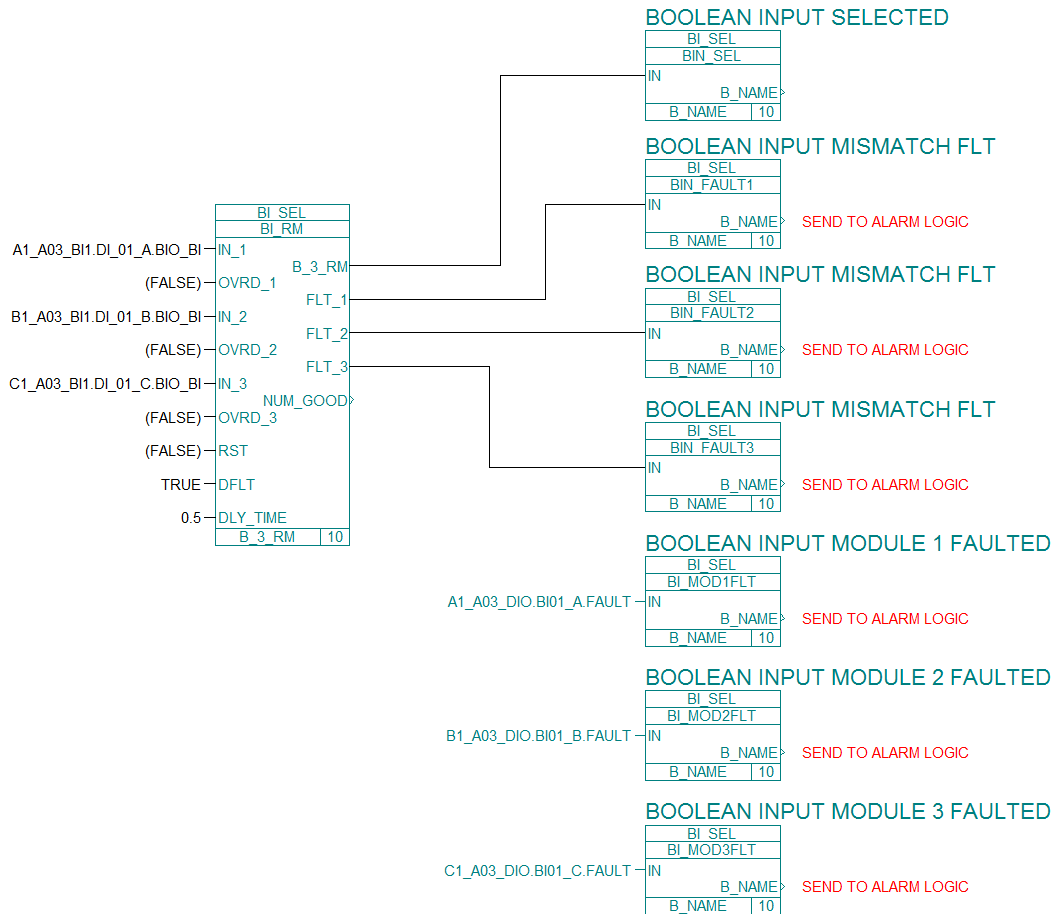


Figure 3-8. MicroNet TMR Boolean Input Redundant Manager GAP Configuration

### Alarm

The alarm output from the redundancy manager, “BIN\_FAULT1.B\_NAME”, “BIN\_FAULT2.B\_NAME” and “BIN\_FAULT3.B\_NAME” shall be sent to the alarm logic. In addition, the hardware module fault BI\_MOD1FLT.B\_NAME”, “BI\_MOD2FLT.B\_NAME” and BI\_MOD3FLT.B\_NAME” shall be sent to the alarm logic.

### TMR Analog Input

#### TMR Analog Input Configuration

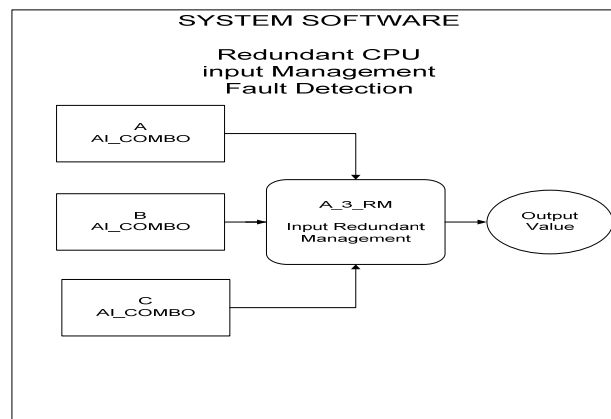


Figure 3-9. MicroNet TMR Analog Input Block Diagram

The analog inputs to the analog redundancy selection logic shall be configured per Figures 3-10 and 3-11.

See Appendix A for AI\_COMBO descriptions.

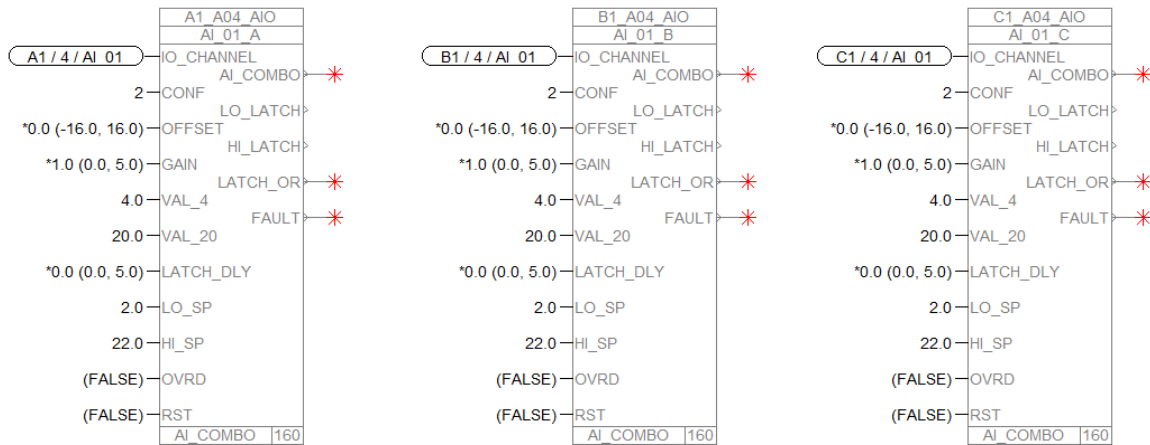


Figure 3-10. MicroNet TMR Analog Input GAP Configuration

The following adjustments are allowable for the AI\_COMBO analog input blocks:

The OFFSET and GAIN may be adjusted by the application engineer to calibrate the analog output.

The LATCH\_DLY is the delay (milliseconds) after a fault is detected before the fault is latched.

## Signal Processing

The signal processing required is accomplished using the A\_3\_RM (Triplex Redundancy Manager) block per Figure 3-11. For each channel, the A\_3\_RM monitors all three input analog signals for hardware faults detected in the Analog Input hardware blocks, as well as differences between the signals. The A\_3\_RM latches hardware alarms and automatically selects the value to be used by the system.

If all three inputs are active and good,  $AVG = (A+B+C)/3$ ,  $HSS = \max(A, B, C)$ ,  $LSS = \min(A, B, C)$ ,  $MEDIAN = \text{median}(A, B, C)$ . If one of the inputs is inactive or failed, MEDIAN is calculated using the two active inputs and the ALLFAIL\_EQ value. See GAP help for more details.

See Appendix A for A\_3\_RM, A\_NAME and B\_NAME descriptions.

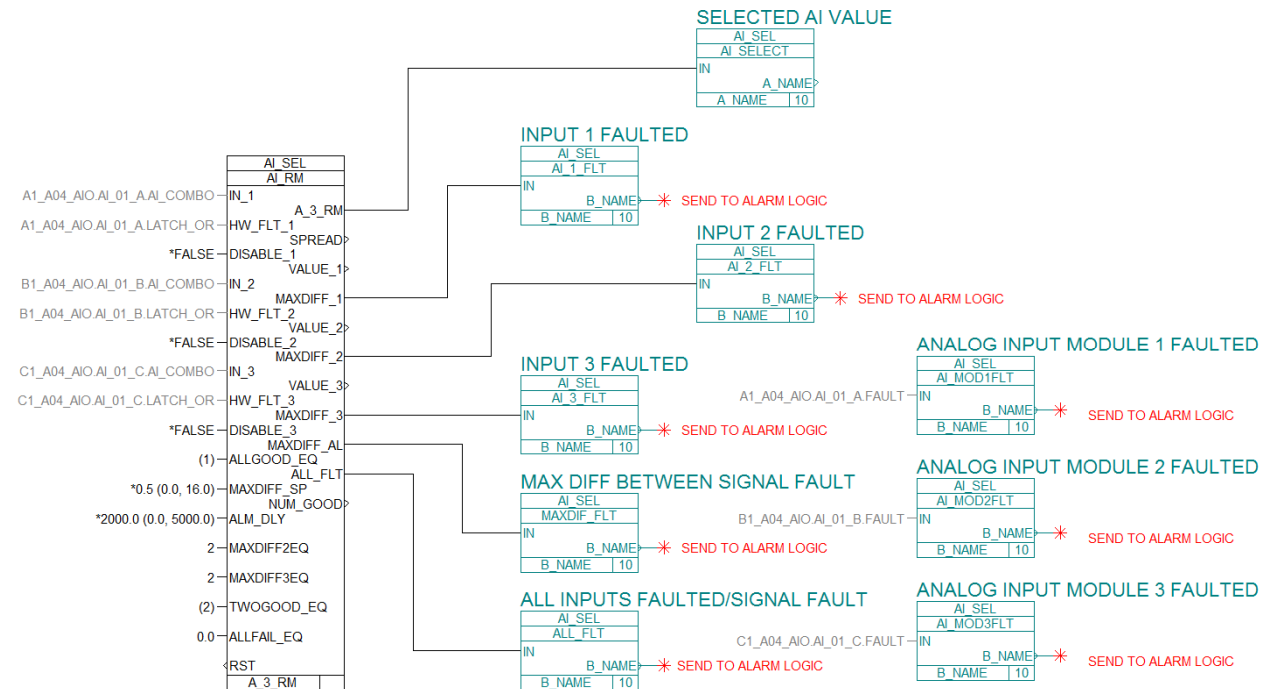


Figure 3-11. MicroNet TMR Analog Input Redundant Manager GAP Configuration

The A\_3\_RM (see Appendix A) must be configured per Figure 3-11 with the following allowable modifications. The modifications may be made by the application engineer or system designer to configure the applicable signal for safe operation of the system.

MAXDIFF\_SP (see Appendix A)

The MAXDIFF\_SP is the maximum allowable difference between the valid input signals before a fault is latched.

ALM\_DLY set point: (see Appendix A)

Defines how long the MAXDIFF\_AL alarm conditions must exist, in milliseconds, before being output as alarms.

### Alarms

The alarm output from the redundancy manager, “AI\_1\_FLT.B\_NAME”, “AI\_2\_FLT.B\_NAME”, “AI\_3\_FLT.B\_NAME”, “ALL\_FLT.B\_NAME”, “MAXDIF\_FLT.B\_NAME”, “AI\_MOD1FLT.B\_NAME”, “AI\_MOD2FLT.B\_NAME” and “AI\_MOD3FLT.B\_NAME” outputs shall be individually alarmed and shall be sent to the alarm logic.

## MR Boolean (Relay) Output

### TMR Boolean Output Configuration

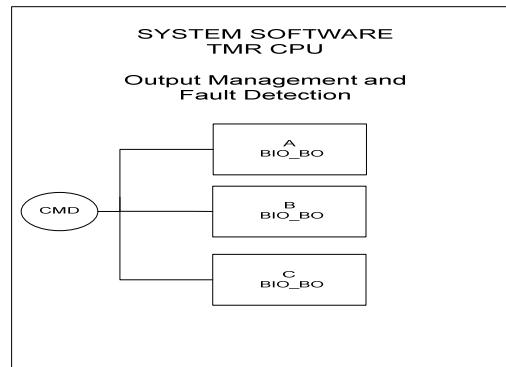


Figure 3-12. MicroNet TMR Boolean (Relay) Output Block Diagram

The TMR Boolean outputs shall be configured per Figures 3-13 and 3-14.

See Appendix A for BIO\_BO and IO\_FLT descriptions.



Figure 3-13. MicroNet TMR Boolean (Relay) Output GAP Configuration

### Signal Processing

The signal processing required is accomplished per Figure 3-14. No specific redundancy software logic is required for dual Boolean outputs as the fail-safe operation is dependent on the system hardware. The Boolean output function is configured to function with the TMR FTM.

A six-relay configuration is used to form each fault tolerant relay output. When a relay output is closed, the contacts of all six relays are closed. Because of the series-parallel configuration that the relays are in, the failure of any individual relay will not cause the output to be open. This series-parallel configuration also allows any single relay of the six relay configuration to be removed and replaced “on-line” with no affect on the state of the fault tolerant relay output.

When a relay output is open, the contacts of all six relays are open. Because of the series-parallel configuration that the relays are in, the failure or removal of any one relay will not cause the output to be closed. The relay output would continue to be open. See Manual 26167V1 and 26167V2 for more details.

See Appendix A for B\_NAME description.

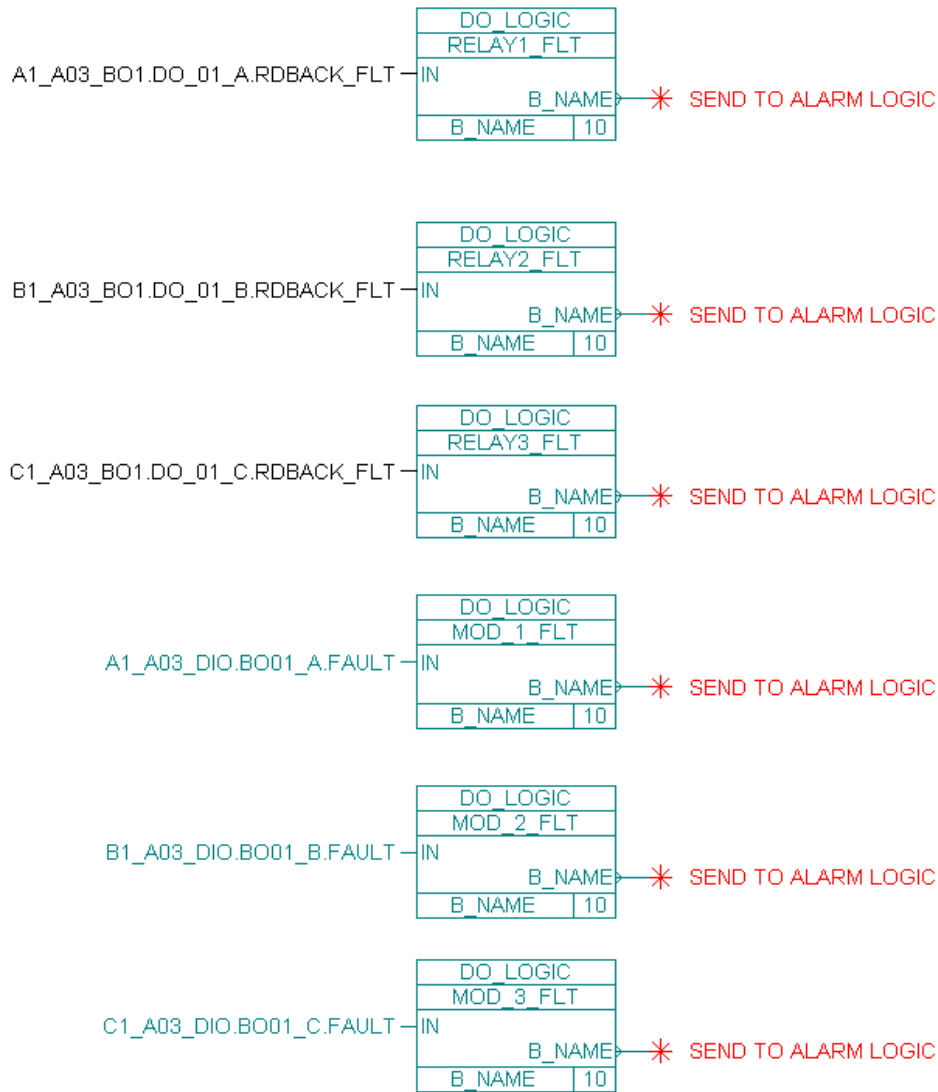


Figure 3-14. MicroNet TMR Boolean (Relay) Output GAP Configuration

### Alarms

The RDBACK\_FLT outputs from the BIO\_BO block, “RELAY1\_FLT.B\_NAME”, RELAY2\_FLT.B\_NAME” and “RELAY3\_FLT.B\_NAME”, shall be sent to the alarm logic. In addition, the hardware module fault “MOD\_1\_FLT.B\_NAME”, “MOD\_2\_FLT.B\_NAME and “MOD\_3\_FLT.B\_NAME” shall be sent to the alarm logic.

## TMR Analog Outputs

### TMR Analog Output Configuration

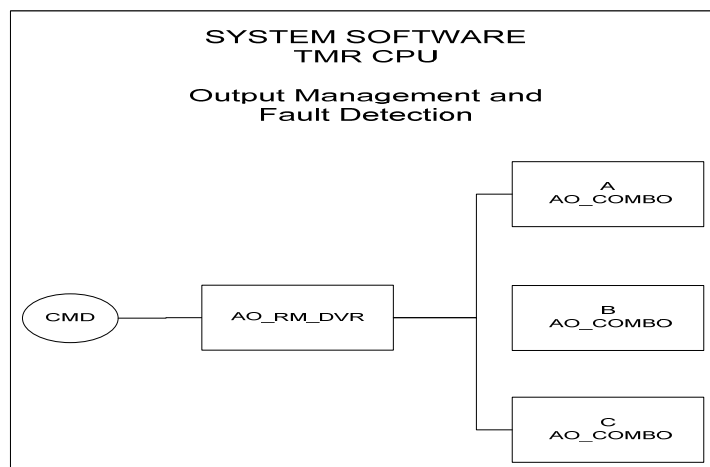


Figure 3-15. MicroNet TMR Analog Output Block Diagram

The TMR Analog outputs shall be configured per Figures 3-16 and 3-17.

See Appendix A for AO\_COMBO description.

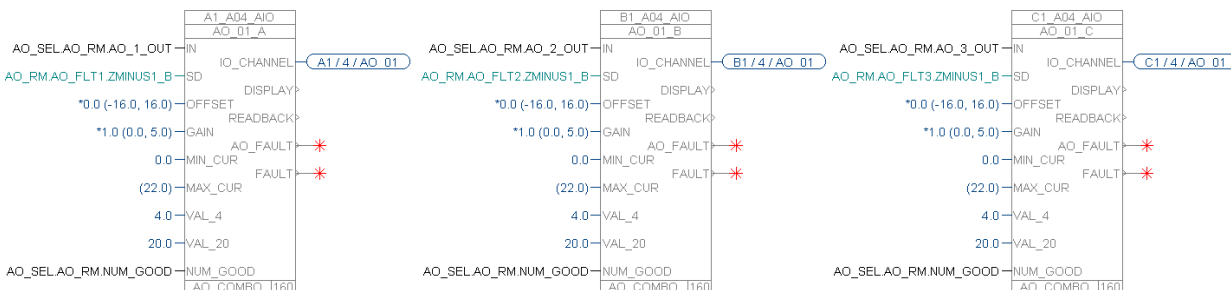


Figure 3-16. MicroNet TMR Analog Output GAP Configuration

The following adjustments are allowable for the AO\_COMBO analog output blocks:

The IN must be configured with the system driving function.

The OFFSET and GAIN may be adjusted by the application engineer to calibrate the analog output.

### Signal Processing

The software signal processing required is accomplished using the AO\_RM\_DVR (Fault-tolerant analog output or actuator driver output) block per Figure 3-17. The AO\_RM\_DVR monitors all three analog output signals for faults detected and automatically selects the output module to be used by the system by shutting down the faulted analog output(s). The system will continue to function with one or two of the Analog outputs faulted.

See Appendix A for OR, ZMINUS1\_B, AO\_RM\_DVR, and B\_NAME description.



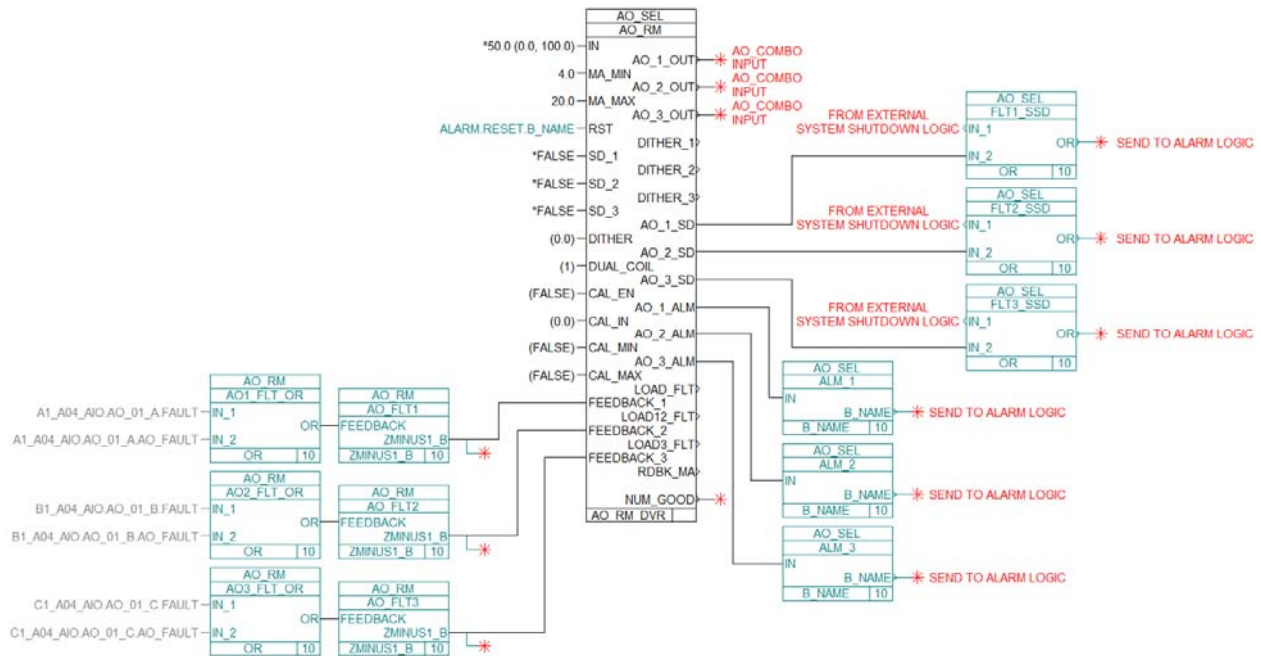


Figure 3-17. MicroNet TMR Analog Output Redundant Manager GAP Configuration

### Alarms

The redundancy manager alarms “ALM\_1.B\_NAME”, “ALM\_2.B\_NAME”, “ALM\_3.B\_NAME” and “FLT1\_SSD.OR”, “FLT2\_SSD.OR”, “FLT3\_SSD.OR” outputs shall be individually alarmed and sent to the alarm logic.

## Appendix A.

# GAP Block Description

More detailed help is available with the on-line GAP help.

### **BIO\_BI**

#### **BLOCK DESCRIPTION:**

This block specifies a Boolean input channel for a discrete input on the combination discrete BI48\_BO24 board. This block must be placed/defined in a BIO\_I\_B1, BIO\_I\_B2, or BIO\_I\_B3 block.

### **B\_2\_RM**

#### **BLOCK DESCRIPTION:**

The Boolean Two Input Redundancy Manager block accepts two Boolean Input Field values and compares them. If the two values are the same the output is set to the same value as the inputs. If the two values do not match, the output is set to the value at the default (DFLT) input and the alarm output (ALM) goes true. The block is primarily used in applications with redundant I/O to simplify redundant Boolean I/O handling.

The Boolean 2 redundancy manager was changed to have a delay time before the ALM output is set. This value can be a tunable, constant or from a block.

### **B\_3\_RM**

#### **BLOCK DESCRIPTION:**

The Boolean Three Input Triple Redundancy Manager block accepts three Boolean input values and compares them. If the three values are the same the output is set to the same value as the inputs. If one of the inputs does not match the others, the fault output (FLT\_x) for that input is set to true and the output is set to the value of the two inputs that still match. The fault output will not go true if the mismatch does not last longer than the delay time (DLY\_TIME) and will never go true if the override for that input (OVRD\_x) is true. The fault outputs are latching and require a reset (RST) to clear them.

### **B\_NAME**

#### **BLOCK DESCRIPTION:**

The block allows you to name a Boolean value and use that name throughout the rest of the GAP application. B\_NAME is useful for cases where a tunable value is used as an input to more than one block in an application. This block simplifies program flow and reduces processing time compared to using several tunable values scattered in different locations of the program. B\_NAME can also make it easier to follow Boolean signals in the program flow.

### **AI\_COMBO**

#### **BLOCK DESCRIPTION:**

The analog input 4–20 mA channel converts its input signal to an output, scaled in engineering units, that is linearly proportional to the input signal. The analog input is configurable as either 4–20 mA or 1–5 Vdc. There are a total of four latching time-stamped outputs available. The block will timestamp the input failure, high or low, down to a resolution of 5 milliseconds. The block can also timestamp an event level based on the high and low timestamp setpoints (HI\_TS\_SP & LO\_TS\_SP). The input calibration can be adjusted using either the VAL\_4 & VAL\_20 inputs or the OFFSET & GAIN inputs. This block must be placed/defined in an AIO\_COMBO board block.

**Isolation Note:** The analog inputs of the high density AIO\_COMBO and AI24\_A08 modules are high-impedance isolated.

**A\_2\_RM****BLOCK DESCRIPTION:**

**Analog two redundancy manager:** Accomplishes typical signal processing required for redundant analog signals. Both input signals are monitored for low, high, difference, and hardware/external failures as defined by inputs LO\_SP, HI\_SP, MAXDIFF\_SP, FLT\_1 and FLT\_2. If desired, failure detection may be enhanced by using a fail on rate scheme (FAILONRATE) for loose/cut wires. If needed, signal inputs IN\_1 and IN\_2 may be individually disabled using DISABLE\_1 and DISABLE\_2.

When a failure is detected, the selected signal processing such as averaging, high signal select, low signal select, median value, or fail to value is immediately applied to the main block output A\_2\_RM. In addition, if the alarm condition exists for ALM\_DLY (ms), a fault output is latched and the appropriate signals are prohibited from being used in the signal processing until a RST is received.

Valid literal functions are:

AVG = (IN\_1+IN\_2)/2

HSS = max(IN\_1,IN\_2)

LSS = min(IN\_1,IN\_2)

MEDIAN = median(IN\_1, IN\_2, ALLFAIL\_EQ)

MAXDIFF\_SP:

Defines an allowable difference error for signals IN\_1 & IN\_2.

Assuming both signals are valid and this difference error is exceeded, the A\_2\_RM uses the MAXDIFF\_EQ as it's output. If MAXDIFF\_SP continues to be exceeded for ALM\_DLY(ms), the MAXDIFF\_AL alarm is latched true.

ALM\_DLY:

Defines how long (ms) the IN\_1\_FLT, IN\_2\_FLT, & MAXDIFF\_AL alarm conditions must exist before being output.

**NOTE:** This persistence only affects annunciation of the alarm and not the A\_2\_RM output.

**A\_3\_RM****BLOCK DESCRIPTION:**

Accomplishes typical signal processing required for triplex analog input values. All three input signals are monitored for difference and hardware/external failures as defined by inputs MAXDIFF\_SP, HW\_FLT\_1, HW\_FLT\_2, and HW\_FLT\_3. If needed, signal inputs may be individually disabled using DISABLE\_1, DISABLE\_2, and DISABLE\_3. When a failure is detected, appropriate signal processing such as: averaging, high signal select, low signal select, median value, fail to constant or analog value is immediately applied to the main block output A\_3\_RM. In addition, if the alarm condition exists for ALM\_DLY (ms), a fault output is latched and the appropriate signal processing (MAXDIFFxEQ) is used.

**A\_NAME****BLOCK DESCRIPTION:**

The block allows you to name an Analog value and use that name throughout the rest of the GAP application. A\_NAME is useful for cases where a tunable value is used as an input to more than one block in an application. This block simplifies program flow and reduces processing time compared to using several tunable values scattered in different locations of the program. A\_NAME can also make it easier to follow Analog signals in the program flow.

**BIO\_BO****BLOCK DESCRIPTION:**

This block specifies a Boolean output channel on the combination discrete input/output BI48\_BO24 board. This block must be placed/defined in a BIO\_O\_B1 or BIO\_O\_B2 block.

**AO\_COMBO****BLOCK DESCRIPTION:**

The Analog output 4–20 mA channel converts its input signal, scaled in engineering units, to a milliamp output value that is linearly proportional to the input signal. This block must be placed/defined in an AIO\_COMBO block.

**AO\_2\_RM****BLOCK DESCRIPTION:**

Analog Output Field redundancy management. This block is used to control two Analog Output Field blocks into one load.

**AO\_RM\_DRV****BLOCK DESCRIPTION:**

Fault-tolerant analog output or actuator driver output. This block is designed to interface 3 analog outputs to a single load or 3 actuator outputs to a single, or to a dual coil actuator, or to a dual redundant actuator configuration in a fault tolerant TMR control system. Its function is to compensate for failed outputs by shutting them down and adjusting the remaining good outputs to new levels for continued operation. The block allows the output maximum and minimum milliamp (MA\_MIN & MA\_MAX) values to be adjusted to calibrate the output to the device when the calibration mode is enabled (CAL\_EN is True) as well as the ability to manually position the output to check the calibration and stroke the output.

**Connection Requirements:**

AO\_COMBO or ACT\_COMBO BOOLEAN output fault fields must be connected to the FEEDBACK\_x inputs.

AO\_COMBO.IN or ACT\_COMBO.IN fields must be connected to the AO\_x\_OUT outputs.

AO\_COMBO.NUM\_GOOD or ACT\_COMBO.NUM\_GOOD fields must be connected to the NUM\_GOOD output.

See: Woodward Governor AO\_RM\_DVR Theory in the GAP help for Coder 5.04.

**OR****BLOCK DESCRIPTION:**

This block's output will be false only if all of the Boolean Input Fields are false. If any one of the inputs is true then the output of this block will be true.

**ZMINUS1****BLOCK DESCRIPTION:**

Z to the minus one block for Booleans.

**When not in a loop**, the ZMINUS1 block causes a delay from its input to its output of one Rate Group. More than one ZMINUS1\_B block may be connected together in series. The second block will have a delay of 2 rate groups etc. This is used to create digital dynamics.

**When in a loop**, the ZMINUS1\_B block will break the loop at the position of the ZMINUS1\_B block. For example if block 1 feeds block 2 and block 2 feeds block 3 and block 3 loops back to block 1, this is a loop. The loop *must* be broken by the loop breaker blocks, ZMINUS1\_I, ZMINUS1\_B, or ZMINUS1, and the placement of the ZMINUS1\_B will determine the place the loop is broken. If the ZMINUS1\_B block is inserted between block 3 and block 1, the execution order will be 1-2-3-z, however, if the ZMINUS1\_B block is inserted between block 2 and block 3 the execution order will be 3-1-2-z. Notice the ZMINUS1\_B block is always last.

# Revision History

## Changes in Revision A—

- Updated title on Cover page
- Added NOTICE boxes to draw attention to product specific SIL information to Chapter 1
- Added clarifying text to the last sentence in the General section of Chapter 1
- Added clarifying text to captions for Figures 1-3 and 1-4
- Added Electromagnetic Environment Recommendations section to top of the manual
- Gap Manual reference changed in Related Reference Documents in Chapter 1
- Added Cable Chassis, FTM, Module, and Software part numbers to Table 1-2 in Chapter 1
- Table 1-3 SIL Approved MSM total content replacement in Chapter 1
- Added Table 1-4 SIL Approved ProTech TPS Devices to Chapter 1
- Added Table 1-5 SIL Approved ProTech SX Devices to Chapter 1

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