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WOODWARD

Product Manual 26167V1
(Revision P, 8/2024)
Original Instructions

MicroNet TMR®
Digital Control

This manual replaces manual 85584 (MicroNet TMR)

Manual 26167 consists of 3 volumes: (26167V1, 26167V2, 26167V3)

Installation and Operation Manual Volume 1

Released

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.**

Revisions	**This publication may have been revised or updated since this copy was produced. The latest version of most publications is available on the Woodward website.** **http://www.woodward.com** **If your publication is not there, please contact your customer service representative to get the latest copy.**

Proper Use	**Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.**

Translated Publications	**If the cover of this publication states "Translation of the Original Instructions" please note:** **The original source of this publication may have been updated since this translation was made. The latest version of most publications is available on the Woodward website.** **www.woodward.com/publications** **Always compare with the original for technical specifications and for proper and safe installation and operation procedures.** **If your publication is not on the Woodward website, please contact your customer service representative to get the latest copy.**

Revisions— A bold, black line alongside the text identifies changes in this publication since the last revision.

Contents

This manual is divided into three volumes:
- Volume 1 contains Chapters 1–8 (manual 26167V1).
- Volume 2 contains Chapters 9–16 and the appendixes (manual 26167V2).
- Volume 3 contains obsolete sections from Volume 1 and Volume 2 (manual 2616V3).

Illustrations and Tables

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

Lockout/Tagout LOTO

Ensure that personnel are fully trained on LOTO procedures prior to attempting to replace or service equipment on a "live" running engine. All safety protective systems (overspeed, over temperature, overpressure, etc.) must be in proper operational condition prior to the start or operation of a running engine. Personnel should be equipped with appropriate personal protective equipment to minimize the potential for injury due to release of hot hydraulic fluids, exposure to hot surfaces and/or moving parts, or any moving parts that may be activated and are located in the area of control of the unit.

⚠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.**

⚠WARNING **Automotive Applications**	**On- and Off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.**

⚠WARNING

IOLOCK

IOLOCK: driving I/O into a known state condition. When a control fails to have all the conditions for normal operation, watchdog logic drives it into an IOLOCK condition where all output circuits and signals will default to their de-energized state as described below. ***The system MUST be applied such that IOLOCK and power OFF states will result in a SAFE condition of the controlled device.***

- **Microprocessor failures will send the module into an IOLOCK state.**
- **Discrete outputs / relay drivers will be non-active and de-energized.**
- **Analog and actuator outputs will be non-active and de-energized with zero voltage or zero current.**

Network connections like CAN stay active during IOLOCK. This is up to the application to drive actuators controlled over network into a safe state.

The IOLOCK state is asserted under various conditions, including:

- **Watchdog detected failures**
- **Microprocessor failure**
- **PowerUp and PowerDown conditions**
- **System reset and hardware/software initialization**
- **PC tool initiated**

NOTE—Additional watchdog details and any exceptions to these failure states are specified in the related section of the product manual.

NOTICE **Battery Charging Device**	**To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.**

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. Touch your finger to a grounded surface to discharge any potential before touching the control, smart valve, or valve driver, or installing cabling connectors. Alternatively, ESD mitigation may be used as well: ESD smocks, ankle or wrist straps and discharging to a reference grounds surface like chassis or earth are examples of ESD mitigation.
   - ESD build up can be substantial in some environments: the unit has been designed for immunity deemed to be satisfactory for most environments. ESD levels are extremely variable and, in some situations, may exceed the level of robustness designed into the control. Follow all ESD precautions when handling the unit or any electronics.
     - I/O pins within connectors have had ESD testing to a significant level of immunity to ESD, however do not touch these pins if it can be avoided.
       - Discharge yourself after picking up the cable harness before installing it as a precaution.
     - The unit is capable of not being damaged or improper operation when installed to a level of ESD immunity for most installation as described in the EMC specifications. Mitigation is needed beyond these specification levels.

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

Regulatory Compliance

European Compliance for CE Marking:
These listings are limited only to those units bearing the CE Marking.

EMC Directive: Declared to Directive 2014/30/EU of the European Parliament and of the Council of 26 February 2014 on the harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC).

Conditions for Use:
This equipment is intended to be installed in a metal cabinet or enclosure. In TMR systems with 3 expansion racks (a 4-rack system), the installation must use an EMC enclosure to meet RF emission requirements. An EMC enclosure may be used any time to improve performance, however it is only required when more than one TMR chassis and two expansion racks are used.

Low Voltage Directive: Directive 2014/35/EU on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits.

North American Compliance:
These listings are limited only to those units bearing the CSA identification.

CSA: CSA Listed for Class I, Division 2, Groups A, B, C, & D, T3A at +55 °C surrounding air temperature or non-hazardous locations only for use in Canada and the United States.
5441-694 DIO FTM Relay Driver rated for temperatures up to +75˚C
CSA Certificate of Compliance 2314167

Conditions for Safe Use:
This equipment may be suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.

⚠WARNING	**The 24/12, 16-Channel and 5009 F/T Relay Fault Tolerant Interface Modules are suitable for ordinary or non-hazardous locations only.**

Wiring must be in accordance with North American Class I, Division 2 and in accordance with the authority having jurisdiction.
A fixed wiring installation is required.

The power supply mains should be properly fused according to the National Electrical Code. The recommended fuse is a European Type T fuse.

Ground leakage current exceeds 3.5 mA.

Grounding is required by the input PE terminal.

A switch or circuit breaker shall be included in the building installation that is in close proximity to the equipment and within easy reach of the operator and that is clearly marked as the disconnecting device for the equipment. The switch or circuit breaker shall not interrupt the protective earth conductor.

An emergency switch shall be included in the building installation that is in close proximity to the equipment and within easy reach of the operator and that is clearly marked as the emergency disconnecting device for the equipment.

Field wiring must be suitable for at least 80 °C for operating ambient temperatures expected to exceed 55 °C.

Personnel must discharge their electrostatic build up to the cabinet ground point or use an ESD strap prior to touching the MicroNet or modules if the engine/turbine is operational.

CPU modules contain internal energy limited circuits. These circuits have no external connections and are not affected by module loading.

CPU modules contain single cell primary batteries. These batteries are not to be charged and are not customer replaceable.

For environmental specifications, please refer to the appropriate appendix in Volume 2 of this manual.

⚠WARNING	**EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.** **Substitution of components may impair suitability for Class I, Division 2 applications.** **Do not remove or install power supply while circuit is live unless area is known to be non-hazardous.** **Do not remove or install modules while circuit is energized unless area is known to be non-hazardous.**

⚠AVERTISSEMENT	**RISQUE D'EXPLOSION—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.** **La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, applications Division 2.** **Ne pas enlever ni installer l'alimentation électrique pendant que le circuit est sous tension avant de s'assurer que la zone est non dangereuse.** **Ne pas enlever ni installer les cartes pendant que le circuit est sous tension sans s'assurer que la zone non dangereuse.**

Safety Symbols

 Direct Current

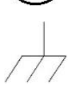
 Alternating Current

 Both Alternating and Direct Current

 Caution, risk of electrical shock

 Caution, refer to accompanying documents

 Protective conductor terminal

 Frame or chassis terminal

Chapter 1. General Information

1.1. Introduction

The MicroNet control is a 32-bit microprocessor-based digital controller that is programmable for many types of applications in the control of:

- Gas Turbines
- Steam Turbines
- Hydro Turbines
- Diesel Engines
- Gas Engines

The MicroNet platform provides a flexible system to control any prime mover and its associated processes such as high-speed control functions, system sequencing, auxiliary system control, surge control, monitoring and alarming, and station control. The MicroNet platform is available in simplex, redundant, and triple modular redundant (TMR) configurations. This manual covers only TMR based control configurations. Please refer to MicroNet Plus manual 26166 for simplex and redundant based control configurations using the MicroNet Plus CPU. Please refer to manual 26336 for information on VxWorks Operating System tools used with the TMR5200 CPU module.

The MicroNet Operating System, together with Woodward's GAP Graphical Application Program, produces a powerful control environment. Woodward's unique rate group structure ensures that control functions will execute deterministically at rate groups defined by the application engineer. Critical control loops can be processed within five milliseconds. Less critical code is typically assigned to slower rate groups. The rate group structure prevents the possibility of changing system dynamics by adding additional code. Control is always deterministic and predictable.

Synchronized inputs and outputs (I/O) are available for key control signals while distributed I/O can be used for other less critical parameters.

The MicroNet platform provides several types of communications to program and service the control as well as to interface with other systems (Plant DCS, HMI, etc.). Woodward's GAP and Ladder Logic programming tools are used to generate Application code. A service interface allows the user to view and tune system variables. Several tools are available to provide this interface (see Engineering and Service Access). Communication protocols such as TCP/IP, OPC, Modbus, and other current designs are included so that the user can correctly interface the control to existing or new plant level systems.

The MicroNet TMR platform is expandable into multiple chassis as required by the system size and will support any mix of I/O, including networked and distributed I/O. The MicroNet TMR main control chassis is only available in one size with 18 VME slots. All slots are dedicated to the control section. The power supply for the MicroNet TMR main control chassis is a separate chassis which connects to either the lower right or left of the MicroNet TMR main control chassis. The power supply chassis contains redundant power supplies.

The MicroNet TMR control may be expanded to a multi-chassis system using the Plus8 or Plus14 chassis options. For field upgrades, the expansion racks may also be the older Simplex6 or Simplex12 chassis. Each expansion chassis has dedicated power supply, control, and I/O sections located in a single chassis. The expansion power supply architecture supports simplex or redundant power supplies.

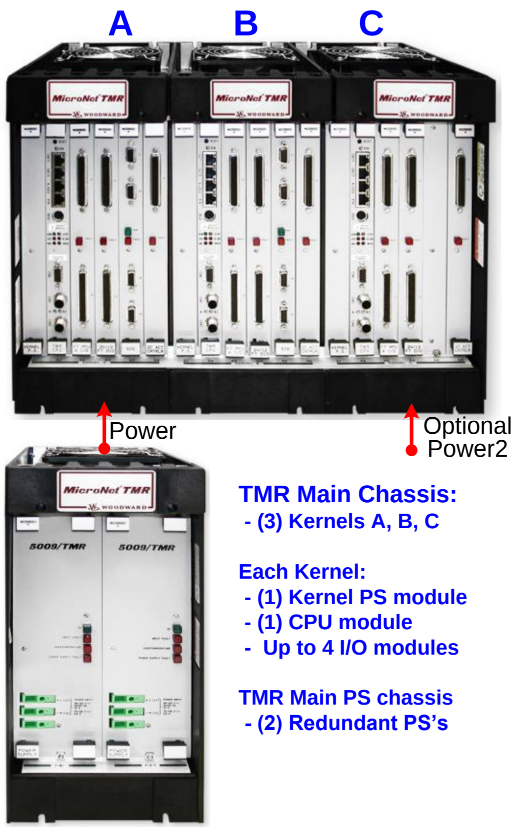


Figure 1-1. MicroNet TMR System (Single Rack)

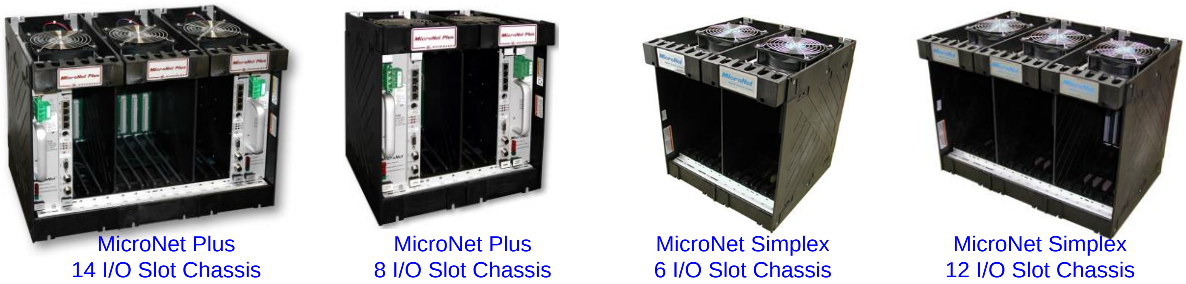


Figure 1-2. Expansion Chassis Options

1.2. Specifications and Compatibility

For environmental specifications and MicroNet compatibility information, please refer to the appropriate appendix in Volume 2 of this manual.

Chapter 2.
MicroNet TMR Systems

2.1. MicroNet TMR

The TMR Main chassis provides slots for kernel power supplies, CPU's, and twelve I/O Modules. This is the basis of the TMR systems whether using the TMR5200 processor or the TMR040 processor. NOTE: Kernel PS modules must be matched to the type of CPU being used. The system may be expanded to 3 I/O chassis using RTN networks with the TMR5200 processors. With the RTN each CPU has access to the I/O so I/O in the expansion chassis is considered **Shared I/O**.

With the TMR040 processors, Transceiver modules and copper or fiber cables are used to connect to multiple chassis to accommodate additional system I/O requirements. In this case, I/O is dedicated to a specific CPU.

2.1.1 MicroNet TMR Main Chassis

In the MicroNet TMR Main Chassis, whether the TMR040 or TMR5200 CPUs are used, the I/O modules are associated with a particular Kernel. If that Kernel fails, the associated I/O modules are failed.

MicroNet TMR

MicroNet TMR Chassis
3 Kernel Power Supplies
3 TMR CPU Modules
4 I/O modules slots per Kernel
Expandable to a 4-rack system.

Figure 2-1. MicroNet TMR Main Chassis

2.1.2.MicroNet TMR Power Supply Chassis

The MicroNet TMR Power Supply Chassis, contains two redundant TMR power supply modules. Power supply modules come in low voltage DC, AC/DC, and high voltage AC/DC versions. Each module supplies power to the Kernel PS Modules.

MicroNet TMR Power Supply Chassis

- 1 or 2 TMR Power Supply Chassis can be configured.
- (2) Redundant PS Modules per Chassis
- PS Modules are load sharing
- 3 Module versions available
  - Low voltage DC
  - 120 Vac / Vdc
  - 220 Vac/Vdc

Figure 2-2. MicroNet TMR Power Supply Chassis

2.1.3 MicroNet TMR5200 Expansion Chassis

With the TMR5200 systems, connection to up to 3 Expansion chassis is accomplished through Real Time Networks (RTNs) associated with each Kernel. There are 3 RTN networks. The TMR5200 system supports the MicroNet Plus 8 or 14 chassis and MicroNet Simplex 6 or 12 chassis. The MicroNet Plus 8 or 14 chassis can have either 1 or 2 RTN modules. The MicroNet 6 or 12 chassis only have one RTN module. The I/O in the Expansion Chassis is not associated with a specific Kernel and is considered “shared” I/O. The failure of any Kernel does not affect the ability for the other CPUs to access the I/O.

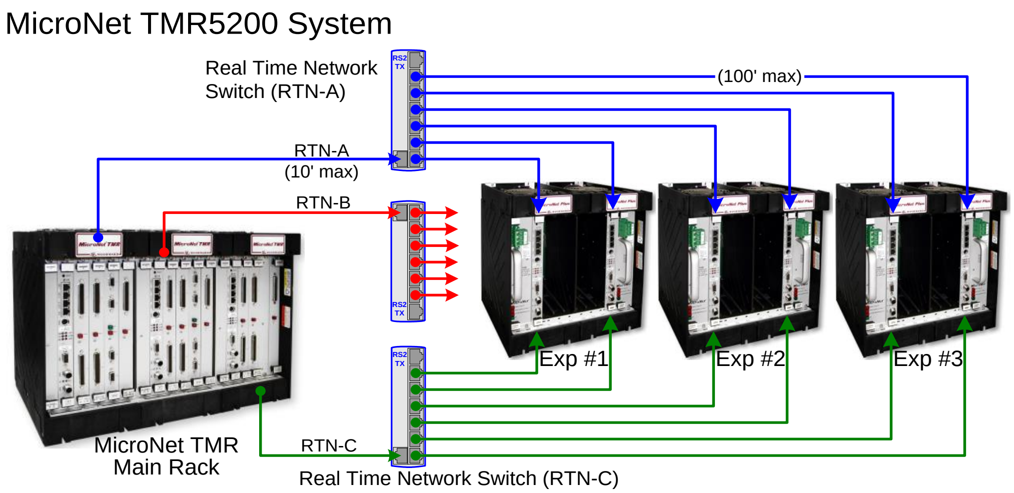


Figure 2-3. MicroNet TMR5200 Expansion Chassis

2.1.4 MicroNet TMR040 Expansion Chassis

With the TMR040 systems, each Kernel can be connected to up to 15 Expansion I/O Chassis via Transceiver (XCVR) modules. The TMR040 system supports the MicroNet 6 or 12 chassis. Refer to Chapters 6-2 through 6-4 for detailed information on the use of XCVR modules. Each expansion chassis is associated with a particular Kernel. If that Kernel fails, the associated I/O modules local and expansion are failed.

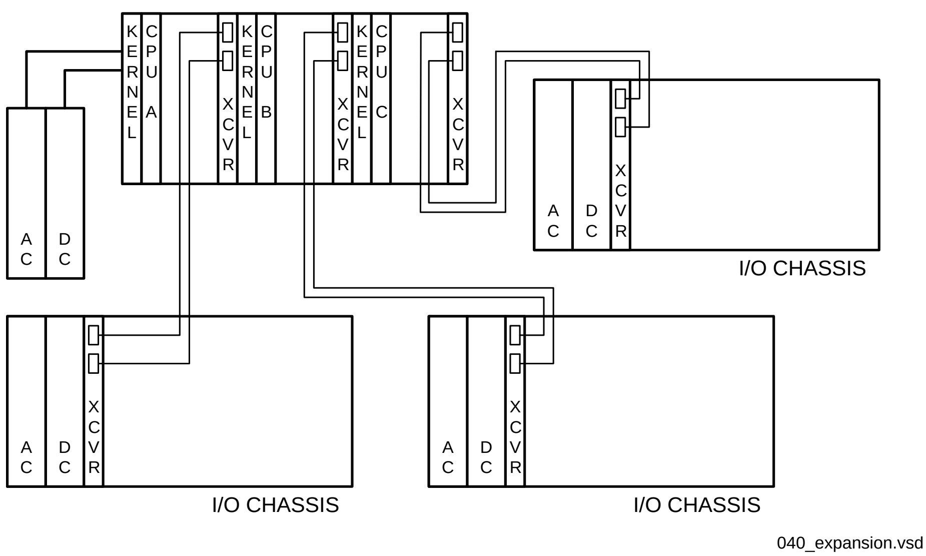


Figure 2-4. MicroNet TMR040 Expansion Chassis

2.1.5 TMR CPU Theory

The basis of this control's fault tolerance architecture is to detect control related faults, annunciate these faults, and allow on-line service/replacement of modules and/or transducers to correct these faults. A CPU fault tolerance logic of 3-2-0 allows the control to function normally with any CPU module failed or removed. A power supply fault tolerance logic of 2-1-0 allows the control to function normally with any one power supply failed or removed. I/O Fault tolerance can be customized to meet the application reliability requirements. This is discussed in more detail later.

In the TMR Main Chassis, three isolated kernel sections (A, B & C) each house a Kernel Power Supply module, CPU module, and have 4 VME slots for I/O modules. A single motherboard supplies nine electrically isolated data paths. Each CPU has a data path to its VME modules and two separate data paths, one to each of the other CPU modules. There are six paths between CPUs allowing for redundancy and error checking.

Each CPU module runs the identical software application as the other two. All inputs from each kernel are distributed to the other two kernels. Each CPU then compares the value it read, with the value the other two CPUs read, before outputting a signal to the application software. Depending on the configuration, nine values for the same input parameter could be used in the voting logic to provide the best signal to the application software. Even if a data value has been corrupted along any one of the data paths shown in Figure 2-1, all CPUs use the same correct data for their application calculations. All CPUs use the same voted input signals in the same application calculations to generate the same outputs.

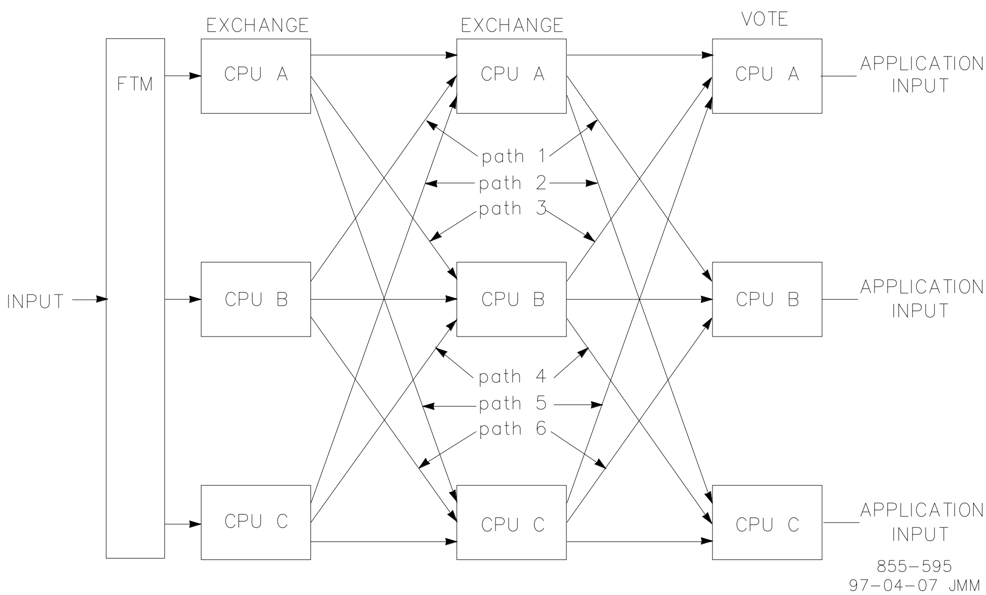


Figure 2-5. Double Exchange and Vote Structure

All output values are exchanged between kernels, the results are voted and the appropriate value is output from each kernel. Since the system can handle significant single errors, even multiple errors may not shutdown a kernel section. In the event of consistent errors from one of the kernel section, an alarm will be annunciated and that particular kernel will be shut down.

2.1.6 TMR Inputs and Outputs

In a full TMR application, I/O modules are also triplicated. Each Kernel would have the same module and any expansion chassis would be triplicated. Specific TMR I/O Modules and Field Terminal Modules (FTMs) are designed for this sort of application. Inputs from a single field source are fanned out to three channels in three different I/O modules. After the control's kernels double exchange their input values, and vote out any erroneous values, the Application Software Redundancy Manager then compares each kernel's voted result to select a value to be used within the application logic. Analog Outputs are summed together so that up to two failures can be tolerated with no loss of output functionality. Relay outputs are managed by fault tolerant relays.

Depending on the application, Critical field devices may also be replicated or triplicated. In some cases more than 3 devices may be used. Application software must be defined to manage this different configurations but specific Redundancy Management software has been designed to address the most common cases.

2.1.7 Analog Input Example

Each analog input can withstand up to two failures with no loss of control functionality. If any two of an analog input's three "legs" are failed, the control uses the third healthy leg's sensed input signal to control with.

All analog inputs are connected to the control via a TMR FTM. An input's termination module is used to terminate customer control wiring and distribute each input signal to all three kernels. After the control's kernels double exchange their input values and vote out any erroneous values, the Application Software Redundancy Manager then compares each kernel's voted result to select a value to be used within the application logic. Figure 2-2 is a graphical view of a control's input architecture. Table 2-1 displays the redundancy manager's input selection logic for each possible input condition.

An analog input signal is determined to be faulty when the I/O Module or I/O Channel fails or when it is below its "Fail Low Value" setting, or above its "Fail High Value" setting. For a 4–20 mA input, these high and low failure level settings typically correspond to 2 mA and 22 mA respectively. If an input is determined to be failed, that input is removed from the control's voting logic.

Input deviation alarms are used to annunciate if any of the input channels or input legs are sensing a value that is different than the voted-good value used by the application. If an input channel's sensed value deviates from the voted-good value, by a greater margin than its "Max Deviation" setting, an input channel alarm will be issued. This type of annunciation can be used to indicate when an input channel, or system transducer is going out of calibration. Max Deviation settings are typically defaulted to 1% (deviation range = 0.1 to 10%) of the configured input range. If a deviation alarm condition occurs, the alarmed input is not removed from the control's voting logic, and still can be used to control with, in case all other channels fail.

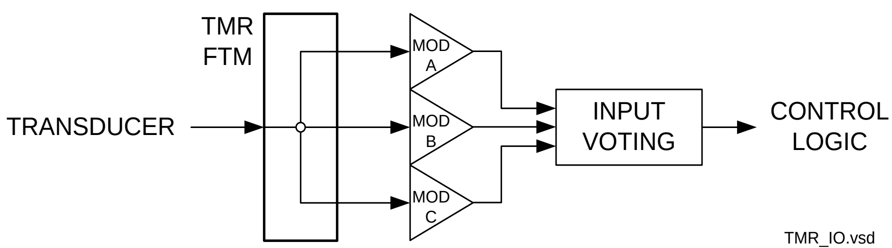


Figure 2-6. Fault Tolerant Analog Input

Table 2-1. AI Redundancy Manager Truth Table

A-FAULT	B-FAULT	C-FAULT	OUTPUT OF BLOCK (APPLICATION INPUT
FALSE	FALSE	FALSE	MEDIAN OF A, B, & C-INPUT
FALSE	FALSE	TRUE	HSS* OF A & B-INPUT
FALSE	TRUE	FALSE	HSS* OF A & C-INPUT
FALSE	TRUE	TRUE	A-INPUT
TRUE	FALSE	FALSE	HSS* OF B & C-INPUT
TRUE	FALSE	TRUE	B-INPUT
TRUE	TRUE	FALSE	C-INPUT
TRUE	TRUE	TRUE	APPL. INPUT SET TO ZERO/FAULT SET TRUE

*HSS ->HIGH SIGNAL SELECT

2.1.8 Discrete Input Example

Each discrete input can withstand up to two failures with no loss of control functionality. If any two of a discrete input's three "legs" fail, the control uses the third healthy leg's sensed input signal to control with.

All discrete inputs are connected to the control via discrete termination modules (DTMs). A DTM is used to terminate customer control wiring and distribute each input signal to all three kernels. After the control's kernels double exchange their input values and vote out any erroneous inputs, the Application Software Redundancy Manager then compares each kernel's voted result to select a value to be used within the application logic. Figure 2-3 is a graphical view of the control's discrete input architecture.

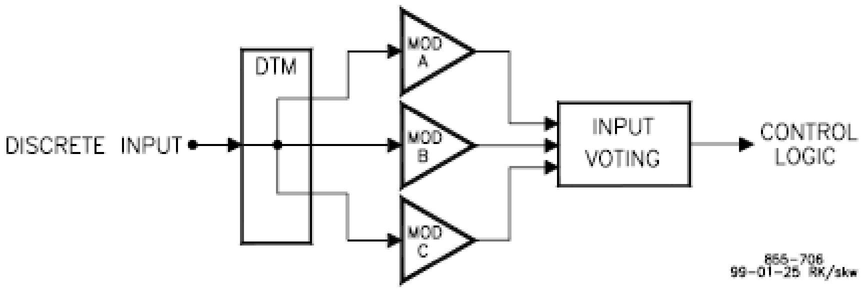


Figure 2-7. Fault Tolerant Discrete Input

A discrete input signal is determined to be faulty when the I/O Module or I/O Channel fails or when it is determined to be different then the voted-good value used by the application. If an input is determined to be faulty, the input is removed from the control's voting logic and an input channel alarm is issued. Once the input fault is corrected the alarm condition can be reset by issuing a control "Reset" command.

Table 2-2. DI Redundancy Manager Truth Table

A-Fault	B-Fault	C_Fault	Output of Block (Application Input)
FALSE	FALSE	FALSE	2 out of 3
FALSE	FALSE	TRUE	A OR B
FALSE	TRUE	FALSE	A OR C
FALSE	TRUE	TRUE	A
TRUE	FALSE	FALSE	B OR C
TRUE	FALSE	TRUE	B
TRUE	TRUE	FALSE	C
TRUE	TRUE	TRUE	FALSE

2.1.9 Analog Outputs

Each control readout can withstand up to two failures with no loss of output functionality. Any leg of an output channel can drive a readout's full 4–20 mA current signal. Each CPU generates an analog output command using a Redundancy manager and known good output channels. The analog output commands are voted between the CPUs and the voted value is sent to the respective output channel.

Precision resistors are used in each channel's readback circuitry to measure and verify the health of each output "leg". If a fault condition is detected, the faulty output leg is disabled, and the Redundancy Manager redistributes the output signal to the remaining legs. In a case where two failures are experienced at the same time within different legs, the single good channel (leg) will drive the entire output. Figure 2-4 shows a Fault Tolerant Analog Output's architecture. The TMR Field Termination Module (FTM) combines each analog output signal from all three kernels into one signal at the FTM's terminal blocks.

Typically, an output is considered failed, and an alarm issued, when the I/O Module or I/O Channel fails or if a channel's combined output or any leg of the output measures a difference of more than 10% from the output demand.

With this output architecture, any single output driver failure results in the output signal only stepping to 66.66% of its original value. The time between when a failure is sensed and when the control corrects for it by redistributing current through the other drivers depends on the application software scheduling and the I/O module response but can be as fast as 5 ms.

Upon the correction of an output failure, and a “Control Reset” command, each failed output performs a continuity check though the its external load before current is again redistributed evenly between all output drivers. This continuity check outputs a small amount of current through the failed driver’s output load and compares that value to the readback value.

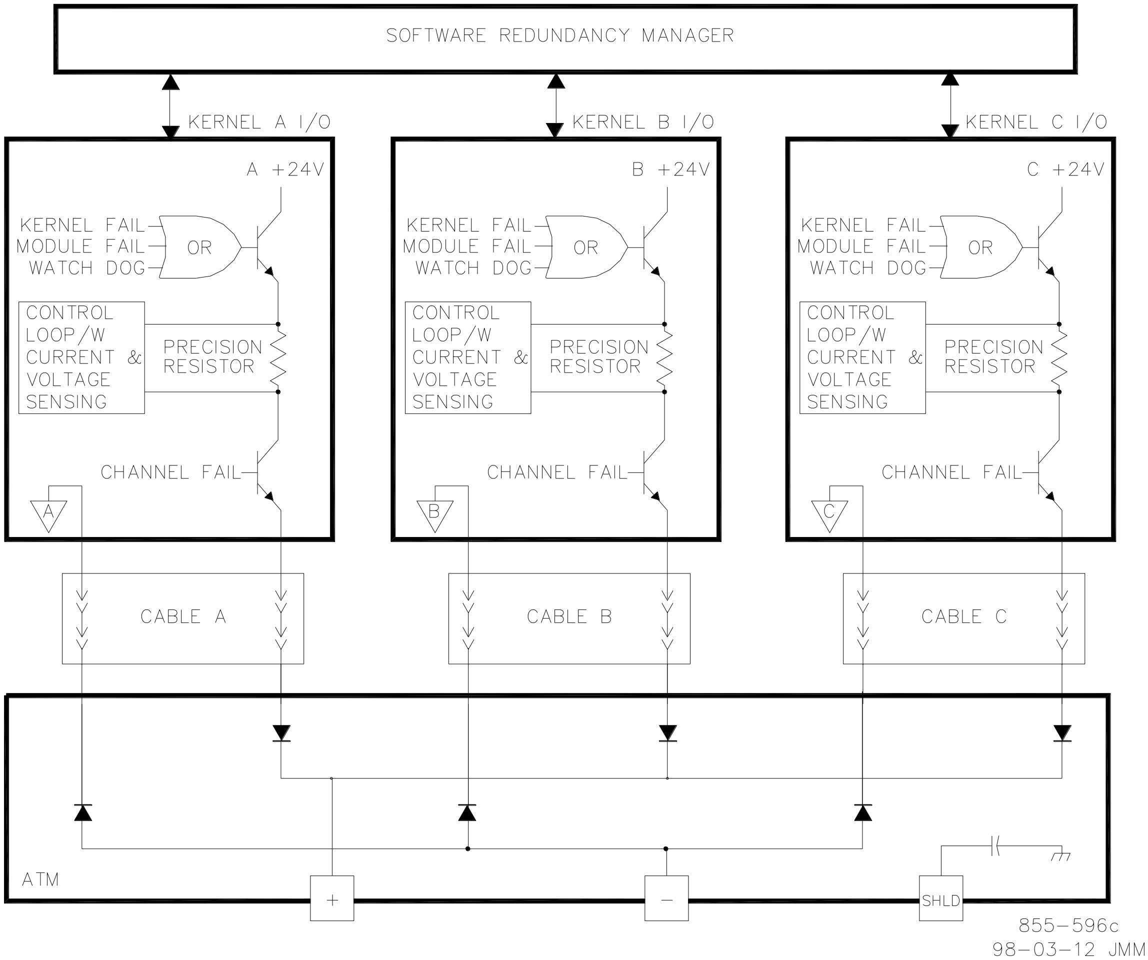


Figure 2-8. Fault Tolerant Analog Output

2.1.10 Actuator Outputs

Each actuator output can withstand up to two failures with no loss of output functionality. Any leg of an output channel can drive an output’s full current signal (4–20 mA or 20–160 mA). Each CPU generates an analog output command using a Redundancy manager and known good output channels. The analog output commands are voted between the CPUs and the voted value is sent to the respective output channel.

Precision resistors are used in each channel’s readback circuitry to measure and verify the health of each output “leg”. If a fault condition is detected, the faulty output leg is disabled, and the Redundancy Manager redistributes the output signal to the remaining legs. In a case where two failures are experienced at the same time within different legs, the lone good channel (leg) will drive the entire output. Figures 2-6 and 2-7 show a Fault Tolerant Actuator Output’s architecture. The TMR Field Termination Module (FTM) combines each actuator output signal from all three kernels into one signal at the FTM’s terminal blocks.

An output is considered failed, and an alarm issued, when the I/O Module or I/O Channel fails or if a channel's combined output or any leg of the output measures a difference of more than 10% from the output demand.

Actuator outputs are treated the same way as the other analog outputs, with the exception of an added precision resistor in the actuator output's return path. This resistor is used to measure and detect ground loops and coil shortages that are possible when interfacing to an actuator. If a single coil actuator is being driven, the dual coil terminal blocks are jumpered (wired) to the single coil terminal blocks and the redundancy manager shares the current equally between all three kernels. In the event of a fault, the Redundancy Manager will redistribute the load.

If the actuator is connected to a dual coil actuator, the Redundancy Manager shares half the current evenly between Kernels A & B outputs, and the other half comes from the Kernel C output. In the event of a fault, the Redundancy Manager redistributes load current.

With this output architecture, any single output driver failure results in the output signal only stepping to 66.66% of its original value (possibly 50% for dual coil applications). The time between when a failure is sensed and when the control corrects for it by redistributing current through the other drivers depends on the application software scheduling and the I/O module response but can be as fast as 5 ms.

Upon the correction of an output failure, and a "Control Reset" command, each failed output performs a continuity check though the actuator before current is again redistributed evenly between all output drivers. This continuity check outputs a small amount of current through the failed driver's output load and compares that value to the readback value.

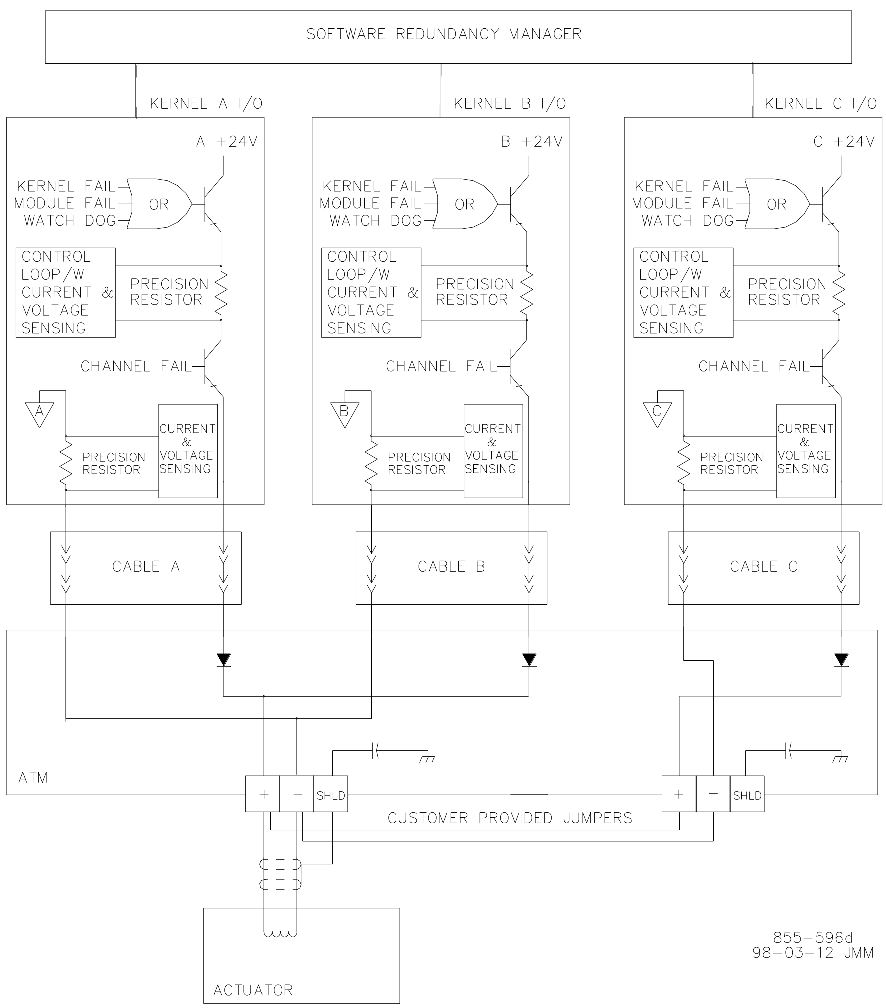


Figure 2-9. Fault Tolerant Single Coil Actuator Output

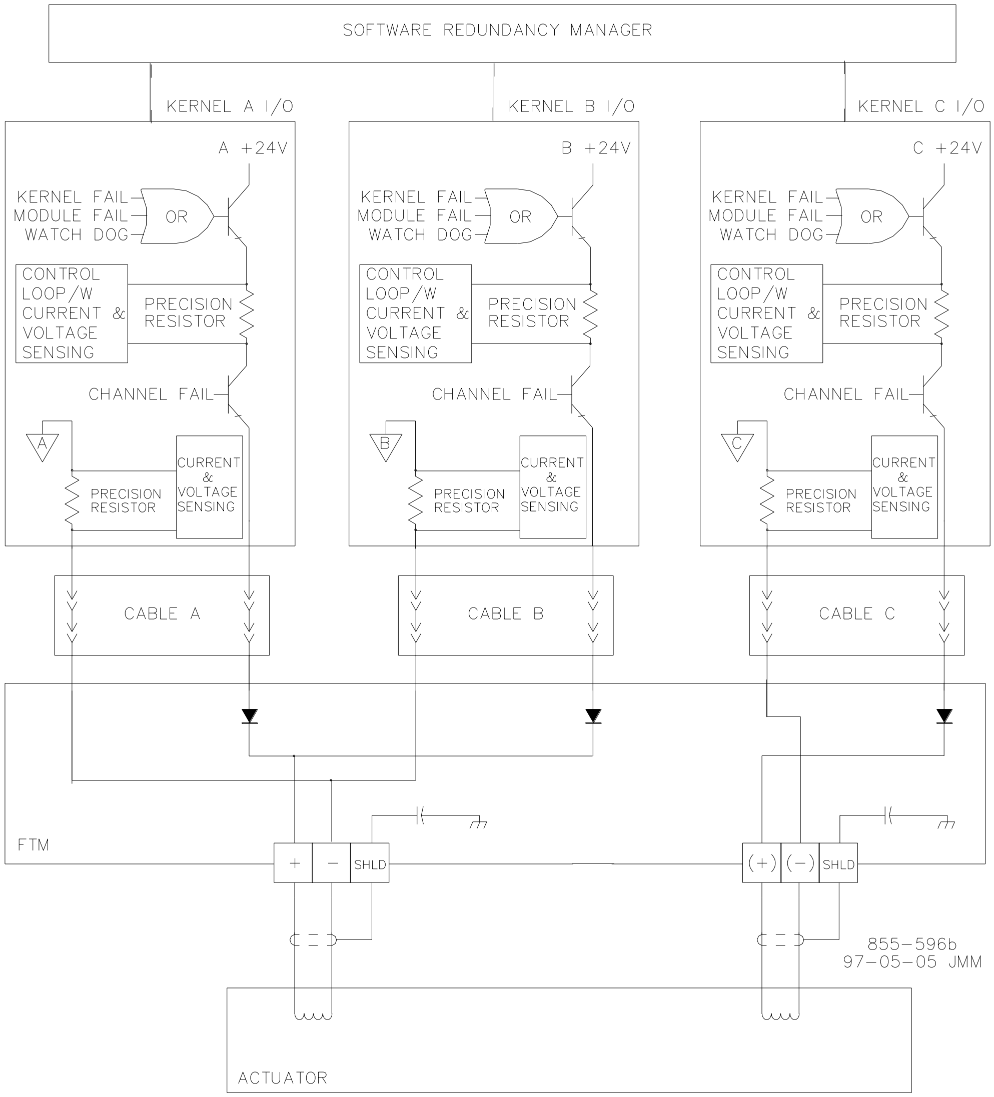


Figure 2-10. Fault Tolerant Dual Coil Actuator Output

2.1.11 Relay Outputs

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 effect 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.

Since this control’s fault tolerant architecture can tolerate a single fault, it is possible for this fault to go undetected. This is called a latent fault. If a second fault occurs while a latent fault exists, the state of the fault tolerant relay output may be affected, possibly resulting in a shutdown condition. This is why it is important to detect and annunciate latent faults in a fault tolerant system.

Latent fault detection is provided with this control to detect any relay related failure without effecting the state of the overall relay output. Each individual relay output can be configured to use or not use latent fault detection. A latent fault detection test is performed periodically or on command. The period of time between tests can be set from 1 to 3000 hours.

A relay output is tested by cycling the output's individual relays closed then open (or vice-versa depending on the output state), to ensure that they are in the correct state, and that they can change state. Position readback circuitry allows the state of each relay contact to be detected. Any failures are annunciated, and further testing is disabled without affecting the state of the relay output contact or control operation.

Each fault tolerant relay configuration consists of six relays, driven by two discrete outputs from each kernel (as shown in Figure 2-7). The relays are configured in three legs of two relays each. Customer circuit power is connected to one side of the resulting configuration, and customer load to the other side. Field selectable jumpers, located on system FTMs, are provided to allow each output's latent fault detection logic to be compatible with the circuit being interfaced to. Latent fault detection is used to monitor the actual contact positions of each of the six relays, and to momentarily change states of each relay one at a time. This verifies each relay's "normally open" or "normally closed" contacts.

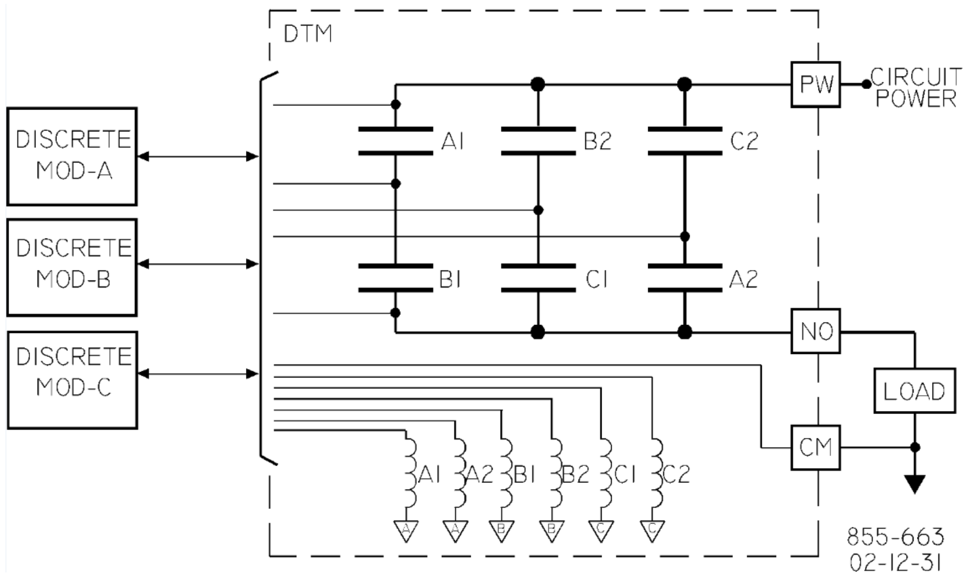


Figure 2-11. Fault Tolerant Discrete Output

Latent fault detection (LFD) is not usable with all applications or circuits. The control's LFD logic can only work with circuits using voltages between 18–32 Vdc, 100–150 Vdc, or 88–132 Vac. For latent fault detection to work, a small leakage current is passed through the circuit's load. Depending on the size of the load, the leakage current may be enough to cause a load to be on or active, when a relay contact is open. In this case, the individual relay's latent fault detection logic may be disabled, eliminating the leakage current, or a shunt resister can be used across the load to reduce the leakage current.

2.1.12 Simplex Inputs and Outputs

The TMR system can also use Simplex I/O modules and FTMs. Typically these are used for non-critical signals although different levels of redundant and even TMR configurations can be supported with the correct application software and the correct selection and distribution of module and signals. Systems can consist of a hybrid of TMR I/O and Simplex I/O.

Each I/O module has connectors on the faceplate. For analog and discrete I/O, cables connect the module to a Field Terminal module (FTM). The FTM is used to connect to the field wiring. For communication modules, FTMs are not used. Cables are connected directly to the faceplate of the communications module. The following diagram shows the flow of analog and discrete inputs from the field to the application.

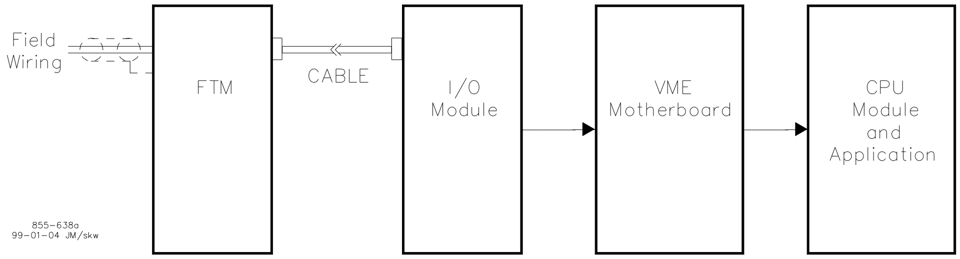


Figure 2-12. Input Flow

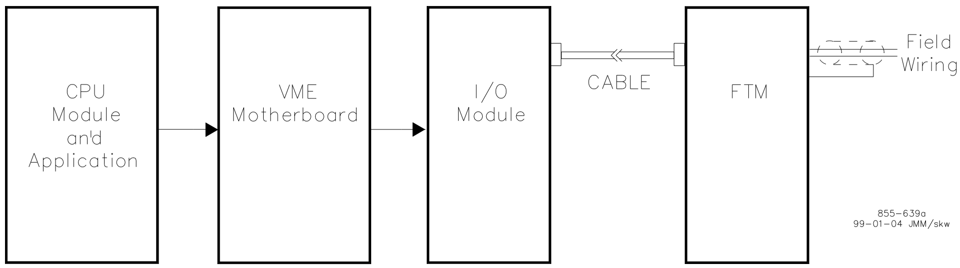


Figure 2-13. Output Flow

2.1.13 Redundant Input Examples

Two levels of redundancy are available. The first involves wiring two external input devices to two separate input channels. See Figure 2-10. In the event of a failed sensor or a failure in the connection from the sensor to the control, a valid input is still available

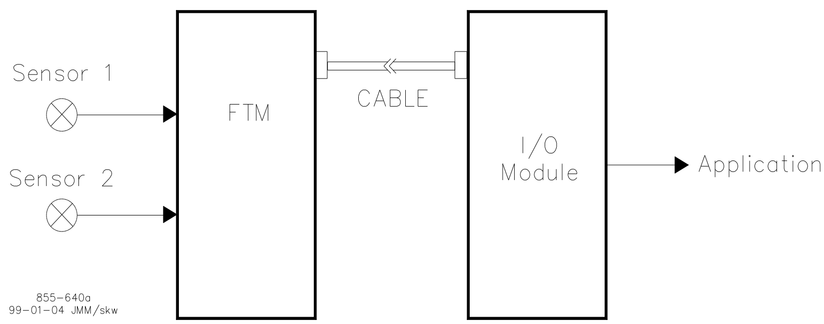


Figure 2-14. Redundant Sensors

The second level is wiring two external input devices to two separate I/O modules. See Figure 2-11. In the event of a failure in one of the sensors, connections, cables, FTMs, or I/O modules, a valid input is still available.

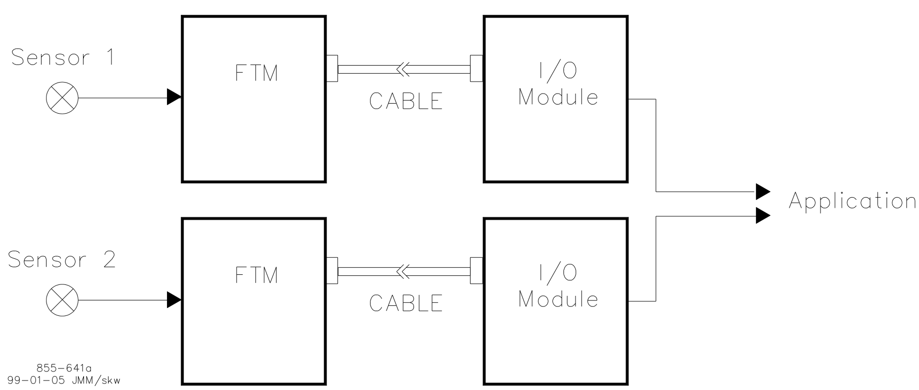


Figure 2-15. Redundant Inputs

2.1.14 Redundant Output Examples
Redundancy can be added to the outputs as well. Additional external relays can be used to prevent a faulted output from affecting the external device. For discrete outputs, this would require four relays for each output. For the actuator outputs, a dual coil actuator can be used. The dual coils will allow one coil to operate the actuator in the event of a failure.

The value of redundancy is dependent on the ability of the application to detect the failure. For analog and actuator outputs, current and/or voltage readback is provided. For discrete outputs, fault detection requires sensing the relay contact state.

2.2. MicroNet TMR Operation

2.2.1. Theory of Operation
MicroNet TMR systems are designed for 3-2-0 operation. Thus, to start a system, at least two CPUs must be started with the same application. If the CPUs are started individually, the first CPU will wait forever for a second CPU and two CPUs will wait up to 10 seconds for the third CPU. If the third CPU does not join the two CPUs within the 10 seconds the two CPUs will continue with only two. NOTE: CPUs starting together must have both the same application and same EE values (stored tunables) to synchronize. If two CPUs are synchronized, a third CPU must have the same application but it will copy EE values from the running CPUs.

2.2.2 Loading Applications and Starting CPUs.

2.2.2.1 TMR5200
- Load and start the application on each CPU using AppManager.
- If the Control is given a CTRL_ID in the SYS_INFO block of the application software, AppManager can interface with the three CPUs as one system.
- AppManager can be used to start the three CPUs together.
- Once an application has started, Auto-start will be set. The CPU will automatically start on CPU initialization (whether from a power up or from a reset).

2.2.2.2 TMR040
- Load the application on each CPU using a PCMCIA card or Ethernet module.
- The application will start once it has been loaded.
- After an application has been loaded, the CPU will automatically start on CPU initialization when the Reset switch is toggled.

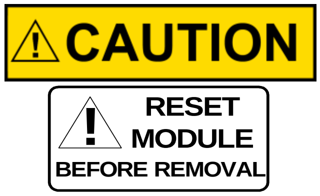
2.3. Module Replacement

TMR systems are designed to allow replacement of modules while running (hot-swap). This is a key to maintaining the high level of availability for critical applications. The hardware is fully capable of supporting hot-swap, but care must be taken in the application software design to ensure that a module hot-swap does not adversely affect the application.

Chapter 14 contains installation procedures and Chapter 15 contains replacement procedures for VME Modules, power supplies, relay boxes, and other devices. Individual CPU and I/O module sections in Chapters 6 through 9 are an additional reference for installation and replacement information.

Chapter 4 contains additional details for power supply installation and replacement.

Note: power must be removed from the power supply input before a module is removed or inserted.

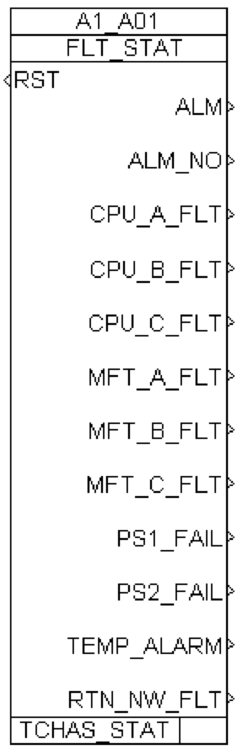


Live insertion and removal of the TMR5200 and Remote RTN modules is allowed in a MicroNet TMR or Plus chassis. These modules should be reset immediately before removing them from the chassis. This notifies the module that it will be removed and provides a graceful CPU shutdown or failover to another healthy Remote RTN module if available.

2.4. Latent Fault Detection

Because a TMR system can tolerate single faults, it is possible for a fault to go undetected. Undetected faults are termed latent faults. If another fault occurs when a latent fault exists, the second fault could cause a shutdown. It is important to detect a latent fault in a TMR system so that it may be repaired before another fault occurs. For single, redundant, or TMR I/O points, fault detection is dependent on the application software to detect its I/O faults.

An example of MicroNet TMR5200 fault information available from the TCHAS_STATstatus block.



ALM: This output displays the status of the Kernels alarms. A true indicates that the Kernel has an alarm.

ALM_NO: This output displays the Kernels Alarm number. See the GAP help manual for a list of valid alarms.

CPU_X_FLT: This output displays the status of Kernel "X". A true indicates that Kernel "X" has failed.

MFT_X_FLT: This output displays the status of the Kernel "X" MFT (Minor Frame Timer). A true indicates that the Kernel "X" MFT has failed.

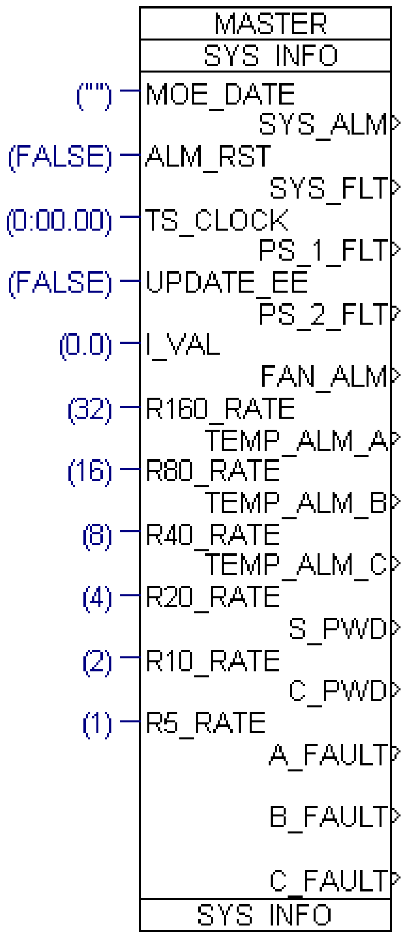
PS1_FAIL: This output field goes true when a fault on the MAIN TMR #1 Power Supply is detected.

PS2_FAIL: This output field goes true when a fault on the MAIN TMR #2 Power Supply is detected.

TEMP_ALARM: This output field goes true when a high temperature is detected in the chassis.

Figure 2-16. TCHAS_STAT Block

An example of MicroNet TMR040 fault information available from the SYS_INFO block.



SYS_ALM: The System Alarm Boolean will be set true any time the operating system detects an alarm. This should be used in your application for alarm indications.

SYS_FLT: The System Fault Boolean will be set true any time the operating system detects a critical fault. It will cause an I/O lock to be asserted.

PS_1_FLT: The Power Supply 1 Boolean will be set true when any of the outputs from Power Supply 1 fail.

PS_2_FLT: The Power Supply 2 Boolean will be set true when any of the outputs from Power Supply 2 fail.

FAN_ALM: The Aux. Fans Are Running Boolean will be set true when the chassis exceeds a preset temperature and the second rack of fans are on.

TEMP_ALM_x: Temperature alarm for Kernel A, B, or C. This output is directly from a fan temperature switch which will trip at 60.0 °C. Only applicable to the MicroNet and MicroNet TMR chassis.

A_FAULT: The CPU A Fault Boolean will be set true when CPU A is not in sync. In a simplex system, A_FAULT, B_FAULT, and C_FAULT are false.

B_FAULT: The CPU B Fault Boolean will be set true when CPU B is not in sync. In a simplex system, A_FAULT, B_FAULT, and C_FAULT are false.

C_FAULT: The CPU C Fault Boolean will be set true when CPU C is not in sync. In a simplex system, A_FAULT, B_FAULT, and C_FAULT are false.

Figure 2-17. SYS_INFO Block

Chapter 3.
Chassis Configurations

3.1. TMR Main Chassis

This chassis contains eighteen slots for kernel power supplies, CPU's, and I/O modules. Normally, this allows three kernel power supplies, three CPUs, and twelve I/O modules. The power supply module will connect to either the lower right or left of the chassis.

If an I/O module slot is not occupied, it must be filled with a blanking plate (3799-301) to maintain proper cooling flow through the chassis.

Figure 3-1. MicroNet TMR Main Chassis

3.1.1 Specification

The MicroNet control is designed around a modular six slot chassis (block). Each block consists of a premolded cage with a fan for cooling and a temperature switch for high temperature detection. The chassis are cooled by forced air, and either a module or a module blank must be installed in every slot to maintain correct air flow. The fans run whenever power is applied to the system.

The eighteen-slot MicroNet TMR control chassis is composed of three blocks with a motherboard inserted in the back of the assembly to make connections between the fans, switches, power supply chassis, and all three kernels. See Figure 3-2. The modules use the VERSAmodule Eurocard (VME) bus standard for connector specification and data transfer. Kernel-to-kernel and slot-to-slot logic and power connections are made through an etched-circuit motherboard. I/O connections are made through cables from the front of the boards to field termination modules (FTM's) in the cabinet.

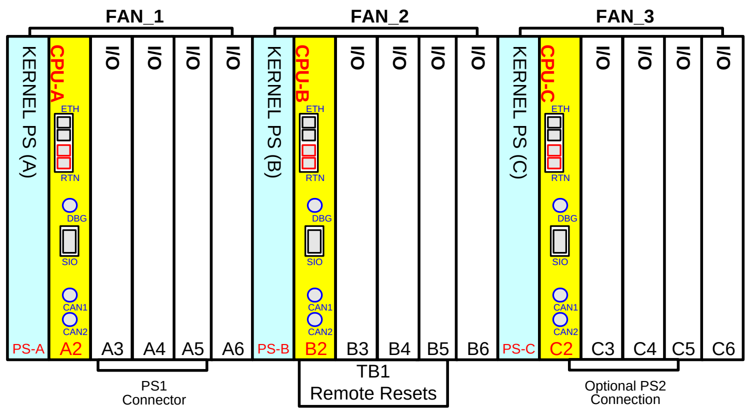


Figure 3-2. MicroNet TMR Control Chassis

From a module connector standpoint, any I/O module can be installed in any of the slots designated for I/O modules. However, when the application software is designed, each module will be assigned to a specific slot and thereafter, the software will expect that specific I/O module to always be in its designated slot.

3.1.2 Chassis Outline Drawing

The MicroNet TMR dimensions are shown below.

Notes:

- Add ~2” (~5 cm) to the depth dimension to account for the cable saddles that are not shown on the outline drawing below.
- The PE ground connection point is located underneath the left side of the chassis.
- To ensure compliance with the EMC certification, all chassis mounting screws (#8-32 M4) should be installed to properly ground the chassis to the mounting plate.
- For proper airflow, the installation should allow a 3” (8 cm) air gap above and below the chassis.

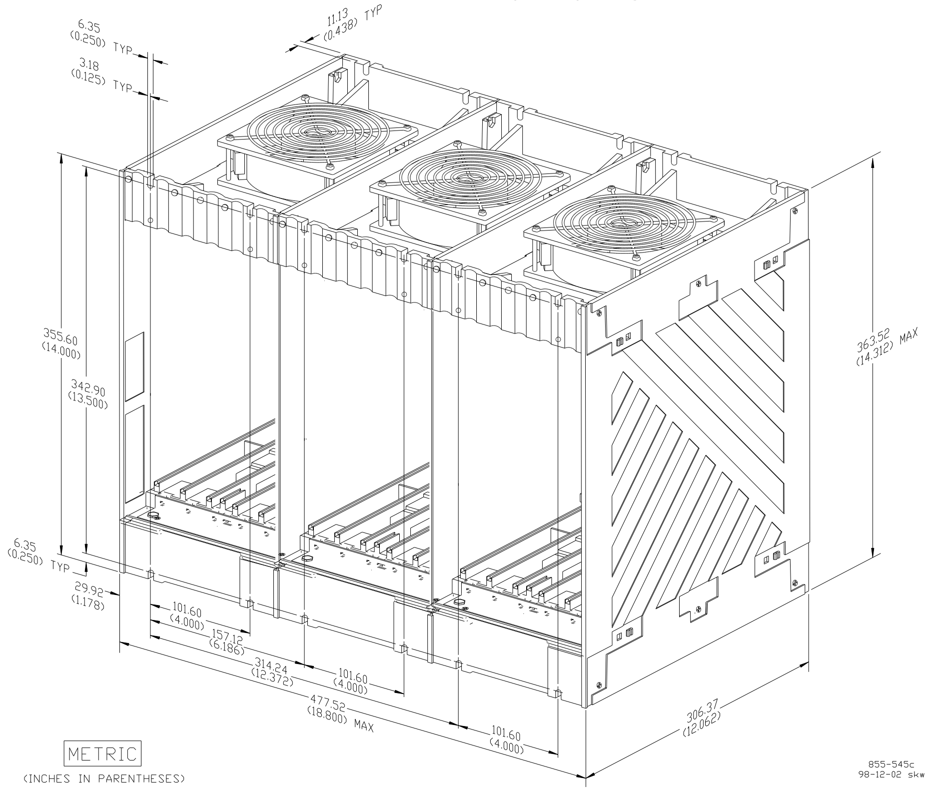


Figure 3-3. Outline Drawing of MicroNet TMR Main Chassis

3.1.3 Installation

Figure 3-3 shows the mounting template and fasteners to bulkhead mount the chassis. Rack mounting is not recommended. For proper airflow, the installation should allow a 3" air gap above and below the chassis.

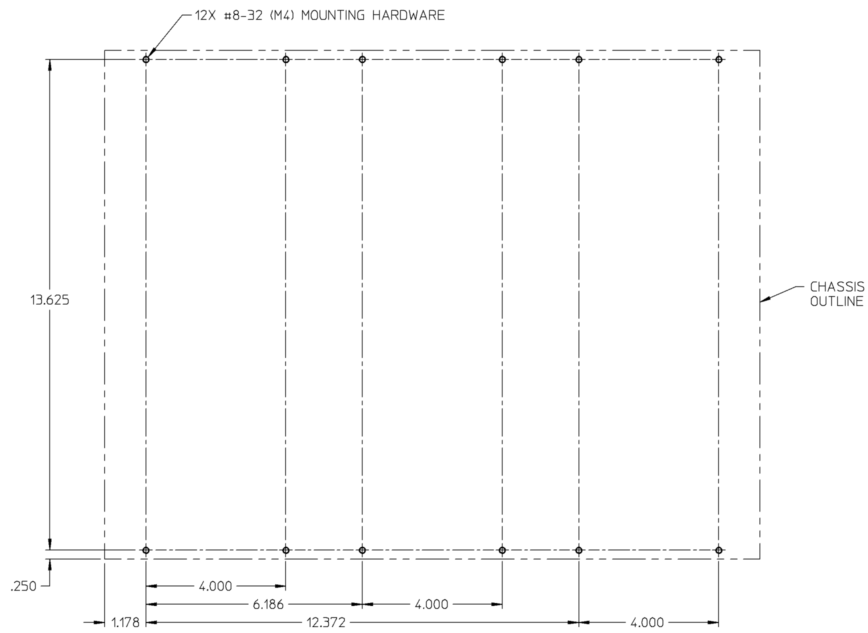


Figure 3-4. Mounting Template of MicroNet TMR Main Chassis

3.2. Expansion MicroNet Plus 8-Slot I/O

Figure 3-5. MicroNet Plus 8-Slot I/O Chassis

The MicroNet Plus 8-slot chassis offers redundant RTN capability and more I/O slots than the MicroNet 6, as well as improvements in airflow and overall system reliability.

Features:

- A total of 8 RTN and I/O slots are available for use
- A new 2-slot wide, redundant, load sharing power supply is used
- Redundant Smart fans are used for early notification of fan-failure
- Chassis temperature switches exist on the motherboard and trip at +65 °C
- Redundant, hot-swappable RTN s are supported

3.2.1 Specification

The MicroNet is designed around a modular 6-slot chassis (block). Each block consists of a premolded cage with a fan for cooling and a temperature switch for high temperature detection. The chassis are cooled by forced air, and either a module or a module blank must be installed in every slot to maintain correct air flow. The fans run whenever power is applied to the system.

The MicroNet Plus 8-slot chassis is composed of two blocks with a motherboard inserted in the back of the assembly to make connections between the fans, switches, power supplies, and control modules. See Figure 3-5. The modules use the VERSAmodule Eurocard (VME) bus standard for connector specification and data transfer. Slot-to-slot logic and power connections are made through an etched-circuit motherboard. I/O connections are made through cables from the front of the modules to field termination modules (FTM's) the cabinet.

From a module connector standpoint, any I/O module can be installed in any of the slots designated for I/O modules. However, when the application software is designed, each module will be assigned to a specific slot and thereafter, the software will expect that specific I/O module to always be in its designated slot.

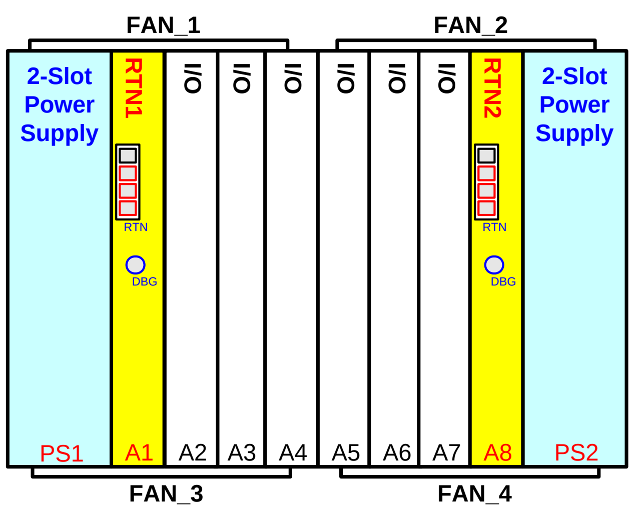


Figure 3-6. MicroNet Plus 8-Slot Chassis

3.2.1.1 RTN Slots (A1, A8)

Chassis slots A1 and A8 are designated as RTN compatible slots. These slots provide extra functionality for monitoring fan status, chassis temperature status, and power supply status information. The RTN slots also support operation of Redundant RTNs and the associated RTN Failover functions. The RTN slots are identical except for slot address, thus a RTN can be installed in either one to control the MicroNet system.

- For simplex systems, RTN slot A8 can also be used as an I/O module slot.
- Live Insertion and removal is supported for field reparability.
- RTNs are located under different fan sets to improve reliability, airflow, and temperature performance.
- RTN slots use VME-64 connectors on the RTN module slots for improved RTN HotSwap capabilities.

3.2.1.2 Power Supply Slots (PS1, PS2)

A smaller 2-slot wide power supply has been designed for the MicroNet Plus chassis, thus allowing (2) more slots for I/O. Each power supply is located under different fan sets for improved reliability. The redundant smart fans are located above and below each power-supply for improved airflow. Each power supply provides input failure (AC_FAIL) and output failure (PWR_ALM) fault information to the RTN slots.

- Power supplies are located under different fan sets to improve reliability, airflow, and temperature performance.
- Three different 2-slot wide power supplies are available for use: a low voltage (24 Vdc input), a high voltage (120 Vac/dc input), and a high voltage 220 Vac input version. Refer to the power-supply section for additional information.

3.2.1.3 Redundant Smart Fans

Each smart-fan provides a tachometer output to the RTN slots. The RTN monitors the fans for slow operation or fan-failure. A GAP application fault is provided for each fan (See GAP help for CHAS_STAT block). Quick-connect FAN connectors are utilized for improved field replacement. (Do not replace fans without taking proper ESD precautions.) The motherboard provides individual, short-circuit protected, +24 V Fan power to each fan.

3.2.1.4 Motherboard Terminal Block (TB1)

The MicroNet Plus chassis includes a terminal block that provides RTN1 and RTN2 Remote reset inputs. The same terminal block provides access to +24 Vdc motherboard power (3 terminals) through two separate 5 A fuses. If a direct short of this power output occurs, the fuses will blow to protect the motherboard, and the power supplies will shut down with a 24 Vdc power fault. Replacement fuses can be ordered as Woodward P/N 1641-1004. The system must be shut down to replace the fuses safely.

3.2.1.5 24 Vdc Motherboard Power

- **TMR & Redundant systems**—Not recommended for use.
- **Simplex systems**—This power may be used for local Ethernet switch power. Consider carefully the possibility of shorts and the type of connector wiring used.

NOTICE	**The Motherboard +24 Vdc power outputs should be used locally in the same MicroNet cabinet only in rare instances, as the quality of this supply is critical to proper system operation.**

3.2.1.6 RTN Remote Reset Inputs (RST1, RST2)

Each RTN may be reset by either using the front-panel reset button or a remote-reset input provided on the motherboard. The remote-reset inputs are available at the TB1 terminal block located at the bottom center of the chassis. The individual remote resets for each RTN are designated RST1+, RST1– for slot A1 and RST2+, RST2– for slot A8. These inputs are optically isolated on each respective RTN module and require both a 24 V(+) and a common(-) to be wired. A momentary high will cause a RTN-reset.

3.2.1.7 Chassis Overtemp Alarm

The MicroNet Plus 8-slot chassis provides (2) over-temperature switches on the motherboard. The over-temperature switches will trip at 65°C ± 3°C and communicate this warning to the RTN and GAP application.

3.2.1.8 Chassis Outline Drawing

The MicroNet Plus 8-slot chassis is physically the same dimensions as the MicroNet Simplex 6-slot chassis.

Notes:

- Add ~2” (~5 cm) to the depth dimension to account for the cable saddles that are not shown on the outline drawing below.
- The PE ground connection point is located underneath the left side of the chassis.
- To ensure compliance with the EMC certification, all chassis mounting screws (#8-32 M4) should be installed to properly ground the chassis to the mounting plate.
- For proper airflow, the installation should allow a 3” (8 cm) air gap above and below the chassis.

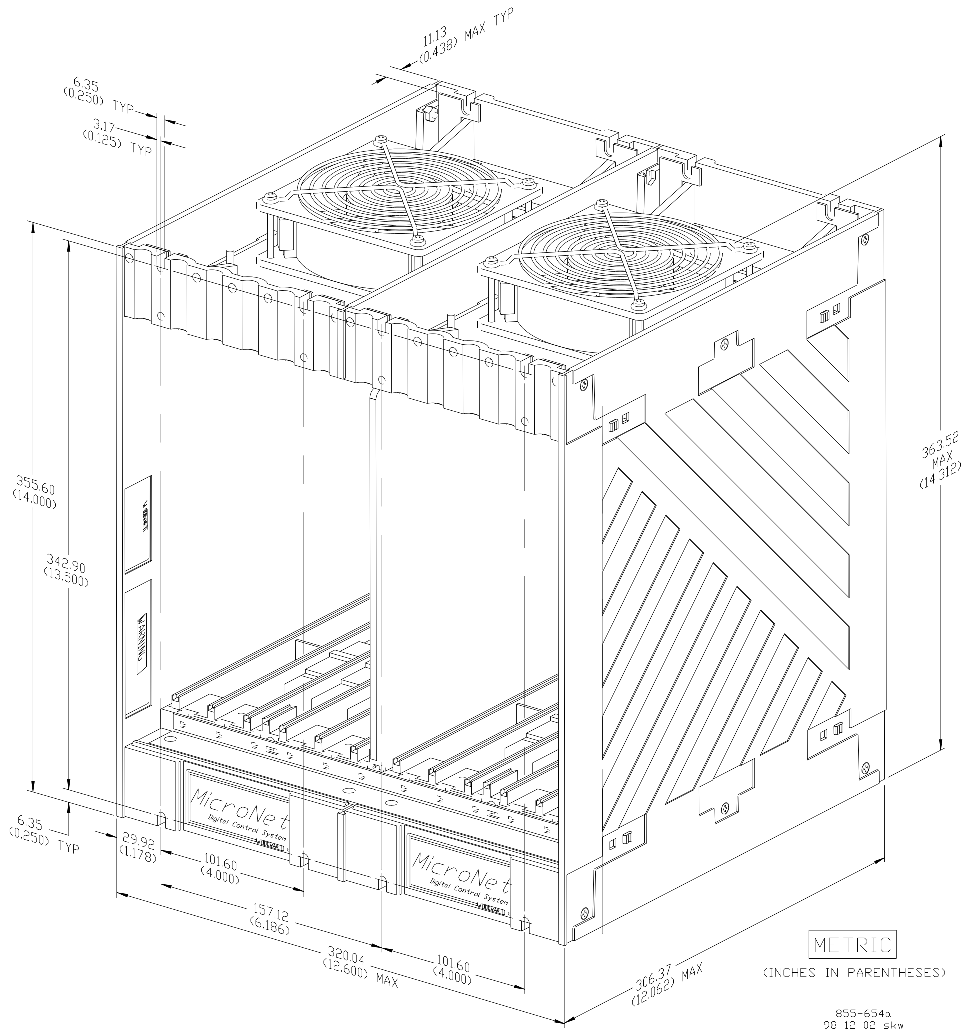


Figure 3-7. Outline Drawing of MicroNet Plus 8-Slot Chassis

3.2.2 Installation

Figure 3-8 shows the mounting template and fasteners to bulkhead mount the chassis. Rack mounting is not recommended. For proper airflow, the installation should allow a 3" air gap above and below the chassis.

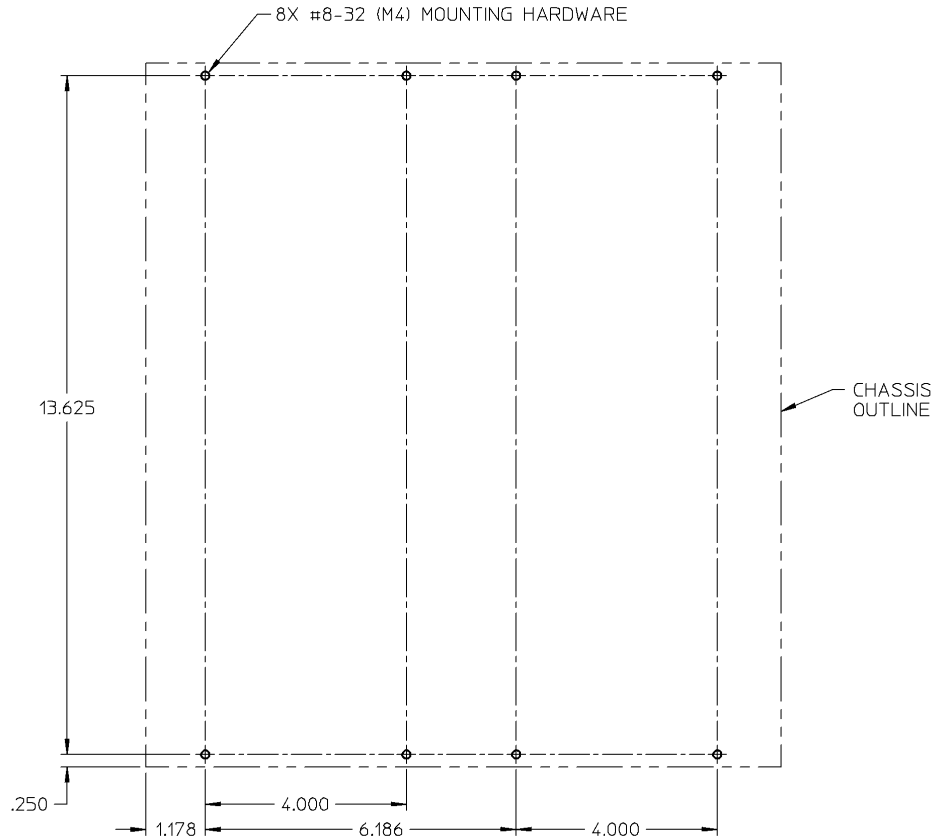


Figure 3-8. Mounting Template of MicroNet Plus 8-Slot I/O Chassis

3.3. Expansion MicroNet Plus 14-Slot I/O

Figure 3-9. MicroNet Plus 14-Slot I/O Chassis

The MicroNet Plus 14-slot chassis offers redundant RTN capability and more I/O slots, as well as improvements in airflow and overall system reliability.

Features:

- A total of (14) RTN and I/O slots are available for use
- A new 2-slot wide, redundant, load sharing power supply is used
- Redundant Smart fans are used for early notification of fan failure
- Chassis temperature switches exist on the motherboard and trip at +65 °C
- Redundant, hot-swappable RTNs are supported

3.3.1 Specification

The MicroNet is designed around a modular 6-slot chassis (block). Each block consists of a premolded cage with a fan for cooling and a temperature switch for high temperature detection. The chassis are cooled by forced air, and either a module or a module blank must be installed in every slot to maintain correct airflow. The fans run whenever power is applied to the system.

The MicroNet Plus chassis is composed of three blocks with a motherboard inserted in the back of the assembly to make connections between the fans, switches, power supplies, and control modules. See Figure 3-8. The modules use the VERSAmodule Eurocard (VME) bus standard for connector specification and data transfer. Slot-to-slot logic and power connections are made through an etched-circuit motherboard. I/O connections are made through cables from the front of the modules to field termination modules (FTM's) the cabinet.

From a module connector standpoint, any I/O module can be installed in any of the slots designated for I/O modules. However, when the application software is designed, each module will be assigned to a specific slot and thereafter, the software will expect that specific I/O module to always be in its designated slot.

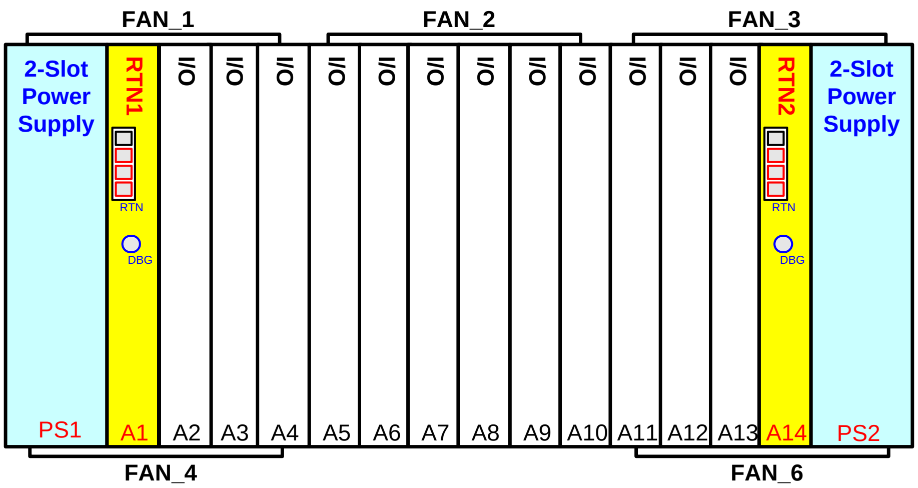


Figure 3-10. MicroNet Plus 14-Slot Chassis

3.3.1.1 RTN Slots (A1, A14)

Chassis slots A1 and A14 are designated as RTN compatible slots. These slots provide extra functionality for monitoring fan status, chassis temperature status, and power supply status information. The RTN slots also support operation of Redundant RTNs and the associated RTN Failover functions. The RTN slots are identical except for slot address, thus a RTN can be installed in either one to control the MicroNet system.

- For simplex systems, RTN slot A14 can also be used as an I/O module slot.
- Live Insertion and removal is supported for field reparability.
- RTNs are located under different fan sets to improve reliability, airflow, and temperature performance.
- RTN slots use VME-64 connectors on the RTN module slots for improved RTN HotSwap capabilities.

3.3.1.2 Power Supply Slots (PS1, PS2)

A smaller 2-slot wide power supply has been designed for the MicroNet Plus chassis, thus allowing (2) more slots for I/O. Each power supply is located under different fan sets for improved reliability. The redundant smart fans are located above and below each power-supply for improved airflow. Each power supply provides input failure (AC_FAIL) and output failure (PWR_ALM) fault information to the RTN slots.

- Power supplies are located under different fan sets to improve reliability, airflow, and temperature performance.
- Three different 2-slot wide power supplies are available for use: a low voltage (24 Vdc input), a high voltage (120 Vac/dc input), and a high voltage 220 Vac input version. Refer to the power-supply section for additional information.

3.3.1.3 Redundant Smart Fans

Each smart-fan provides a tachometer output to the RTN slots. The RTN monitors the fans for slow operation or fan-failure. A GAP application fault is provided for each fan. Quick-connect FAN connectors are utilized for improved field replacement. (Do not replace fans without taking proper ESD precautions.) The motherboard provides individual, short-circuit protected, +24 V Fan power to each fan.

3.3.1.4 Motherboard Terminal Block (TB1)

The MicroNet Plus chassis includes a terminal block that provides RTN1 and RTN2 Remote reset inputs. The same terminal block provides access to +24 Vdc motherboard power (3 terminals) through two separate 5 A fuses. If a direct short of this power output occurs, the fuses will blow to protect the motherboard, and the power supplies will shut down with a 24 Vdc power fault. Replacement fuses can be ordered as Woodward P/N 1641-1004. The system must be shut down to replace the fuses safely.

3.3.1.5 24 Vdc Motherboard Power

- **TMR & Redundant systems**—Not recommended for use.
- **Simplex systems**—This power may be used for local Ethernet switch power. Consider carefully the possibility of shorts and the type of connector wiring used.

NOTICE	**The Motherboard +24 Vdc power outputs should be used locally in the same MicroNet cabinet only in rare instances, as the quality of this supply is critical to proper system operation.**

3.3.1.6 RTN Remote Reset Inputs (RST1, RST2)

Each RTN may be reset by either using the front-panel reset button or a remote-reset input provided on the motherboard. The remote-reset inputs are available at the TB1 terminal block located at the bottom center of the chassis. The individual remote resets for each RTN are designated RST1+, RST1– for slot A1 and RST2+, RST2– for slot A14. These inputs are optically isolated on each respective RTN module and require both a 24 V(+) and a common(-) to be wired. A momentary high will cause a RTN-reset.

3.3.1.7 Chassis Overtemp Alarm

The MicroNet Plus chassis provides (3) over-temperature switches on the motherboard. The over-temperature switches will trip at 65°C ± 3 °C and communicate this warning to the RTN and GAP application.

3.3.1.8 Chassis Outline Drawing

The MicroNet Plus 14-slot chassis is physically the same dimensions as the MicroNet Simplex 12-slot chassis.

Notes:

- Add ~2” (~5 cm) to the depth dimension to account for the cable saddles that are not shown on the outline drawing below.
- The PE ground connection point is located underneath the left side of the chassis.
- To ensure compliance with the EMC certification, all chassis mounting screws (#8-32 M4) should be installed to properly ground the chassis to the mounting plate.
- For proper airflow, the installation should allow a 3” (8 cm) air gap above and below the chassis.

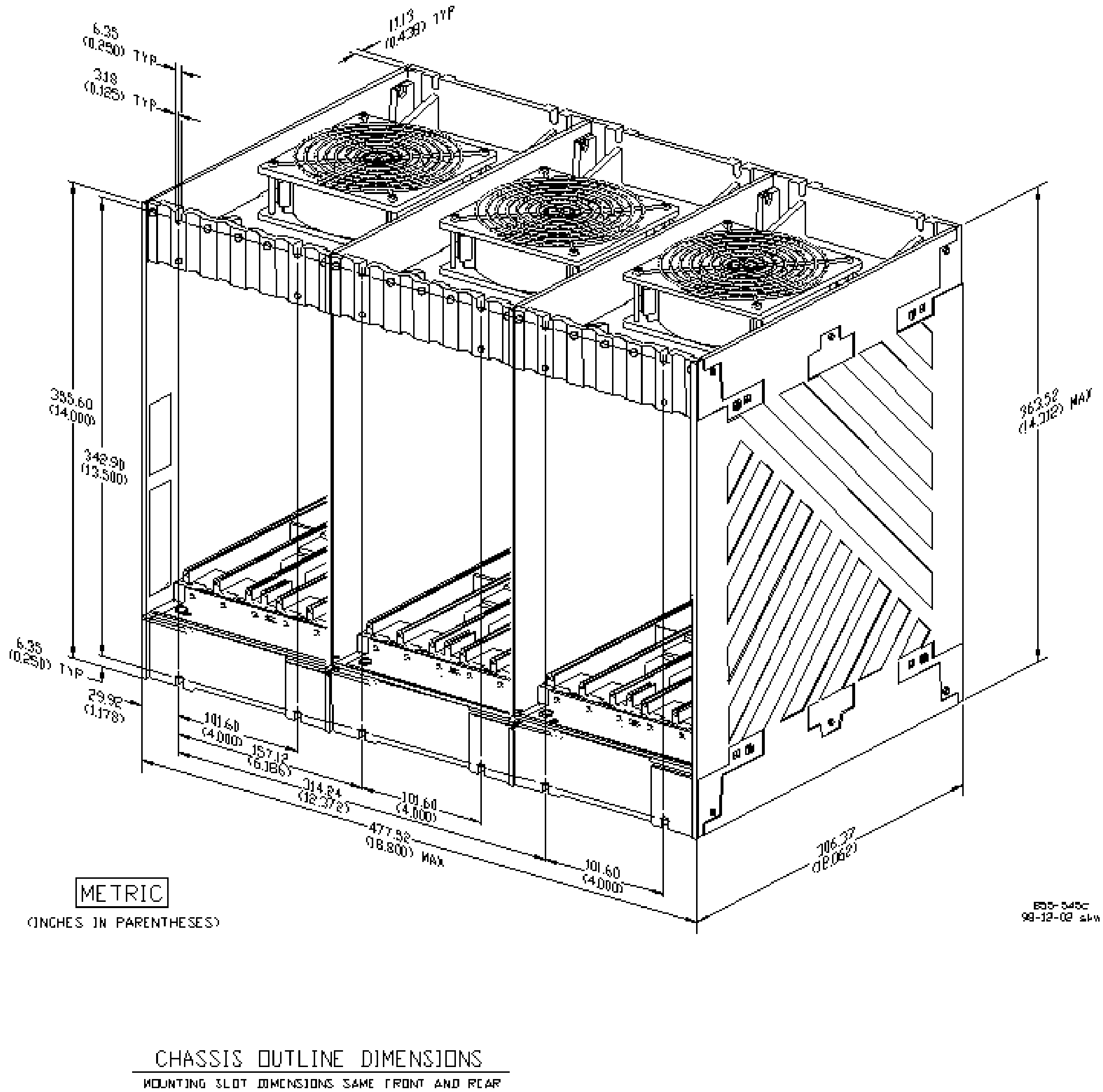


Figure 3-11. Outline Drawing of MicroNet Plus Chassis

3.3.2 Installation

Figure 3-12 shows the mounting template and fasteners to bulkhead mount the chassis. Rack mounting is not recommended. For proper airflow, the installation should allow a 3” air gap above and below the chassis.

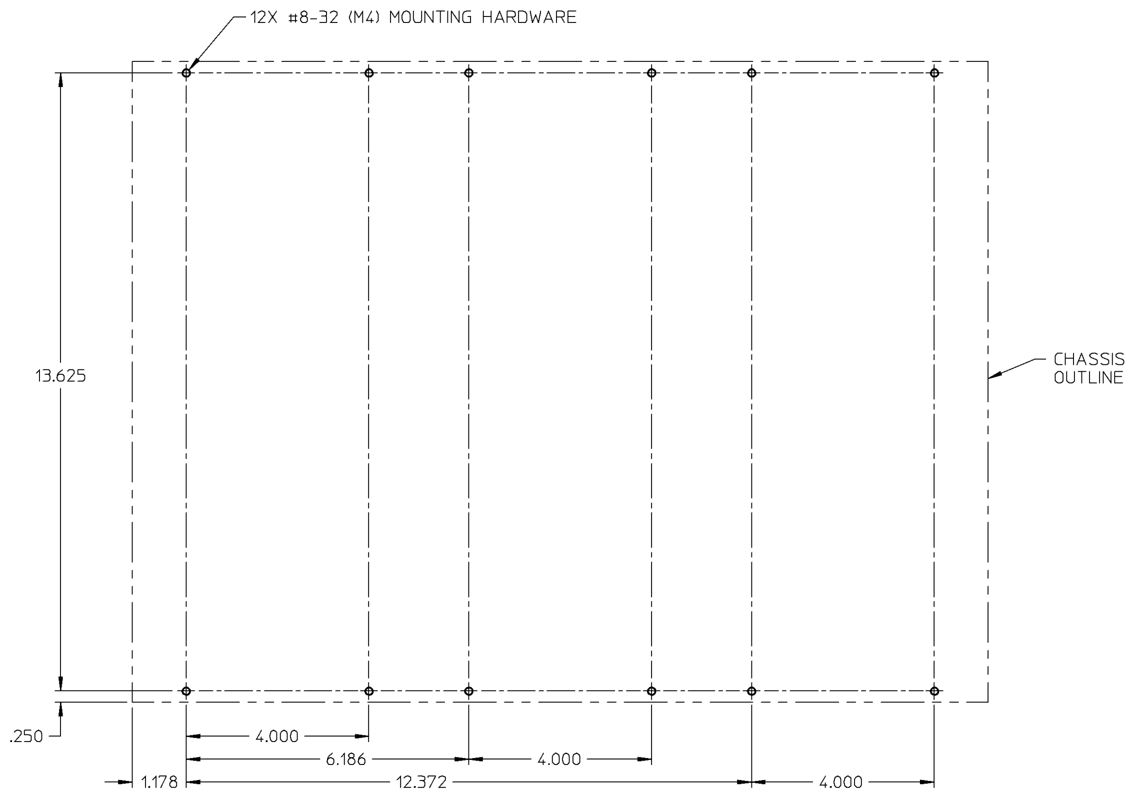


Figure 3-12. Mounting Template of MicroNet Plus 14-Slot I/O Chassis

3.4. Expansion MicroNet Simplex 6-Slot I/O

This chassis contains six slots for remote transceiver and I/O modules. This allows one Remote XCVR or RTN module and five I/O modules, redundant RTNs are not allowed. In addition to the six I/O slots, two power supply positions are provided, which allows for redundant power input. Each power supply module occupies three slots of chassis space. The total width of the chassis is therefore twelve slots wide, when counting both power supply *and* I/O slots.

If a power supply or I/O module slot is not occupied, it must be filled with a blanking plate (3799-301) to maintain proper cooling flow through the chassis.

IMPORTANT	**The 6 slot expansion chassis should not be used for new applications. The 6 slot expansion chassis should only be used in retrofit situations where the chassis is already installed.**

Figure 3-13. Simplex MicroNet Six Slot I/O

3.4.1 Specification

The MicroNet control is designed around a modular six slot chassis (block). Each block consists of a premolded cage with a fan for cooling and a temperature switch for high temperature detection. The chassis are cooled by forced air, and either a module or a module blank must be installed in every slot to maintain correct air flow. The fans run whenever power is applied to the system.

The six slot MicroNet expansion chassis is composed of two blocks with a motherboard inserted in the back of the assembly to make connections between the fans, switches, power supplies, and control modules. See Figure 3-13. The modules use the VERSAmodule Eurocard (VME) bus standard for connector specification and data transfer. Slot-to-slot logic and power connections are made through an etched-circuit motherboard. I/O connections are made through cables from the front of the modules to field termination modules (FTM's) in the cabinet.

From a module connector standpoint, any I/O module can be installed in any of the slots designated for I/O modules. However, when the application software is designed, each module will be assigned to a specific slot and thereafter, the software will expect that specific I/O module to always be in its designated slot.

Notes:

- Add ~2" (~5 cm) to the depth dimension to account for the cable saddles that are not shown on the outline drawing below.
- The PE ground connection point is located underneath the left side of the chassis.
- To ensure compliance with the EMC certification, all chassis mounting screws (#8-32 M4) should be installed to properly ground the chassis to the mounting plate.
- For proper airflow, the installation should allow a 3" (8 cm) air gap above and below the chassis.

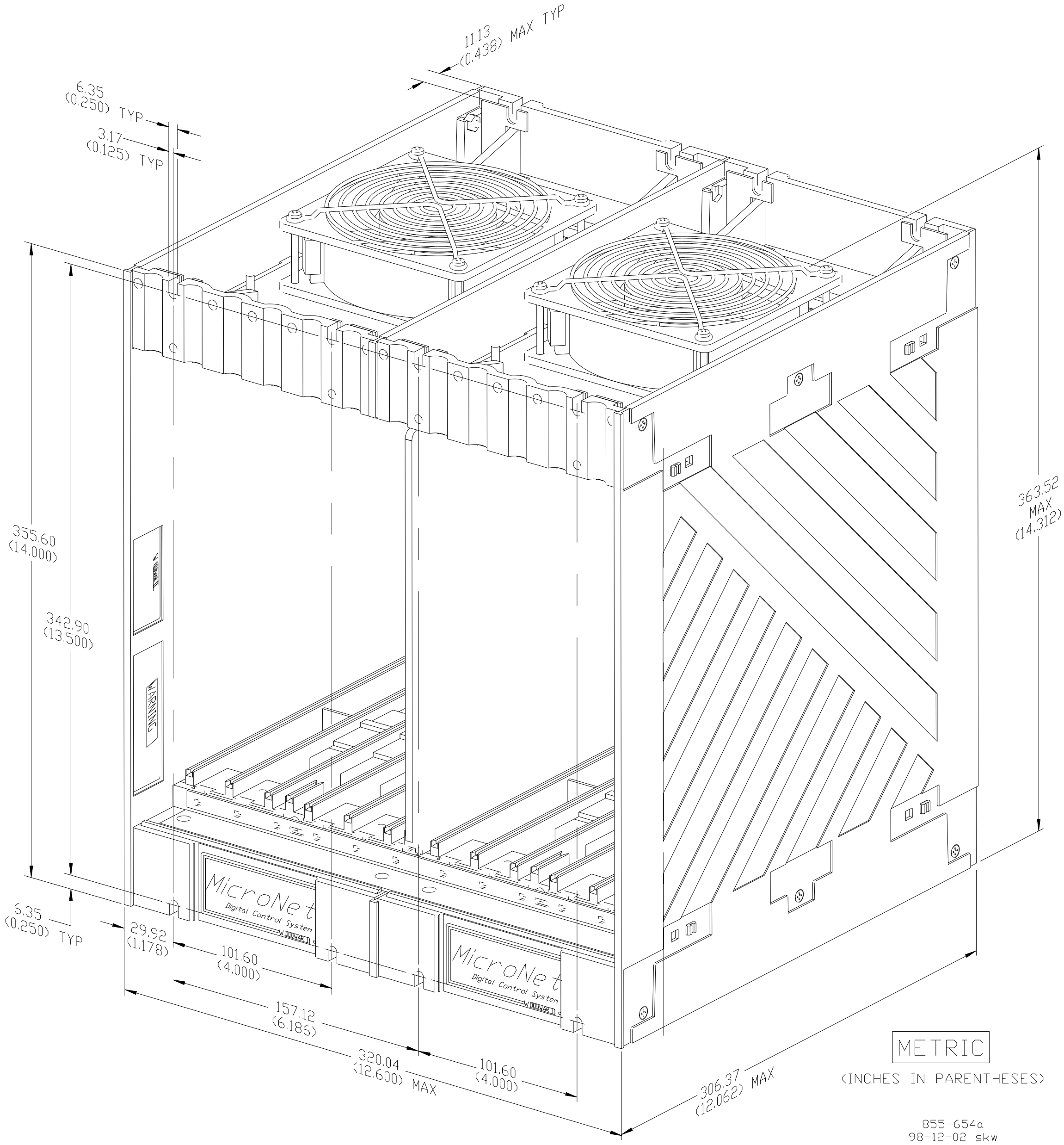


Figure 3-14. Outline Drawing of MicroNet Six Slot I/O

3.4.2 Installation

Figure 3-15 shows the mounting template and fasteners to bulkhead mount the chassis. Rack mounting is not recommended. For proper airflow, the installation should allow a 3” air gap above and below the chassis.

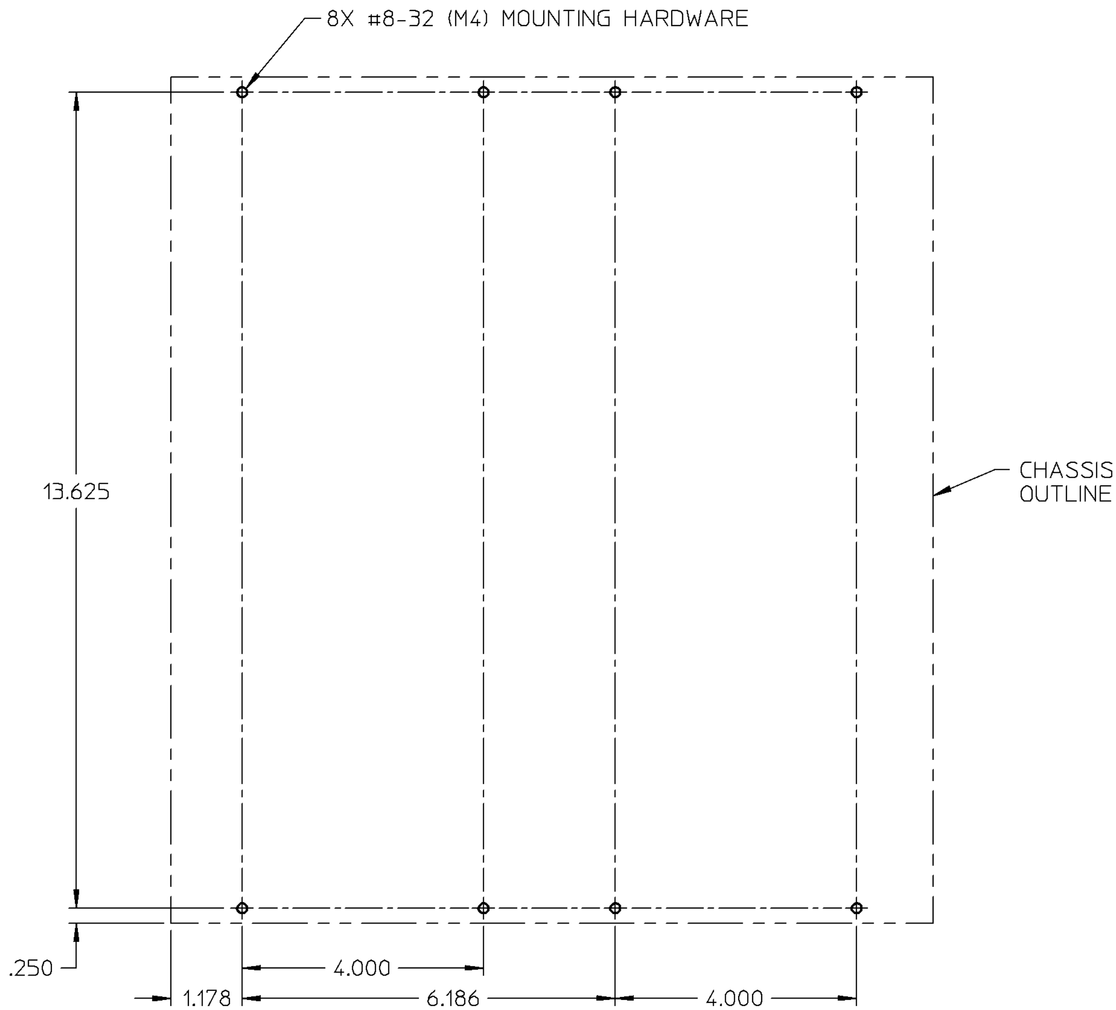


Figure 3-15. Mounting Template of MicroNet 6 Slot I/O Chassis

3.5. Expansion MicroNet Simplex 12-Slot I/O

3.5.1 Description

This chassis contains twelve slots for remote transceiver and I/O (input/output) modules. This allows one Remove XCVR or RTN module and eleven I/O modules, redundant RTN modules are not allowed. In addition to the 12 XCVR/RTN – I/O slots, two power supply positions are provided, which allows for redundant power input. Each power supply module occupies three slots of chassis space. When counting power supply and I/O slots, the total width of the chassis is 18 slots wide.

If a power supply or I/O module slot is not occupied, it must be filled with a blanking plate (3799-301) to maintain proper cooling flow through the chassis.

IMPORTANT	**The 12 slot expansion chassis should not be used for new applications. The 12 slot expansion chassis should only be used in retrofit situations where the chassis is already installed.**

Figure 3-16. Simplex MicroNet 12 Slot I/O

3.5.2 Specification

The MicroNet is designed around a modular six slot chassis (block). Each block consists of a premolded cage with a fan for cooling and a temperature switch for high temperature detection. The chassis are cooled by forced air, and either a module or a module blank must be installed in every slot to maintain correct airflow. The fans run whenever power is applied to the system.

The twelve slot MicroNet expansion chassis is composed of three blocks with a motherboard inserted in the back of the assembly to make connections between the fans, switches, power supplies, and control modules. See Figure 3-16. The modules use the VERSAmodule Eurocard (VME) bus standard for connector specification and data transfer. Slot-to-slot logic and power connections are made through an etched-circuit motherboard. I/O connections are made through cables from the front of the modules to field termination modules (FTM's) in the cabinet.

From a module connector standpoint, any I/O module can be installed in any of the slots designated for I/O modules. However, when the application software is designed, each module will be assigned to a specific slot and thereafter, the software will expect that specific I/O module to always be in its designated slot.

Notes:

- Add ~2" (~5 cm) to the depth dimension to account for the cable saddles that are not shown on the outline drawing below.
- The PE ground connection point is located underneath the left side of the chassis.
- To ensure compliance with the EMC certification, all chassis mounting screws (#8-32 M4) should be installed to properly ground the chassis to the mounting plate.
- For proper airflow, the installation should allow a 3" (8 cm) air gap above and below the chassis.

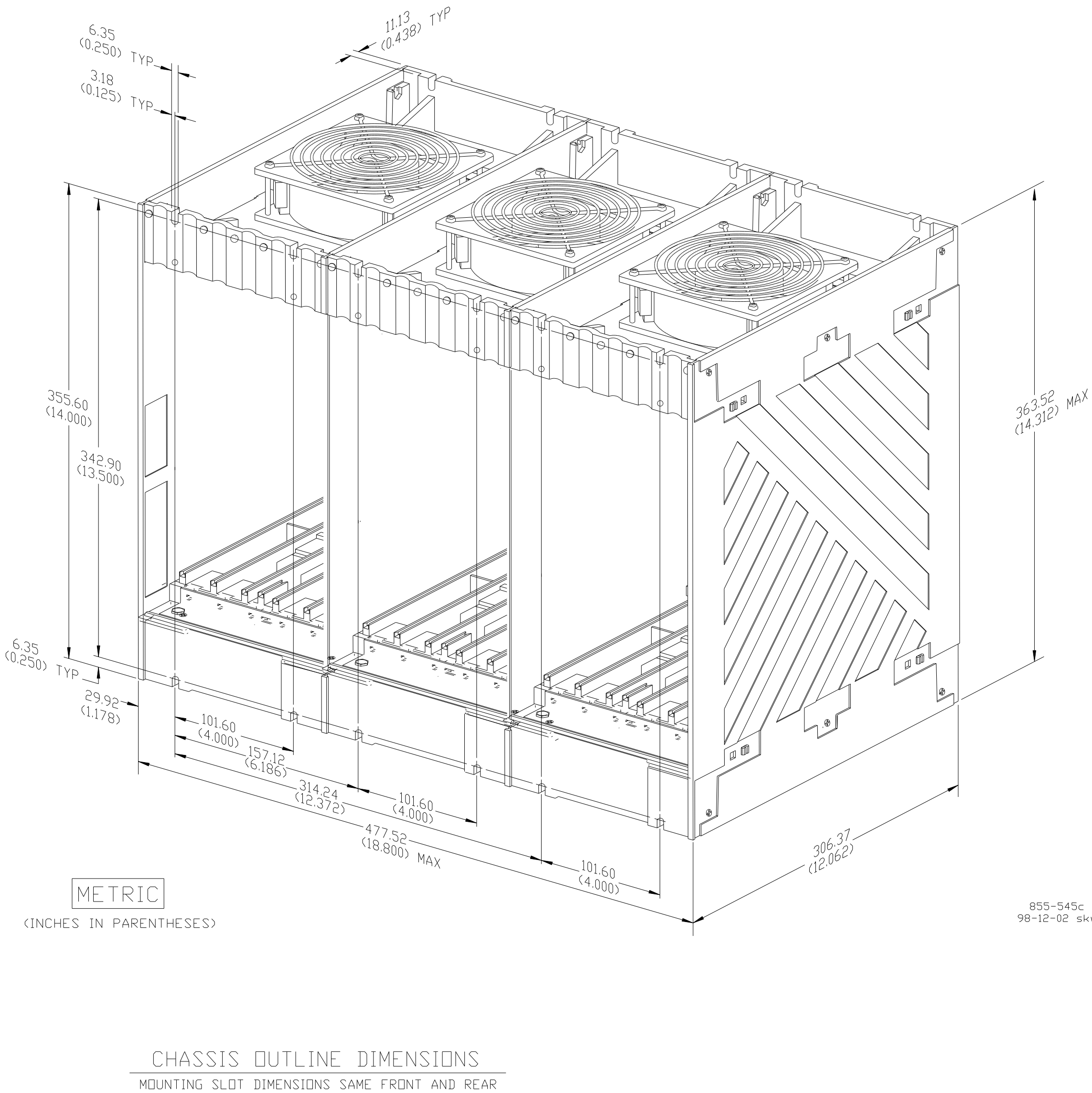


Figure 3-17. Outline Drawing of MicroNet 12 Slot I/O

3.5.3 Installation

Figure 3-18 shows the mounting template and fasteners to bulkhead mount the chassis. Rack mounting is not recommended. For proper airflow, the installation should allow a 3" air gap above and below the chassis.

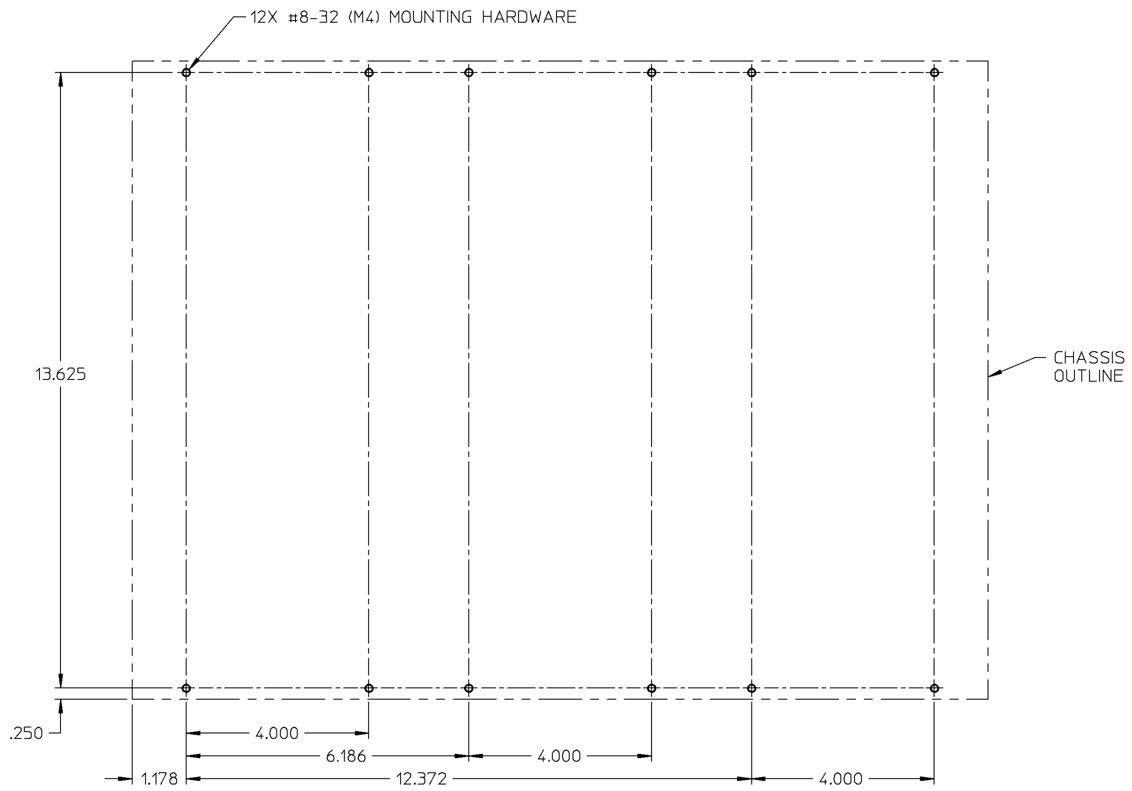


Figure 3-18. Mounting Template of MicroNet 12 Slot I/O Chassis

Chapter 4. Power Supplies

4.1. TMR Main Power Supplies

4.1.1 Module Description

The MicroNet TMR main control power supply chassis uses redundant power supplies. A motherboard located on the back of the power supply chassis allows the two power supplies to form a redundant power system providing six separately regulated 24 Vdc, 6 A outputs to the control. See Figure 4-1. Power output regulation, including line, load, and temperature effects, is less than +5%.

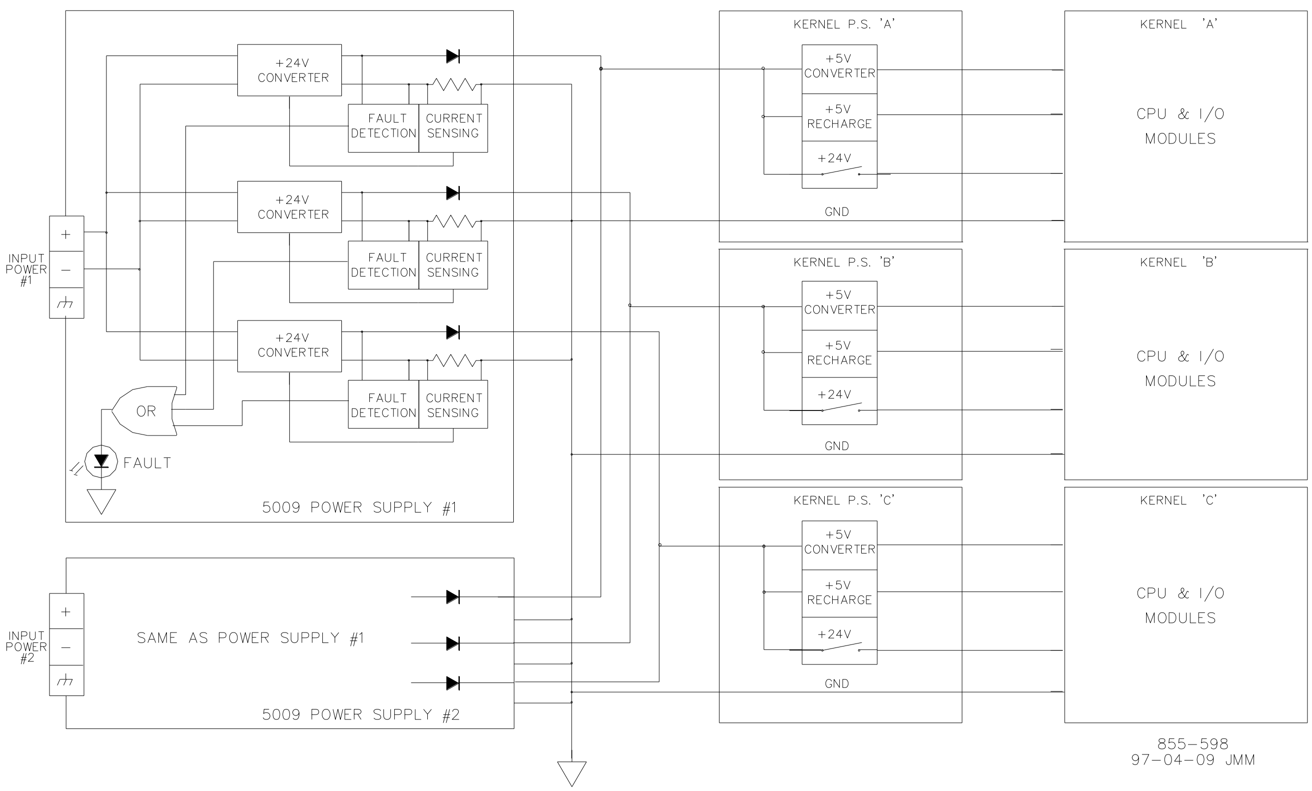


Figure 4-1. TMR Power Supply Diagram

When redundant power supplies are running, current sharing circuitry balances the load to reduce heat and improve the reliability of the power supplies. In the event that one supply needs replacement, this feature also ensures hot replacement of the power supplies without disrupting the operation of the control.

Each main power supply has four LEDs to indicate power supply health (OK, Input Fault, Overtemperature, and Power Supply Fault). See MicroNet TMR Power Supply Troubleshooting (Section 4.8) for a description of the LED indications.

Input power connections are made to the main power supply through terminals on the front of the power supplies. A 50-pin ribbon cable (5416-977) is used for connecting the power supply chassis to the control chassis.

The ribbon cable connects to a connector at the back underside of the TMR Main Chassis. There are connectors beneath the A and C Kernels – either can be used. See Figure 4-2. NOTE: It is also possible to use two TMR Power Supply Chassis and connect one to each connector.

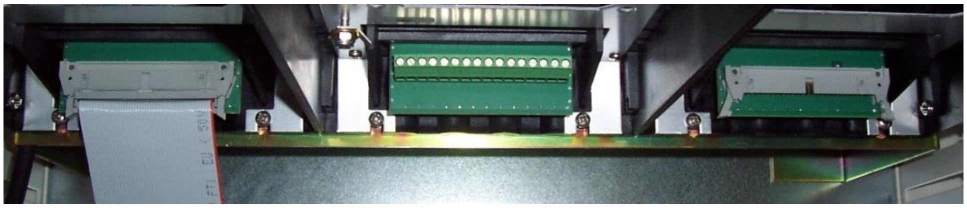


Figure 4-2. TMR Main Chassis PS Ribbon Cable Connections

On the Power Supply Chassis, the cable connects toward the back of the upper side of the Chassis. See Figure 4-3. The Power Supply Ribbon cable (5416-977) is only 6 inches in length so the TMR PS Chassis must be located immediately beneath the A or C Kernels of the TMR Main Chassis

Figure 4-3. TMR PS Chassis PS Ribbon Cable (5416-977) Connections

A second Chassis-to Chassis Power Cable (5417-293) should can be used to provide redundant connections. See Figure 4-4.

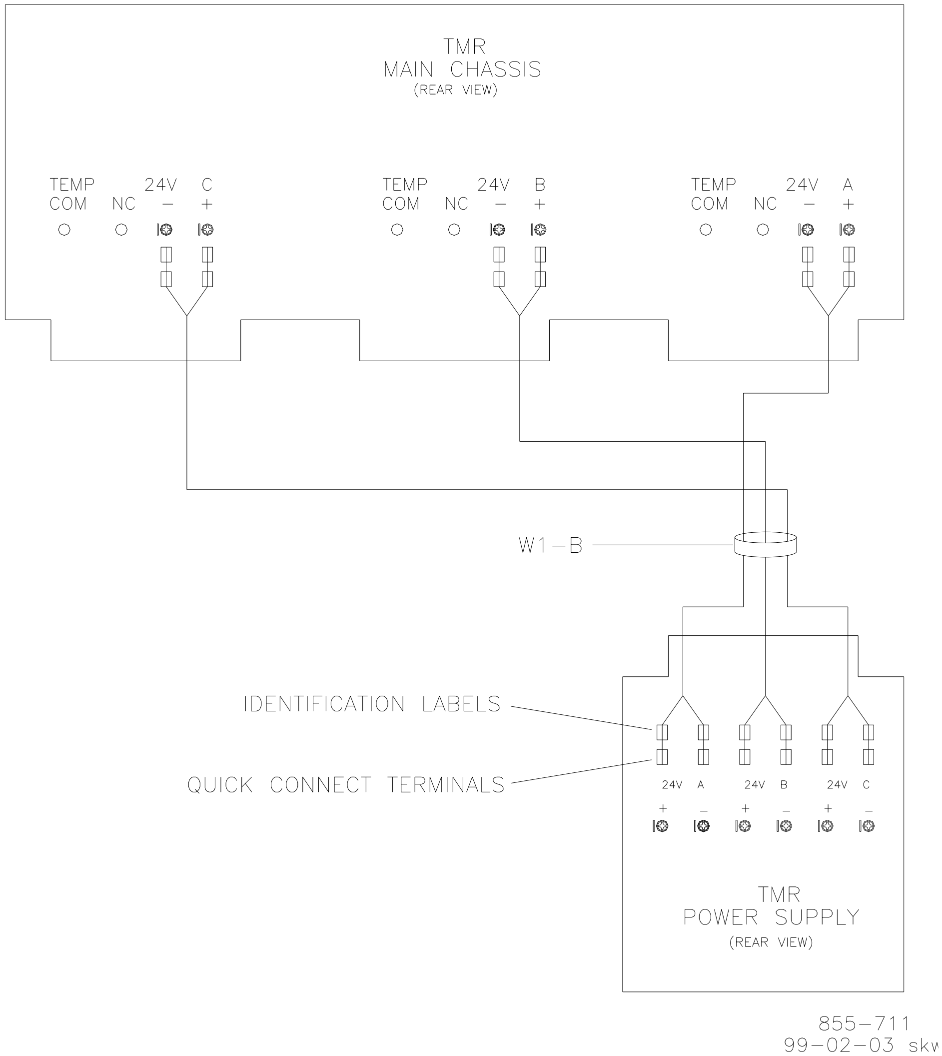


Figure 4-4. Chassis-to-Chassis Power Cable (5417-293)

⚠WARNING

The MicroNet TMR Main power supplies must have the input power removed before installing or removing.

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.

Wiring must be in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.

Figure 4-5. TMR Power Supply Modules (24 Vdc/120 Vac/dc)

4.2. TMR Main Power Supply Specifications

4.2.1 Main PS TMR (24 Vdc Input)

Operating range:	18 to 36 Vdc
Nominal voltage rating:	20 to 32 Vdc, as on power supply label
Maximum current:	32 A
Maximum power:	576 W
Input power fuse/breaker rating:	50 A time delay
Holdup time:	5 ms @ 24 Vdc

4.2.2 Main PS TMR (120 Vac/dc Input)

4.2.2.1 AC

Operating range:	88 to 132 Vac (47 Hz to 63 Hz)
Nominal voltage rating:	98 to 120 Vac, as on power supply label
Maximum current:	13 A
Maximum power:	1150 VA
Input power fuse/breaker rating:	20 A time delay
Holdup time:	1 cycle @ 120 Vac

4.2.2.2 DC

Operating range:	100 to 150 Vdc
Nominal voltage rating:	111 to 136 Vdc, as on power supply label
Maximum current:	5.8 A
Maximum power:	576 W
Input power fuse/breaker rating:	10 A time delay
Holdup time:	7 ms @ 120 Vdc

4.2.3 Main PS TMR (220 Vac Input)

4.2.3.1 AC

Operating range:	180 to 264 Vac (47 Hz to 63 Hz)
Nominal voltage rating:	200 to 240 Vac, as on power supply label
Maximum current:	6.5 A
Maximum power:	1150 VA
Input power fuse/breaker rating:	10 A time delay
Holdup time:	1 cycle @ 220 Vac

4.2.3.1 DC

Operating range:	200 to 300 Vdc
Nominal voltage rating:	223 to 272 Vac, as on power supply label
Maximum current:	2.9 A
Maximum power:	600 VA
Input power fuse/breaker rating:	10 A time delay
Holdup time:	7 ms @ 200 Vdc

4.3. TMR Main Power Supply Installation

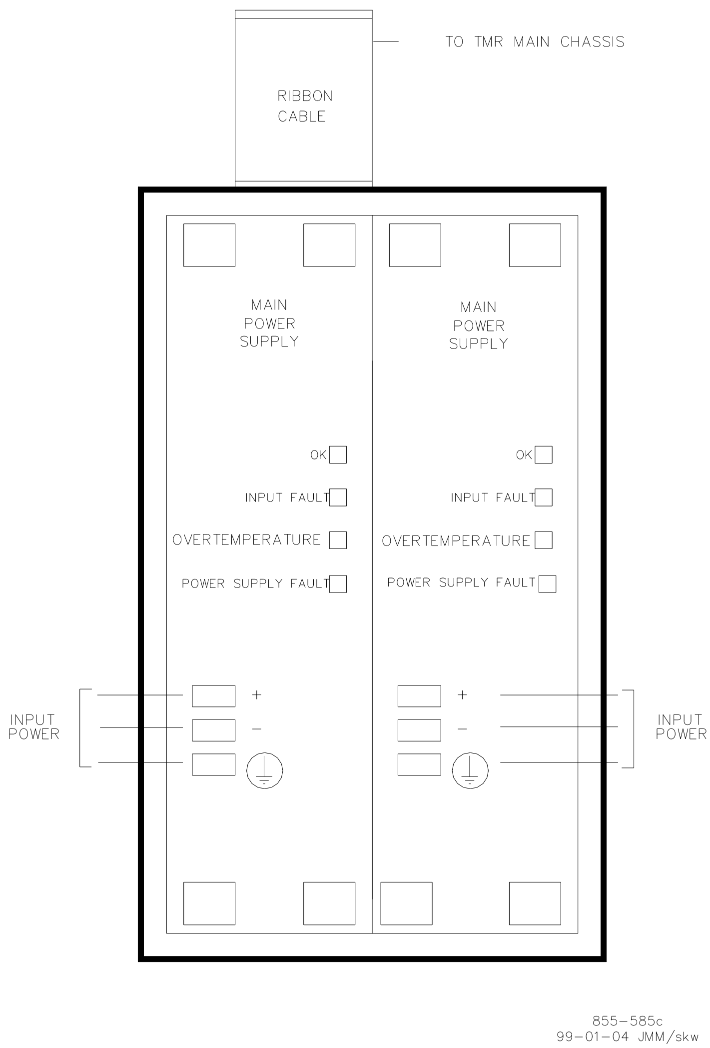


Figure 4-6. TMR Main Power Supply

4.3.1 Input Power Wiring

MicroNet TMR controls require a fixed wiring installation for AC applications. Ground leakage exceeds 3.5 mA AC. Maximum ground leakage for AC installations is 7.2 mA at 60 Hz. A ground conductor connected to the chassis is required for safety. The power supply grounding terminal(s) should also be connected to earth to ensure grounding of the power supply printed circuit boards. The grounding conductor must be the same size as the main supply conductors.

IMPORTANT

Note that the control's power supplies are not equipped with input power switches. For this reason, some means of disconnecting input power to each main power supply must be provided for installation and servicing. A circuit breaker meeting the above requirements or a separate switch with appropriate ratings may be used for this purpose. To avoid nuisance trips, use only time-delay fuses or circuit breakers.

Branch circuit fuses, circuit breakers, and wiring must meet appropriate codes and authorities having jurisdiction for the specific country (CE, UL, etc.). See Table 4-1 for maximum recommended fuse or breaker ratings. Do not connect more than one main power supply to any one fuse or circuit breaker. Use only the wire sizes specified in Table 4-1, which meet local code requirements. Time delay fuses or circuit breakers must be used to prevent nuisance trips.

Power requirements depend on the number and type of modules supplied for each system. For a system with a single I/O chassis, size the input power source according to the rating of the MicroNet TMR main power supply to which the source is connected. Do not size the supply mains for the sum of the MicroNet TMR main power supply ratings when redundant supplies are used. MicroNet supplies are redundant when installed in the same chassis. Redundant supplies share the load between them equally, but each must provide for full load in the event that one of the units is disabled. Table 4-1 gives the maximum overload protection for supply mains connected to any single or redundant pair of MicroNet main power supplies. It is not recommended that both MicroNet main power supplies of a redundant pair be connected to a single source, since failure of that source would disable the system.

Multiple chassis systems using MicroNet TMR main power supplies may have power supplies of the same model, but in different chassis, connected to the same source. In this case, each branch to a chassis must have its own overcurrent protection sized according to Table 4-1, and the power source must be sized for the sum of the branches.

Not all systems will require the full load capability of the MicroNet TMR main power supply. If not otherwise indicated on a cabinet system nameplate, either use the MicroNet TMR main power supply input ratings for sizing the system's source or consult Woodward for determining the minimum source requirements.

Table 4-1 provides fuse and wire size specifications for each power supply.

Table 4-1. MicroNet TMR Power Supply Requirements

MAXIMUM INPUT VOLTAGE RANGE	MAXIMUM FUSE/ C.B. RATING (Time Delay)	WIRE SIZE ** (AWG/mm²)
18–36 Vdc	50 A	8 / 10 *
100–150 Vdc	10 A	14 / 2.5
88–132 Vac 47–63 Hz	20 A	12 / 4
200–300 Vdc	5 A	16 / 1.5
180–264 Vac 47–63 Hz	10 A	14 / 2.5

* must use wire rated for at least 75 °C for use at 30 °C ambient
** except as noted, wire sizes are rated 60 °C for 30 °C ambient

When a cabinet is not supplied with the system, input power connections are made through terminals on the front of each main power supply. These terminals accept wires from 0.5 to 10 mm² (20–8 AWG). For a good connection, the inserted wires should have the insulation stripped back 8–9 mm (0.33 in). Torque to 0.5 to 0.6 N·m (0.37 to 0.44 lb-ft).

The 24 Vdc power supply model uses larger copper input terminals to accommodate the required 10 mm² (8 AWG) wire.

A green/yellow wire connection of at least the same size as the supply wire must be used for the PE ground.

4.4. TMR Kernel PS Module

4.4.1 Module Description

The MicroNet TMR control contains three kernel power supply modules. Each kernel section (A, B, and C) will contain one kernel power supply module. The kernel power supply will be located in the first slot of each kernel section. This module receives 24 Vdc from the MicroNet main power supplies and regulates it to 5 Vdc, 10 A for the rest of the kernel section and also creates a 5 Vdc precharge voltage.

IMPORTANT

Kernel Power Supply 5466-318 MUST be used with the TMR040 CPU.
Kernel Power Supply 5466-1049 MUST be used with the TMR5200 CPU.

Each kernel power supply has one LED to indicate kernel power supply health. See MicroNet TMR Kernel Power Supply Troubleshooting (Section 4.8.2) for a description of the LED indication.

WARNING

The MicroNet TMR Kernel Power Supply module must have all modules in that kernel removed before installing or removing a Kernel Power Supply module.

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.

Figure 4-7. Kernel Power Supply Module

4.5. TMR Kernel PS Module Specifications

Input Voltage:	24 Vdc ±10%
Output Voltage:	5 Vdc ±5%
Output Current:	10 A maximum

4.6. TMR Kernel PS Installation

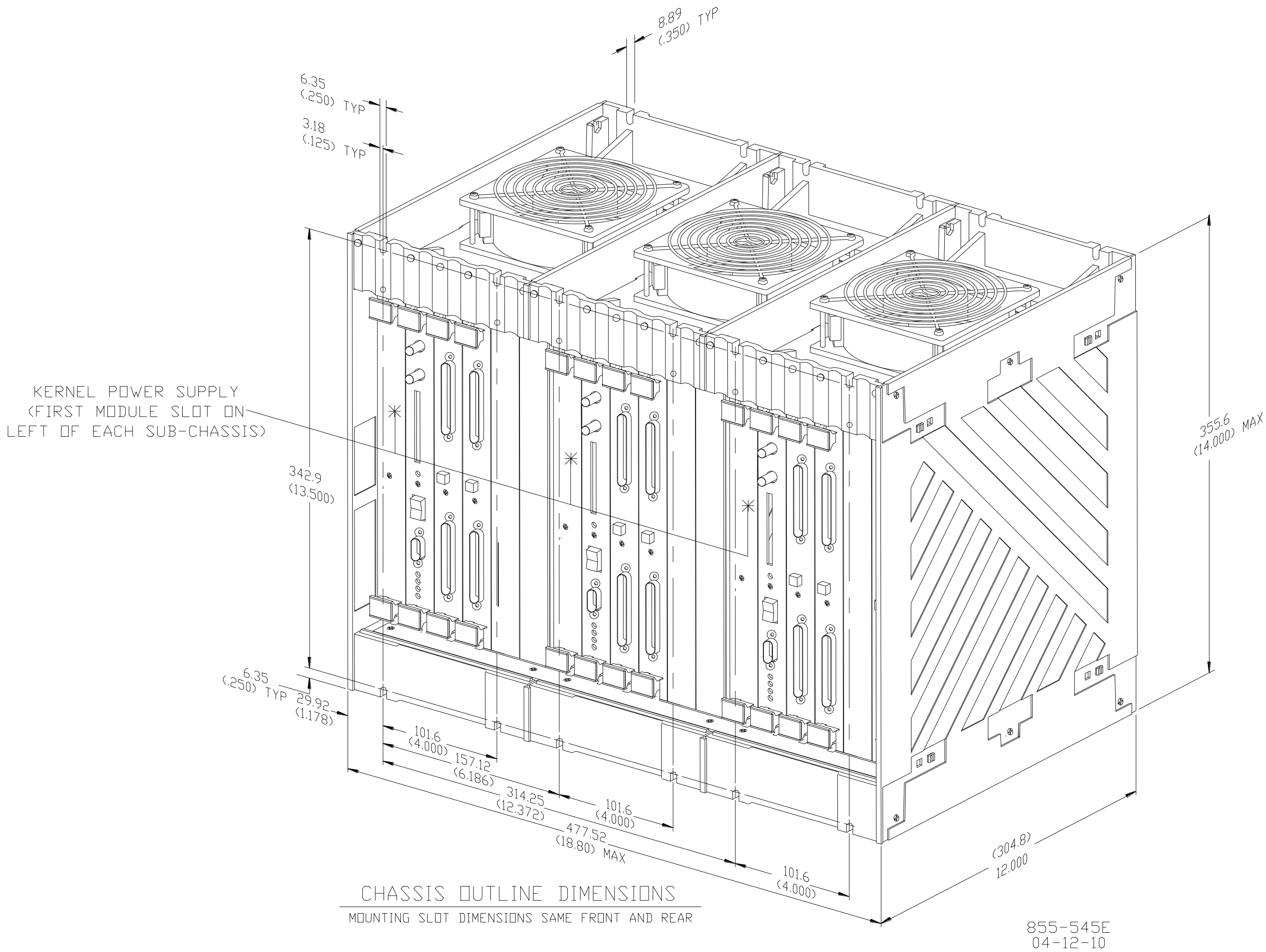


Figure 4-8. MicroNet Kernel Power Supplies

Note: Add ~ 2” to the depth dimension to account for the cable saddles that are not shown on the outline drawing above.

IMPORTANT	**The Kernel Power Supply must be installed in the first module slot from the left for each sub-chassis (kernel). The Kernel CPU module is installed in the next module slot directly to the right of each Kernel Power Supply.**

4.7. TMR System Power-up

If at any time during this procedure the defined or expected result is not achieved, begin system troubleshooting.

1. Verify that the entire MicroNet TMR control system has been installed.

2. Turn on the power for one power supply, and verify that the power supply's green LED is the only power supply LED that is on.

3. Turn on the power for the second power supply, and verify that the power supply's green LED is the only power supply LED that is on.

4. Verify that all of Kernel Power Supply's red fault LEDs are off. If any of the LEDs are on see the Kernel Power Supply Troubleshooting in section 4.8.2.

If the system is configured with the CPU_040 perform step #5 and skip step #6. If the TMR system uses the CPU_5200 skip step #5 and perform step #6.

5. **CPU_040:** Momentarily toggle two of the CPU's RESET switches up, then back to their normal down position. Toggle remaining CPU RESET switch up, then back to its normal down position. At this point the system will perform off-line diagnostic testing, which could take several minutes. When all CPUs have synchronized and completed their diagnostic tests, no red LEDs on the CPU modules or I/O modules should be on, and the control will begin running the application program.

6. **CPU_5200:** Wait until the CPUs finish their off-line diagnostics and the CPUs are visible in AppManager. If the CPUs were running when the CPUs were powered off, the CPUs will automatically start the Application that was running when it was power off. If there was no Application running, select an Application on each CPU in AppManager and select "Start". The CPUs will run the selected Application, synchronize and completed their diagnostic tests. There should be no red LEDs on the CPU modules or I/O modules and the control will be running the application program. The Green SYSCON and RUN LED's should be on and the Yellow STBY LED should be off.

4.8. TMR Power Supply Troubleshooting

4.8.1 TMR Main Power Supply

System diagnostic routines continuously monitor each main power supply for proper operation. If a fault condition is detected, the fault is annunciated and the supply's output disabled. If necessary, use the power supply's front panel LEDs to assist in diagnosing any related problems. If all supply LEDs are off (not illuminated), it's probable that input power is not present, and verification should be made.

4.8.1.1 TMR Main Power Supply LED Descriptions

OK LED—The green LED turns on to indicate that the power supply is operating and that no faults are present.

INPUT FAULT LED—This red LED turns on to indicate that the input voltage is either above or below the specified input range. If this LED is on, check the input voltage, and correct the problem. Long-term operation with incorrect input voltages may permanently damage the power supply. Once the input voltage is within the supply's input specifications, this LED will turn off. Refer to the power supply input specifications.

OVERTEMPERATURE LED—This red LED gives an early warning of a thermal shutdown. The LED turns on to indicate that the internal power supply temperature has exceeded approximately 80 °C. If the internal supply temperature rises to approximately 90 °C, the supply will shut down. Because of the many variables involved (ambient temperature, load, thermal conductivity variations), there is no accurate way of predicting the time between the indication of overtemperature (LED illuminated) and power supply shutdown.

If this LED is turned on, verify that the fan in the power supply chassis is turning and is free of dust and other obstructions, and that the temperature around the power supply is less than 55 °C. If the power supply is cooled down without delay, it can recover from this situation without shutting down. This LED will turn off once the internal power supply heat sink temperature falls below approximately 75 °C.

POWER SUPPLY FAULT LED—This red LED turns on when one of the supply's four power converters has shut down. If this LED is on, check for a short circuit on external devices connected to the control's power supply. When the short circuit has been removed, the supply will resume normal operation. If no short circuit is found, reset the supply by removing input power for one minute. If the power supply is still not functioning after input power has been restored, verify that the supply is properly seated to the motherboard connector. If the supply is properly seated but is not working, then replace the supply.

4.8.1.2 TMR Main Power Supply Checks

The following is a troubleshooting guide for checking areas which may present difficulties. If these checks are made prior to contacting Woodward for technical assistance, system problems can be more quickly and accurately assessed.

- Is the input power within the range of the control's power supply input?
- Is the input power free of switching noise or transient spikes?
- Is the power circuit dedicated to the governor only?
- Are the control's supplies indicating that they are OK?
- Are the control's supplies outputting the correct voltage?

4.8.2 Kernel Power Supply Module

The status of this module's power supplies and communication memories is monitored by the CPU module that is installed in the adjacent slot.

4.8.2.1 Kernel Power Supply LED Description

KERNEL FAULT LED—This LED indicates that either the 5 V is not functioning or that the 5 V precharge is not functioning.

4.8.2.2 Kernel Power Supply Checks

The following is a table to assist in troubleshooting the Kernel Power Supply and the need for replacement.

Table 4-2. Kernel Power Supply Troubleshooting

Possible Cause	Result	Corrective Action
5 V is not functioning	The kernel will not function.	Remove all modules from that kernel and remove the Kernel Power Supply. Re-install the Kernel Power Supply. If the LED does not turn off, replace the module.
5 V precharge is not functioning	The kernel is still functioning.	Remove all modules from that kernel and remove the Kernel Power Supply. Re-install the Kernel Power Supply. If the LED does not turn off, replace the module.

4.9. MicroNet Plus 8/14 Chassis Power Supplies

4.9.1 Module Description

The MicroNet Plus Expansion Chassis may use either single or redundant power supplies. Each power supply module produces three regulated outputs: 24 V @ 12 A (max), 5 V @ 32 A (max, derated above 55 degree C external ambient temperature), and 5 V Precharge @ 3 A (max). A motherboard located on the back of the chassis provides the interconnection of the three outputs from each power supply module into three corresponding power busses: 24 V bus, 5 V bus, and 5 V precharge bus. The 24 V and 5 V busses are load shared between the two power supply modules. The 5 V precharge bus is not load shared. Power output regulation at the motherboard, including line, load, and temperature effects, is less than ±10% for the 24 V bus, +/-5% for the 5 V bus, and +/-10% for the 5 V Precharge bus. The 5 V and 5 V Precharge busses are not for external use. The 24 V bus is accessible from the motherboard for external use (protected by 5 A fuses on the source and return lines).

When redundant power supplies are running, current sharing circuitry balances the load to reduce heat and improve the reliability of the power supplies. In the event that on supply needs to be replaced, the recommended method for changing Power Modules is with the power off (to the module being removed and the module being inserted). The system will tolerate this “cold swap” method without failure.

Each main power supply has four LEDs to indicate power supply health (OK, Input Fault, Overtemperature, and Power Supply Fault). See MicroNet Plus Power Supply Troubleshooting (Section 5.5) for a description of the LED indications.

Input power connections are made to the power supply through a plug/header assembly on the front of the power supply.

For redundant operation, the control can use any combination of power supplies.

The power supplies can only be installed into slots PS1 (power supply #1) and PS2 (power supply #2). If redundant power supplies are not needed, blanking plates must be installed in the slots not being used.

For MicroNet Plus installation instructions, see Chapter 14.

NOTICE	**The MicroNet Plus main power supplies must have the input power removed before installing or removing.** **This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.** **Wiring must be in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.**

Figure 4-9. Power Supply Module

4.9.2 Power Supply Module Specifications

IMPORTANT

- **All Temperature ratings specify the System Ambient Temperature as measured at the front of the MicroNet chassis.**
- **The Power Supply operating temperature range is –10 to +65 °C with de-rated 5 Vdc output current above 55 °C. See Power Supply specifications.**
- **For a particular system configuration, use the MicroNet Power Program to calculate the output current requirements (24 V, 5 V) as a function of the Chassis, CPUs, and I/O modules used in the system.**

Table 4-3. Main PS (24 Vdc Input)

Operating range:	18 to 36 Vdc
Nominal input voltage rating:	24 Vdc
Maximum input current:	33 A
Maximum input power:	600 W
Input power fuse/breaker rating:	50 A time delay
Maximum output current (24 Vdc):	12.0 A @ 65 °C System Ambient Temp
Maximum output current (5 Vdc):	22.0 A @ 65 °C, 28 A @ 60 °C, 32 A@ 55 °C
Holdup time:	5 ms @ 24 Vdc

4.9.2.2 Main PS (110 Vac/dc Input)

AC input

Operating range:	88 to 132 Vac (47 to 63 Hz)
Nominal input voltage rating:	98 to 120 Vac, as on power supply label
Maximum input current:	13.6 A
Maximum input power:	1250 VA
Input power fuse/breaker rating:	20 A time delay
Maximum output current (24 Vdc):	12.0 A @ 65 °C System Ambient Temp
Maximum output current (5 Vdc):	28.0 A @ 65 °C, 32 A @ 60 °C
Holdup time:	1 cycle @ 120 Vac

DC input

Operating range:	100 to 150 Vdc
Nominal input voltage rating:	111 to 136 Vdc, as on power supply label
Maximum input current:	6 A
Maximum input power:	600 W
Input power fuse/breaker rating:	10 A time delay
Maximum output current (24 Vdc):	12.0 A @ 65 °C System Ambient Temp
Maximum output current (5 Vdc):	28.0 A @ 65 °C, 32 A @ 60 °C
Holdup time:	7 ms @ 120 Vdc

4.9.2.3 Main PS (220 Vac Input)

High Voltage AC

Operating range:	180 to 264 Vac (47 to 63 Hz)
Nominal input voltage rating:	200 to 240 Vac, as on power supply label
Maximum input current:	6.7 A
Maximum input power:	1250 VA
Input power fuse/breaker rating:	10 A time delay
Maximum output current (24 Vdc):	12.0 A @ 65 °C System Ambient Temp
Maximum output current (5 Vdc):	22.0 A @ 65 °C, 28 A @ 60 °C, 32 A @ 55 °C
Holdup time:	1 cycle @ 220 Vac

Input Power Wiring

A ground conductor connected to the chassis is required for safety. The power supply grounding terminal(s) should also be connected to earth to ensure grounding of the power supply printed circuit boards. The grounding conductor must be the same size as the main supply conductors.

IMPORTANT

Note that the control's power supplies are not equipped with input power switches. For this reason, some means of disconnecting input power to each main power supply must be provided for installation and servicing.

A circuit breaker meeting the above requirements or a separate switch with appropriate ratings may be used for this purpose. Label the circuit breaker and locate it in close proximity to the equipment and within easy reach of the operator. To avoid nuisance trips, use only time-delay fuses or circuit breakers.

Branch circuit fuses, circuit breakers, and wiring must meet appropriate codes and authorities having jurisdiction for the specific country (CE, UL, etc.). See Table 4-3 for maximum recommended fuse or breaker ratings. Do not connect more than one main power supply to any one fuse or circuit breaker. Use only the wire sizes specified in Table 4-3, which meet local code requirements. Time delay fuses or circuit breakers must be used to prevent nuisance trips.

Power requirements depend on the number and type of modules supplied for each system. For a system with a single I/O chassis, size the input power source according to the rating of the MicroNet Plus power supply to which the source is connected. Do not size the supply mains for the sum of the MicroNet Plus power supply ratings when redundant supplies are used. MicroNet Plus supplies are redundant when installed in the same chassis. Redundant supplies share the load between them equally, but each must provide for full load in the event that one of the units is disabled. Table 4-3 gives the maximum overload protection for supply mains connected to any single or redundant pair of MicroNet Plus main power supplies. It is not recommended that both MicroNet Plus main power supplies of a redundant pair be connected to a single source, since failure of that source would disable the system.

Multiple chassis systems using MicroNet Plus power supplies may have power supplies of the same model, but in different chassis, connected to the same source. In this case, each branch to a chassis must have its own overcurrent protection sized according to Table 4-3, and the power source must be sized for the sum of the branches.

Not all systems will require the full load capability of the MicroNet Plus power supply. If not otherwise indicated on a cabinet system nameplate, either use the MicroNet power supply input ratings for sizing the system's source or consult Woodward for determining the minimum source requirements.

Table 4-3 provides fuse and wire size specifications for each power supply.

Table 4-4. MicroNet Plus Power Supply Requirements

MAXIMUM INPUT VOLTAGE RANGE	MAXIMUM FUSE/ C.B. RATING (Time Delay)	WIRE SIZE ** (AWG/mm²)
18–36 Vdc	50 A	8 / 10 *
100–150 Vdc	10 A	14 / 2.5
88–132 Vac 47–63 Hz	20 A	12 / 4
180–264 Vac 47–63 Hz	10 A	14 / 2.5

* must use wire rated for at least 75 °C for use at 30 °C ambient
** except as noted, wire sizes are rated 60 °C for 30 °C ambient

When a cabinet is not supplied with the system, input power connections are made through a plug/header assembly on the front of each main power supply. The plug accept wires from 0.5 to 16 mm² (20–6 AWG). For a good connection, the inserted wires should have the insulation stripped back 11-12 mm (0.45 in). Torque to 0.5 to 0.6 N·m (0.37 to 0.44 lb-ft).

A green/yellow wire connection of at least the same size as the supply wire must be used for the PE ground.

4.9.2.4 System Power-Up

If at any time during this procedure the defined or expected result is not achieved, begin system troubleshooting.

1. Verify that the entire MicroNet Plus control system has been installed.

2. Turn on the power to one power supply and verify that the power supply's green LED is the only power supply LED on.

3. Turn off the power to the first power supply and turn on the power to the second power supply (if a second power supply is present) and verify that the power supply's green LED is the only power supply LED on.

4. The RTN_CPUs in the chassis will not start automatically, the CPUs in the TMR chassis must command them to start. See GAP application program for details.

4.9.3 Power Supply Troubleshooting

System diagnostic routines continuously monitor each main power supply for proper operation. If a fault condition is detected, the fault is annunciated. If necessary, use the power supply's front panel LEDs to assist in diagnosing any related problems. If all supply LEDs are off (not illuminated), it is probable that input power is not present, and verification should be made.

4.9.3.1 Power Supply LED Descriptions

OK LED—This green LED turns on to indicate that the power supply is operating and that no faults are present.

INPUT FAULT LED—This red LED turns on to indicate that the input voltage is either above or below the specified input range. If this LED is on, check the input voltage, and correct the problem. Long-term operation with incorrect input voltages may permanently damage the power supply. Once the input voltage is within the supply's input specifications, this LED will turn off. Refer to the power supply input specifications.

OVERTEMPERATURE LED—This red LED gives an early warning of a thermal shutdown. The LED turns on to indicate that the internal power supply temperature has exceeded approximately 95 °C. If the internal supply temperature rises to approximately 100 °C, the supply may shut down. Because of the many variables involved (ambient temperature, load, thermal conductivity variations), there is no accurate way of predicting the time between the indication of overtemperature (LED illuminated) and power supply shutdown.

If this LED is turned on, verify that the fans in the power supply chassis are turning and free of dust and other obstructions, and that the temperature around the power supply is less than 55 °C. If the power supply is cooled down without delay, it can recover from this situation without shutting down. This LED will turn off once the internal power supply heat sink temperature falls below approximately 90 °C.

POWER SUPPLY FAULT LED—This red LED turns on when one of the supply's three power converters has shut down or one or more of the supply levels is below internally specified levels. If this LED is on, check for a short circuit on external devices connected to the control's power supply. When the short circuit has been removed, the supply will resume normal operation (Note that if the 24 V or 5 V outputs are shorted, these power converters will be latched OFF and can only be cleared by removing the shorted condition and removing the input power for 1 minute (or until the front panel LEDs extinguish). If no short circuit is found, reset the supply by removing input power for one minute. If the power supply is still not functioning after input power has been restored, verify that the supply is properly seated to the motherboard connector. If the supply is properly seated but is not working, then replace the supply.

4.9.3.2 Simplex Power Supply Checks

The following is a troubleshooting guide for checking areas which may present difficulties. If these checks are made prior to contacting Woodward for technical assistance, system problems can be more quickly and accurately assessed.

- Is the input power within the range of the control's power supply input?
- Is the input power free of switching noise or transient spikes?
- Is the power circuit dedicated to the governor only?
- Are the control's supplies indicating that they are OK?
- Are the control's supplies outputting the correct voltage?
- Is the RTN / CPU Low Vcc LED ON?

4.10. MicroNet Simplex 6/12 Chassis Power Supplies

4.10.1 Module Description

The MicroNet expansion chassis may use either single or redundant power supplies. A motherboard located on the back of the chassis allows the two power supplies to form a redundant power system providing two separately regulated, 24 Vdc, 12 A outputs; two separately regulated, 5 Vdc, 20 A outputs; and two separately regulated, 5 Vdc precharge outputs to the control. Power output regulation, including line, load, and temperature effects, is less than ±5%.

When redundant power supplies are running, current sharing circuitry balances the load to reduce heat and improve the reliability of the power supplies. In the event that one supply needs replacement, this feature also ensures hot replacement of the power supplies without disrupting the operation of the control.

Each main power supply has four LEDs to indicate power supply health (OK, Input Fault, Overtemperature, and Power Supply Fault). See MicroNet Expansion Power Supply Troubleshooting (Section 4.13.1) for a description of the LED indications.

Input power connections are made to the power supply through terminals on the front of the power supply.

For redundant operation, the control can use any combination of power supplies.

The power supplies can only be installed into slots PA1 (power supply #1) and PA2 (power supply #2). If redundant power supplies are not needed, blanking plates (3799-301) must be installed in the slots not being used.

For MicroNet TMR installation instructions, see Chapter 14 and Section 3.3 of this chapter.

IMPORTANT — **The 6/12 slot expansion chassis should not be used for new applications. The 6/12 slot expansion chassis should only be used in retrofit situations where the chassis is already installed.**

⚠WARNING

The MicroNet TMR main power supplies must have the input power removed before installing or removing.

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.

Wiring must be in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.

Expansion Chassis PS (24 Vdc Input)

Expansion Chassis PS (120 Vac/dc Input)

Figure 4-10. Power Supply Modules

4.11. MicroNet Simplex Power Supply Specifications

4.11.1 Main PS Expansion (24 Vdc Input)

Operating range:	18 to 36 Vdc
Nominal voltage rating:	20 to 32 Vdc, as on power supply label
Maximum current:	29.5 A
Maximum power:	531 W
Input power fuse/breaker rating:	50 A time delay
Holdup time:	5 ms @ 24 Vdc

4.11.2 Main PS Expansion (120 Vac/dc Input)

4.11.2.1 AC

Operating range:	88 to 132 Vac (47 to 63 Hz)
Nominal voltage rating:	98 to 120 Vac, as on power supply label
Maximum current:	12.1 A
Maximum power:	1062 VA
Input power fuse/breaker rating:	20 A time delay
Holdup time:	1 cycle @ 120 Vac

4.11.2.2 DC

Operating range:	100 to 150 Vdc
Nominal voltage rating:	111 to 136 Vdc, as on power supply label
Maximum current:	5.3 A
Maximum power:	531 W
Input power fuse/breaker rating:	10 A time delay
Holdup time:	7 ms @ 120 Vdc

4.11.3 Main PS Expansion (220 Vac Input)

4.11.3.1 High Voltage AC

Operating range:	180 to 264 Vac (47 to 63 Hz)
Nominal voltage rating:	200 to 240 Vac, as on power supply label
Maximum current:	5.9 A
Maximum power:	1062 VA
Input power fuse/breaker rating:	10 A time delay
Holdup time:	1 cycle @ 220 Vac

4.11.3.2 High Voltage DC

Operating range:	200 to 300 Vdc
Nominal voltage rating:	223 to 272 Vdc, as on power supply label
Maximum current:	2.7 A
Maximum power:	531 W
Input power fuse/breaker rating:	5 A time delay
Holdup time:	7 ms @ 225 Vdc

4.12. MicroNet Simplex Power Supply Installation

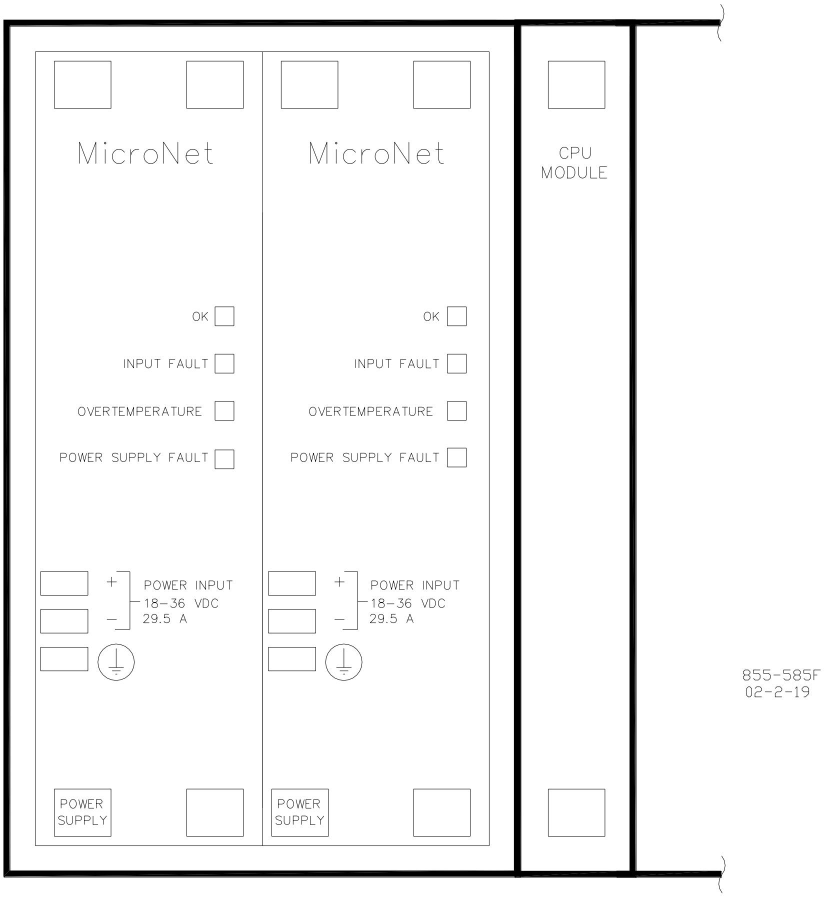


Figure 4-11. MicroNet Simplex Power Supply

4.12.1 Input Power Wiring

MicroNet controls require a fixed wiring installation for ac applications. Ground leakage exceeds 3.5 mA AC. Maximum ground leakage for ac installations is 7.2 mA at 60 Hz. A ground conductor connected to the chassis is required for safety. The power supply grounding terminal(s) should also be connected to earth to ensure grounding of the power supply printed circuit boards. The grounding conductor must be the same size as the main supply conductors.

IMPORTANT	**Note that the control's power supplies are not equipped with input power switches. For this reason, some means of disconnecting input power to each main power supply must be provided for installation and servicing. A circuit breaker meeting the above requirements or a separate switch with appropriate ratings may be used for this purpose. To avoid nuisance trips, use only time-delay fuses or circuit breakers.**

Branch circuit fuses, circuit breakers, and wiring must meet appropriate codes and authorities having jurisdiction for the specific country (CE, UL, etc.). See Table 4-4 for maximum recommended fuse or breaker ratings. Do not connect more than one main power supply to any one fuse or circuit breaker. Use only the wire sizes specified in Table 4-4 which meet local code requirements. Time delay fuses or circuit breakers must be used to prevent nuisance trips.

Power requirements depend on the number and type of modules supplied for each system. For a system with a single I/O chassis, size the input power source according to the rating of the MicroNet power supply to which the source is connected. Do not size the supply mains for the sum of the MicroNet power supply ratings when redundant supplies are used. MicroNet supplies are redundant when installed in the same chassis. Redundant supplies share the load between them equally, but each must provide for full load in the event that one of the units is disabled. Table 4-4 gives the maximum overload protection for supply mains connected to any single or redundant pair of MicroNet main power supplies. It is not recommended that both MicroNet main power supplies of a redundant pair be connected to a single source, since failure of that source would disable the system.

Multiple chassis systems using MicroNet power supplies may have power supplies of the same model, but in different chassis, connected to the same source. In this case, each branch to a chassis must have its own overcurrent protection sized according to Table 4-4, and the power source must be sized for the sum of the branches.

Not all systems will require the full load capability of the MicroNet power supply. If not otherwise indicated on a cabinet system nameplate, either use the MicroNet power supply input ratings for sizing the system's source or consult Woodward for determining the minimum source requirements.

Table 4-4 provides fuse and wire size specifications for each power supply.

Table 4-5. MicroNet Simplex Power Supply Requirements

MAXIMUM INPUT VOLTAGE RANGE	MAXIMUM FUSE/ C.B. RATING (Time Delay)	WIRE SIZE ** (AWG/mm²)
18–36 Vdc	50 A	8 / 10 *
100–150 Vdc	10 A	14 / 2.5
88–132 Vac 47–63 Hz	20 A	12 / 4
200–300 Vdc	5 A	16 / 1.5
180–264 Vac 47–63 Hz	10 A	14 / 2.5

* must use wire rated for at least 75 °C for use at 30 °C ambient
** except as noted, wire sizes are rated 60 °C for 30 °C ambient

When a cabinet is not supplied with the system, input power connections are made through terminals on the front of each main power supply. These terminals accept wires from 0.5 to 10 mm² (20–8 AWG). For a good connection, the inserted wires should have the insulation stripped back 8–9 mm (0.33 in). Torque to 0.5 to 0.6 N·m (0.37 to 0.44 lb-ft).

The 24 Vdc power supply model uses larger copper input terminals to accommodate the required 10 mm² (8 AWG) wire.

A green/yellow wire connection of at least the same size as the supply wire must be used for the PE ground.

4.12.2 System Power-Up

If at any time during this procedure the defined or expected result is not achieved, begin system troubleshooting.

1. Verify that the entire MicroNet control system has been installed.

2. Turn on the power to one power supply and verify that the power supply's green LED is the only power supply LED on.

3. Turn off the power to the first power supply and turn on the power to the second power supply (if a second power supply is present) and verify that the power supply's green LED is the only power supply LED on.

4. If the RTN_CPUs are being used, they will not start automatically, the CPUs in the TMR chassis must command them to start. See GAP application program for details.

4.13. MicroNet Simplex Power Supply Troubleshooting

System diagnostic routines continuously monitor each main power supply for proper operation. If a fault condition is detected, the fault is annunciated and the supply's output disabled. If necessary, use the power supply's front panel LEDs to assist in diagnosing any related problems. If all supply LEDs are off (not illuminated), it is probable that input power is not present, and verification should be made.

4.13.1 Power Supply LED Descriptions

4.13.1.1 Ok LED

This green LED turns on to indicate that the power supply is operating and that no faults are present.

4.13.1.2 Input Fault LED

This red LED turns on to indicate that the input voltage is either above or below the specified input range. If this LED is on, check the input voltage, and correct the problem. Long-term operation with incorrect input voltages may permanently damage the power supply. Once the input voltage is within the supply's input specifications, this LED will turn off. Refer to the power supply input specifications.

4.13.1.3 Overtemperature LED

This red LED gives an early warning of a thermal shutdown. The LED turns on to indicate that the internal power supply temperature has exceeded approximately 80 °C. If the internal supply temperature rises to approximately 90 °C, the supply will shut down. Because of the many variables involved (ambient temperature, load, thermal conductivity variations), there is no accurate way of predicting the time between the indication of overtemperature (LED illuminated) and power supply shutdown.

If this LED is turned on, verify that the fan in the power supply chassis is turning and is free of dust and other obstructions, and that the temperature around the power supply is less than 55 °C. If the power supply is cooled down without delay, it can recover from this situation without shutting down. This LED will turn off once the internal power supply heat sink temperature falls below approximately 75 °C.

4.13.1.4 Power Supply Fault LED

This red LED turns on when one of the supply's four power converters has shut down. If this LED is on, check for a short circuit on external devices connected to the control's power supply. When the short circuit has been removed, the supply will resume normal operation. If no short circuit is found, reset the supply by removing input power for one minute. If the power supply is still not functioning after input power has been restored, verify that the supply is properly seated to the motherboard connector. If the supply is properly seated but is not working, then replace the supply.

4.13.2 Expansion Power Supply Checks

The following is a troubleshooting guide for checking areas which may present difficulties. If these checks are made prior to contacting Woodward for technical assistance, system problems can be more quickly and accurately assessed.

- Is the input power within the range of the control's power supply input?
- Is the input power free of switching noise or transient spikes?
- Is the power circuit dedicated to the governor only?
- Are the control's supplies indicating that they are OK?
- Are the control's supplies outputting the correct voltage?

Chapter 5.
CPUs

5.1. TMR5200 CPU Module

5.1.1 Module Description

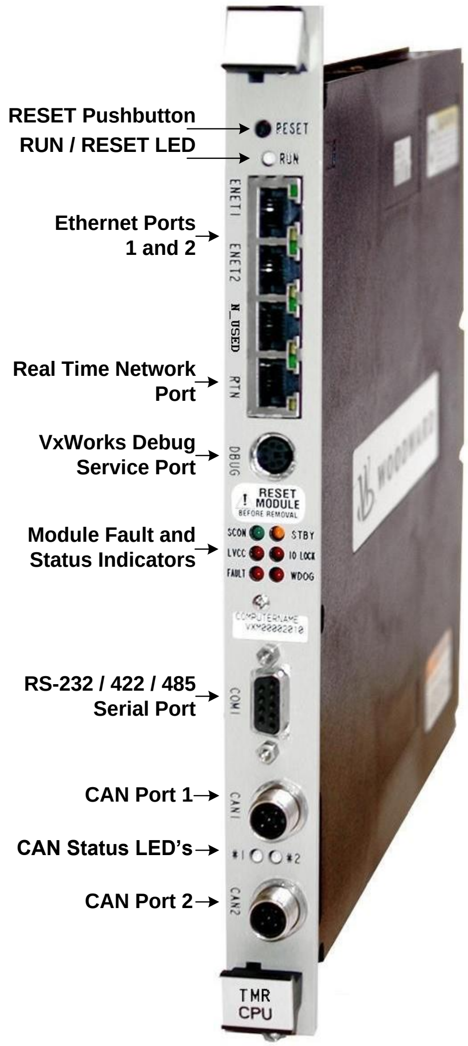


Figure 5-1. TMR5200 CPU Module

The MicroNet TMR5200 CPU module contains a MPC5200 processor, 128 Mbyte DDR RAM, 64 MB of flash memory, a Real Time clock, and various communication peripherals. These peripherals include (2) general use Ethernet ports, (1) Real Time Network port, (1) serial port, (1) one service port, and (2) CAN ports. This module includes an FPGA to provide VMEbus master/slave capability as well as other functions necessary for redundant systems.

The TMR5200 Module is designed for 3-2-0 operation. A TMR system cannot operate with a single CPU.

This module was designed and rated for –40 to +85 °C operation in the industrial marketplace.

For CPU module installation and replacement instructions, see the instructions for installing the VME module in Chapter 14, and the instructions for replacement in Chapter 15.

NOTICE

RESET MODULE BEFORE REMOVAL

Live insertion and removal of this module is allowed in a MicroNet TMR or Plus chassis. This module should be reset immediately before removing it from the chassis. This notifies the module that it will be removed and provides a graceful failover to another healthy CPU module if available.

The CPU module runs the GAP application program. Figure 5-2 is a block diagram of a CPU module. When the power is applied, the CPU module will perform diagnostic tests, before running the application program.

The CPU module contains a battery to power the real time clock when power to the control is off. This battery is not user-replaceable. The resolution of the real time clock is 10 milliseconds.

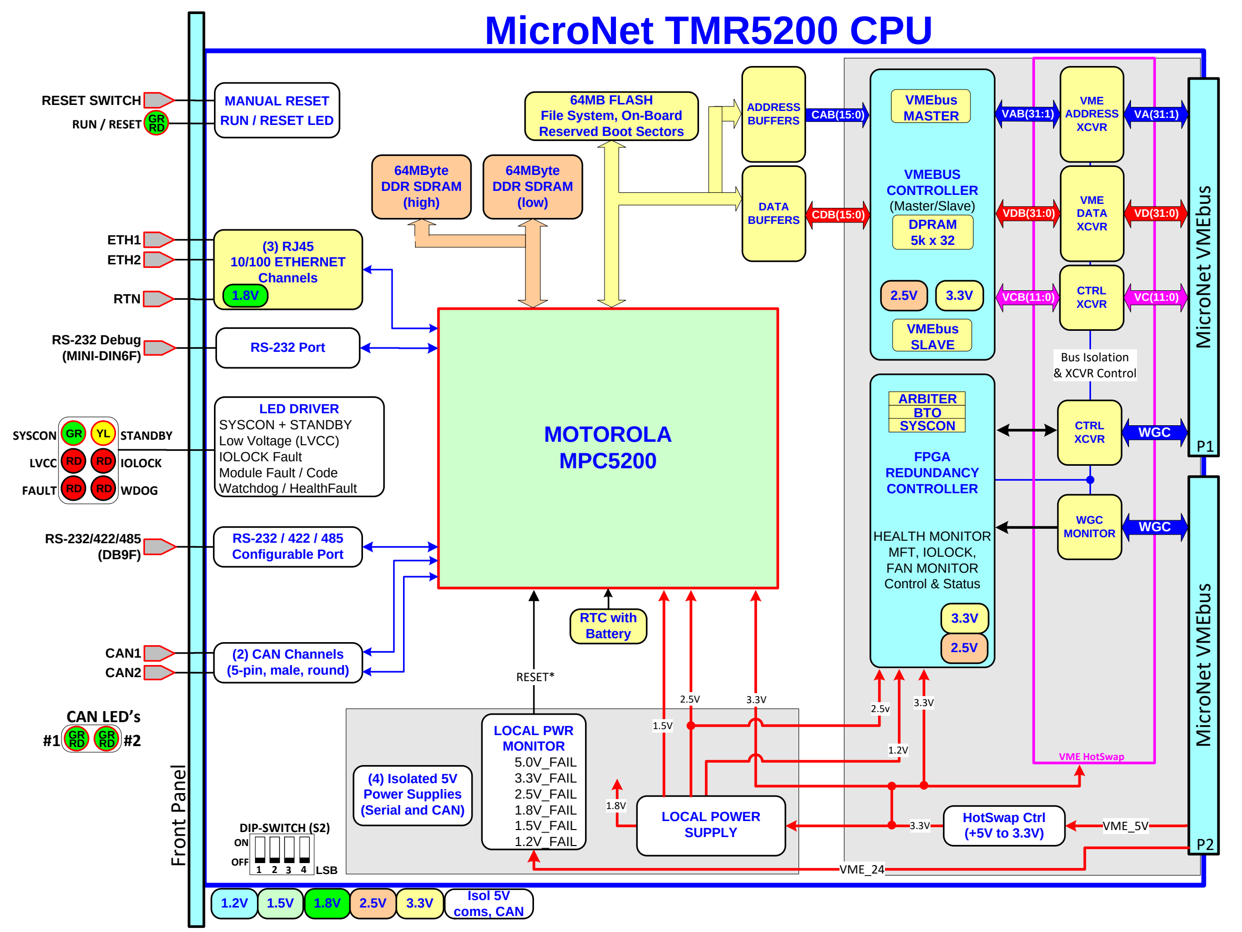
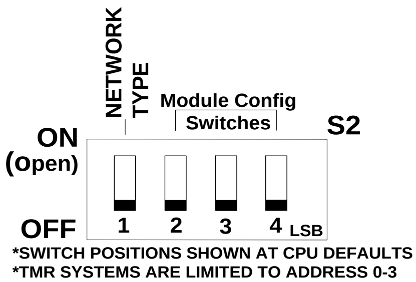


Figure 5-2. CPU Module Block Diagram

5.1.2 Module Configuration

Hardware Configuration. The Module Configuration Switch (S2) must be configured properly for CPU mode (main rack, address 0x000) operation. This module will be factory configured appropriately.



Network Type

Switch	Function
OFF	RTN Network 172.20.x.x
ON	RTN Network 10.250.x.x

Module Config

Addr	Switch	Function
0	000	CPU, MAIN CHASSIS
1	001	RTN, CHASSIS-X1
2	010	RTN, CHASSIS-X2
3	011	RTN, CHASSIS-X3
4	100	RTN, CHASSIS-X4
5	101	RTN, CHASSIS-X5
6	110	RTN, CHASSIS-X6
7	111	RTN, CHASSIS-X7

Figure 5-3. Module Configuration Switch (S2)

IMPORTANT — **It is recommended to verify proper switch settings before installing the module in the system and when troubleshooting CPU-related issues.**

IMPORTANT — **If the CPU module is incorrectly configured for RTN mode, Ethernet ports #1 and #2 are NOT active and AppManager will not be available.**

5.1.2.1 Network Type

The Network Type setting is factory set OFF to automatically configure the RTN communication port IP addresses to the 172.20.x.x series.

IMPORTANT — **It is recommended to verify proper switch settings before installing the module in the system and when troubleshooting CPU or RTN related issues.**

The Network Type setting on all CPU and Remote RTN modules in the system must match for proper system operation.

The customer network attached to Ethernet #1 or #2 may already use the RTN port addresses of 172.20.x.x. In this case, the Network Type switch should be configured ON to use the 10.250.x.x RTN port addresses.

5.1.2.2 Network Configuration

Ethernet ports (ENET1, ENET2) can be configured for the customer network as desired. The RTN ports (RTN1, RTN2) are reserved for communicating with Woodward Real Time Network devices such as expansion racks. See the on-site Network Administrator to define an appropriate I/P address configuration for ENET1 and ENET2.

IMPORTANT — **This module has been factory configured with fixed Ethernet IP addresses of**

- **Ethernet #1 (ENET1) = 172.16.100.1, Subnet Mask = 255.255.0.0**
- **Ethernet #2 (ENET2) = 192.168.128.20, Subnet Mask = 255.255.255.0**

5.1.2.3 Network Configuration Utility (AppManager)

Woodward's *AppManager* software can be used to load Control software (GAP), monitor diagnostic faults, and configure Network settings. The *AppManager* utility can be downloaded from **www.woodward.com/software**. A PC connection must be made to Ethernet #1 (ENET1) using a RJ45 Ethernet cable.

IMPORTANT	**AppManager can always be used to "discover/view" the current CPU IP Address. However, to modify settings or load applications, the PC running AppManager must be reconfigured to be on the same "network" as the CPU.**

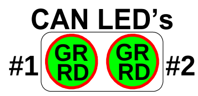
- Locate the ControlName on the module faceplate and highlight it in *AppManager*.
- To VIEW the IP address configuration, select menu option CONTROL - CONTROL INFORMATION. Look for the Ethernet adapter addresses under the Footprint Description.
- To CHANGE the IP address configuration, select menu option CONTROL - CHANGE NETWORK SETTINGS.

5.1.3 Front Panel Indicators (LEDs)

The MicroNet PowerPC TMR5200 module has the following front-panel LEDs.

Table 5-1. MicroNet PowerPC TMR5200 Front Panel LEDs

LED	Name	Description
GR/RD RUN	RUN	RUN / RESET (GREEN/RED)—Active RED when the user pushes the reset switch. Active GREEN upon release and after the CPU Operating system is loaded and running.
ETH G TX/RX	TX/RX	TX/RX (GREEN)—Active GREEN when data is transmitted or received.
ETH Y LINK	LINK	LINK ACTIVE (YELLOW)—A valid Ethernet connection to another device exists
SYSCON GR, YL STANDBY LVCC RD, RD IOLOCK FAULT RD, RD WDOG	SYSCON	System Controller (GREEN)—Active when this CPU module is the VMEbus System Controller.
	STANDBY	Standby Ready (YELLOW) - **NOT used for TMR systems.** Active when this CPU module is ready to release or take over the System Controller functions in a failover event.
	LVCC	Low VCC Power Fault (RED)—A CPU or VME power supply high or low tolerance fault has been detected. - Local CPU power faults could be 1.2 V, 1.5 V, 1.8 V, 2.5 V, or 3.3 V. - VME power faults could be VME_5V, VME_5VPC, or VME_24V
	IOLOCK	IOLOCK (RED)—This LED indicates that an I/O LOCK condition exists either locally on the CPU itself and/or on the VMEbus. **Note:** IOLOCK is a condition driven by the SYSCON where all I/O modules are placed into a failsafe condition and outputs are driven to a known state. For a main CPU rack, IOLOCK is activated within 18 ms of a detected fault condition. For an RTN expansion rack, IOLOCK may take up to 55 ms to be asserted.
	FAULT	CPU FAULT (RED)—Actively flashes CPU fault codes as necessary.
	WATCHDOG	CPU Watchdog / Health Faults (RED)—The processor watchdog or Health monitor has tripped and the CPU or Remote RTN module is prevented from running. The CPU Watchdog includes a 1 ms failover event and an 18 ms timeout event. Health faults include GAP fault, Watchdog events, and local SYSCLK and MFT hardware faults.

	CAN #1, #2	<u>CAN #1, #2 (GREEN/RED)</u>—Active GREEN or RED when data is transmitted or received through CAN port #1 or #2.

5.1.4 Module Reset

5.1.4.1 Front Panel Reset Switch

The CPU module has a pushbutton reset switch on the front panel to reset the module. If a GAP application was successfully running at the time of reset, the same application will be auto-started and re-initialized.

5.1.4.2 CPU Remote Reset

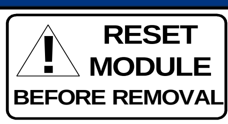
Each CPU module will respond to a +24 V remote reset signal. The chassis provides a terminal-block with inputs RST1+, RST1–, RST2+, RST2–, RST3+, and RST3– for wiring the remote reset signals to each CPU. Each reset signal is routed to an opto-isolated input on the appropriate CPU that requires a +24 V signal to cause a reset.

5.1.4.3 Reset Notes:

- Resetting a CPU or Remote RTN module creates a HealthFault that immediately sets the WDOG light RED.
- The front-panel RUN/RESET led will be RED while reset is held and will turn GREEN for a few seconds after releasing reset. After turning OFF, it will again turn GREEN when the operating system starts to boot.

Note: When a TMR System is running with only 2 healthy CPUs, Pressing the reset on either of the running CPUs will drive IOLOCK and IORESET on the entire TMR system. This will place the Control System and all expansion racks to a safe condition where all output signals are driven to a known failsafe condition.

NOTICE



This module should be reset immediately before removing it from the chassis. This notifies the module and system software that it will be removed.

5.1.5 10/100 BaseT Ethernet Ports

There are two 10/100 BaseT Ethernet Ports (RJ45) available to the application software. These ports are full duplex, auto switching, and do not require the use of an Ethernet FTM box.

IMPORTANT

ETHERNET CABLES—Max cable length is 30 meters. Double shielded, Cat 5 Ethernet cables (SSTP) are required for customer installations.

5.1.6 RTN Port

In a TMR5200 based system, each Kernel CPU provides Real Time Network (RTN) capability for expanding to other racks using Ethernet port 4 (RJ45). This RTN port communicates between the main chassis CPU's and any Remote RTN modules located in an expansion chassis. The GAP software application defines the expansion racks, their I/O modules, and the use of the RTN port (GAP block is RTN).

Up to two Remote RTN modules may be installed into each MicroNet Plus 8/14 expansion chassis (only one RTN for 6/12 slot expansion chassis). When initialized by the main chassis CPU, the Remote RTN modules will acquire either a SYSCON or STANDBY status. The Remote RTN module that becomes SYSCON will control the expansion chassis where it is located. It will synchronize with the STANDBY Remote RTN module and perform any redundancy functions as necessary. Input and output data from all I/O modules will be managed appropriately and made available to the GAP Application running in the main-chassis CPUs.

**Refer to the Communications section and the RTN Remote Transceiver module for additional information to configure expansion racks using either copper or fiber Ethernet cables.

IMPORTANT

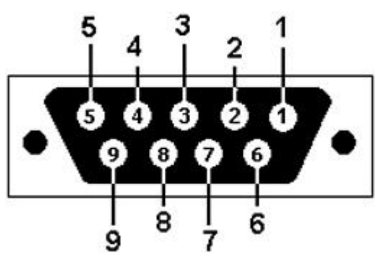
REMOTE RTN CABLES (COPPER)
- **Double shielded, Cat 5 Ethernet cables (SSTP) are required for customer installations.**
- **Cable length between the Main rack and RTN switch is 3 m (10 ft.) max.**
- **Cable length between the RTN switch and Expansion rack is 30 m (100 ft) max.**

5.1.7. RS-232/422/485 Serial Port

An isolated, configurable RS-232 / 422 / 485 serial port is located on the front of the CPU module and is configured by the GAP software application. The baud rate is selectable from 300 baud to 115.2 Kbaud. Shielded cable is required when connecting to the CPU module’s serial port. Using shielded cable will help ensure the robustness of the serial communications.

NOTICE

When using RTU serial protocols, only a single MicroNet slave is supported—no multi-drop.



Pin 1 – RS-422 Transmit (+)
Pin 2 – RS-232 Receive
Pin 3 – RS-232 Transmit
Pin 4 – RS-422 Transmit (-)
Pin 5 – Signal Ground
Pin 6 – Termination Resistor (+)
Pin 7 – RS-485/422 Receive (+)
Pin 8 – RS-485/422 Receive (-)
Pin 9 – Termination Resistor (-)

Figure 5-5. CPU Communications Port (DB9F)

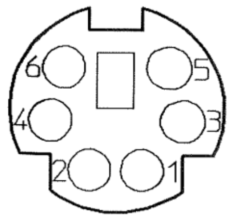
5.1.8 RS-232 Service Port

An isolated RS-232 service port is located on the front of the CPU module. This port is for VxWorks operating system use only and cannot be configured for application software use. The communication settings are fixed at 38.4 Kbaud, 8 data bits, no parity, 1 stop-bit, and no flow control.

For debug use, a null-modem cable and 5450–1065 Serial Adapter cable (PS2M to DB9F) is required to attach this port to a PC.

Note: This port is to be used by trained Field Service personnel only!

Shielded cable is required when connecting to the Service Port. Using shielded cable will help ensure the robustness of the serial communications.

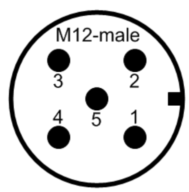


Pin 1 – RS-232 Receive
Pin 2 – RS-232 Transmit
Pin 3 – Signal Ground
Pin 4 – Not Used
Pin 5 – Signal Ground
Pin 6 – Not Used

Figure 5-6. CPU Service Port (mini-DIN6F)

5.1.9 CAN Communication Ports

Two CAN ports on each CPU for a total of six (M12 male connectors) are available for communication with Woodward Valves and other CAN devices. A maximum of 15 Woodward valves configured for operation in the 10 ms rate group may be used.



Pin 1 – CAN Shield (AC coupled)
Pin 2 – not used
Pin 3 – CAN Signal Ground (black)
Pin 4 – CAN High (white)
Pin 5 – CAN Low (blue)

Figure 5-7. CAN Communication Ports (M12 male)

CAN networks must include 120 Ω terminations at each end of the trunk line. Drop cables connecting a device to the trunk line should be as short as possible and less than 6 meters. It is recommended to design the network to be less than 100 meters with a max cumulative drop length of less than 39 meters.

Table 5-2. CAN Network Trunk Line Specifications

Network Speed	Max Trunk Length (Thick cable)	Max Trunk Length (Thin cable)	Max Drop Length	Max Cumulative Drop Length
1 Mbps	30 m	30 m	1 m	6m
500 Kbps	100 m	100 m	6 m	39 m
250 Kbps	250 m	100 m	6 m	78 m
125 Kbps	500 m	100 m	6 m	156 m

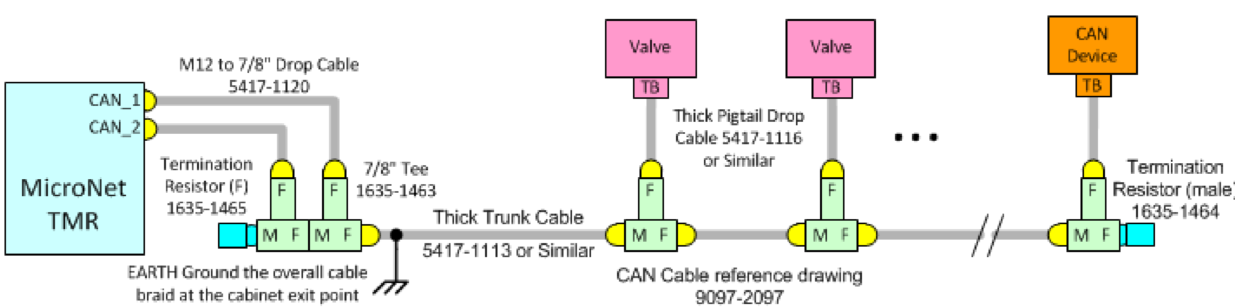
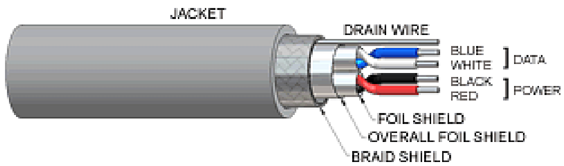


Figure 5-8. MicroNet to Valve CAN Interface

5.1.10 CAN Cable Specification

Thick cable is preferred and recommended for all uses. Most CAN / DeviceNet (trademark of ODVA, Inc.) cable is not rated for temperatures above 80 °C so be careful during installation to avoid hot routing areas. Always use shielded cables for improved communications in industrial environments.

Table 5-3. CAN Cable Specification



Impedance:	120 Ω ±10% at 1 MHz
DC resistance:	< 7 Ω per 1000 ft.
Cable capacitance:	12 pF/ft. at 1 kHz
Propagation delay	1.36 ns/ft. (maximum)
Data Pair:	19 strands, 1.0 mm^2 corresponds to 18 AWG, individually tinned, 3 twists/foot
Power Pair:	19 strands, 1.5 mm^2 corresponds to 15 AWG, individually tinned, 3 twists/foot
Drain / Shield Wire:	19 strands Tinned Copper shielding braid or shielding braid and foil
Cable type:	twisted pair cable. 2x2 lines
Bend Radius:	20x diameter during installation or 7x diameter fixed position
Signal attenuation:	0.13 dB/100 ft. @ 125 kHz (maximum) 0.25 dB/100 ft. @ 500 kHz (maximum) 0.40 dB/100 ft. @ 1000 kHz (maximum)

Recommended Bulk Cable

Cable manufacturer Turck and Belden are widely available in North America. Turck, Lumberg, and Lapp Cable products are available in Europe. All cables below are suitable for DeviceNet trunk and drop cabling. Be aware that cable vendors may not use the same wire colors on individual conductors.

Note: Turck and Lumberg can also provide custom length cord sets with connectors.

Table 5-4. Recommended Bulk Cable

Manufacturer	Part Number	Website
Belden	3082A DeviceNet Thick Cable–Grey	www.belden.com
Belden	3083A DeviceNet Thick Cable–Yellow	www.belden.com
Lapp Cable	2710-250 Unitronic DeviceNet Thick	www.lappcable.com
Lumberg	STL 613	www.lumbergusa.com
Turck	Type 575, DeviceNet Thick Cable – Grey	www.turck.com

5.1.11 Troubleshooting and Tuning

The MicroNet CPU module runs off-line and on-line diagnostics that display troubleshooting messages through the debug Service Port and AppManager. Off-line diagnostics run automatically on power-up and when the Reset switch is asserted. On-line diagnostics run during normal Control System operation when the GAP application is active. More information on diagnostics tests, subsequent LED flash codes, and serial port messages is contained in the VxWorks manual.

Table 5-5. MicroNet CPU Fault LED Flash Codes

Failure	Flash Code
RAM Test Failure	1, 4
Real Time Clock Test Failure	2, 2
Floating Point Unit Test Failure	2, 3
Flash Test Failure	2, 4
HD1 Flash Test Failure	2, 5
I2C Bus Test Failure	2, 6
Module Installed in wrong slot	2, 7
Main Chassis CPU switch must be set to 0	3,5
Remote RTN Rate Group 5 Slip	3, 7
Remote RTN Rate Group 10 Slip	3, 8
Remote RTN Rate Group 20 Slip	3, 9
Remote RTN Rate Group 40 Slip	3, 10
Remote RTN Rate Group 80 Slip	3, 11
Remote RTN Rate Group 160 Slip	3, 12
Remote RTN Chassis Switch Invalid	4, 5
Backup Remote RTN Chassis Switch different from Primary Remote RTN	4, 6
This module does not support the CAN port(s)	4, 7
This module needs a “footprint” update	4, 9

Table 5-6. MicroNet AppManager Message ID values

Description of ID	ID Number
Created by the Coder (Evaluate specific Application)	1-99
“sysinit” – Problem in system initialization	184,185,186
VerifyCpuMem -- Problem in verify CPU memory	103
VerifyNVLog -- Problem in verify NV_LOG functions	104,143,145
ExecuteTMRMessageTask -- Freerun task error	101,102
TMRDportDiagnostics -- Problem running DualPort test	105,106,112,113,114
WaitRTNBuffer -- Problem waiting for the RTN messages	146,147
ioRead -- Problem in the ioRead function	142,183
Run_ll_int -- Problem in the Ladder Logic executive	180
SynCmdBuffer – Problem sending messages to RTN chassis	181
CheckSyncCmdBuffer - Problem sending message to RTN	182
Clk_xvstat -- TMR CPU missing in interrupt service routine	604,605
PresInt -- TMR CPU unable to reach previous target	660
CopyToPickup – Problem syncing lost CPU	130,131,132
Re-sync -- Problem syncing lost CPU	133,134,135,136,137,138
Re-sync -- Lost CPU failed to sync properly	139
TMR_CAN - - Problem with CAN vote-·for count value	200
TMR_CAN - - Problem with CAN vote- ·for FIFO Data	201

Chapter 6. Communication

6.1. Remote RTN Module

6.1.1 Module Description

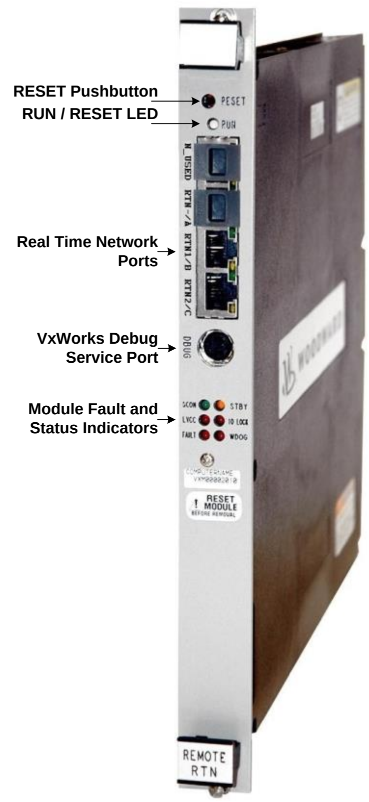


Figure 6-1. Remote RTN Module

The MicroNet Remote Real Time Network (RTN) module is designed to be located in an expansion rack. The module's primary function is to gather data from local I/O modules and communicate this data to the main rack CPUs while providing redundant failover control of the rack in which it is located.

The Remote RTN module contains a MPC5200 processor, 128 Mbyte DDR RAM, 64 MB of flash memory, a Real Time clock, and various communication peripherals. These peripherals include (3) Real Time Network ports and (1) service port. This module includes an FPGA to provide VMEbus master/slave capability, health monitoring, and failover functions necessary for redundant systems.

This module was designed and rated for –40 to +85 °C operation in the industrial marketplace. Figure 6-2 is a block diagram of a Remote RTN module.

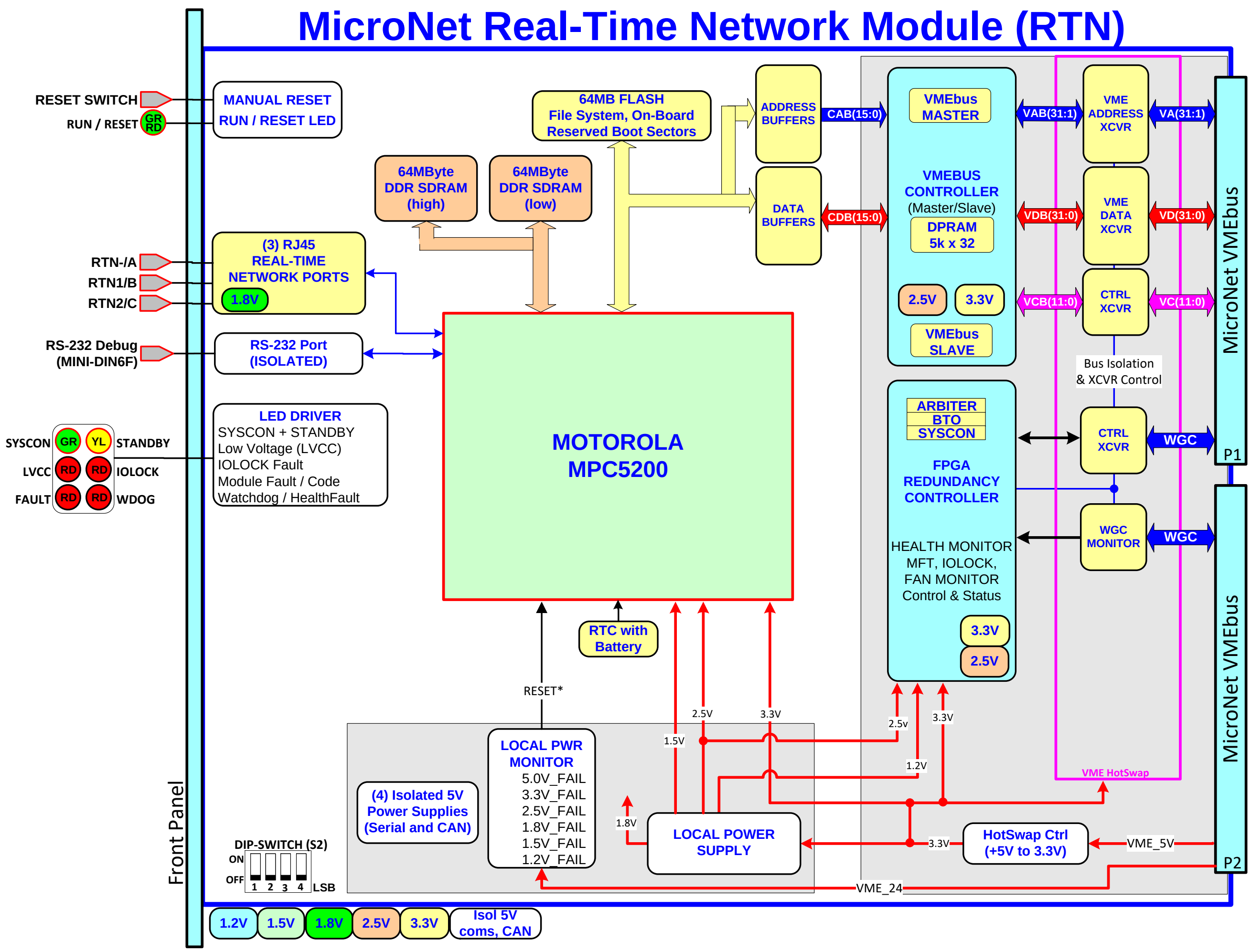


Figure 6-2. Remote RTN Module Block Diagram

Remote RTN modules can support simplex, redundant, and TMR systems. Every RTN expansion chassis contains one Remote RTN module located in the first slot (CPU1) of the chassis. A redundant configuration using a Plus chassis may also have a Remote RTN module located in the CPU2 location (slot 8 or slot 14 depending on the chassis used).

For Remote RTN module installation and replacement instructions, see the instructions for installing the VME module in Chapter 14, and for replacement in Chapter 15. This module will NOT automatically re-initialize to a running state after reset. This module is can only be initialized by the main-chassis CPU when the application starts and upon any application request.

NOTICE **RESET MODULE BEFORE REMOVAL**	**Live insertion and removal of this module is allowed in a MicroNet Plus chassis. This module should be reset immediately before removing it from the chassis. This notifies the module that it will be removed and provides a graceful failover to another healthy Remote RTN module if available.**

6.1.2 Module Operation

For redundant systems, up to two Remote RTN modules may be installed into each MicroNet Plus 8/14 slot expansion chassis (only one RTN can be installed in the MicroNet 6/12 slot chassis). When initialized by the main chassis CPU, the Remote RTN modules will acquire either a SYSCON or STANDBY status. The Remote RTN module that becomes SYSCON will control the expansion chassis it is located in. It will synchronize with the STANDBY Remote RTN module and perform any redundancy functions as necessary. Input and output data from all I/O modules will be managed appropriately and made available to the GAP Application running in the main-chassis CPUs.

The Remote RTN module communicates with the I/O modules in the expansion chassis and also the CPU modules in the main chassis. When the power is applied, the Remote RTN module will perform diagnostic tests before beginning communications.

6.1.3 RTN Expansion Chassis Configurations

The MicroNet TMR5200 can expand from a single main rack to a maximum 4-rack system by using Remote RTN modules and copper or fiber optic Ethernet switches. A maximum of 3 MicroNet Plus expansion racks (14 slot or 8 slot versions) or MicroNet Simplex racks (6 or 12 slot versions) are supported. If desired, fiber optic Ethernet switches can be used to locate each chassis in a different location. It is required to use Woodward approved Ethernet hardware for robust operation.

Example 4-rack systems using copper and fiber Ethernet cables.

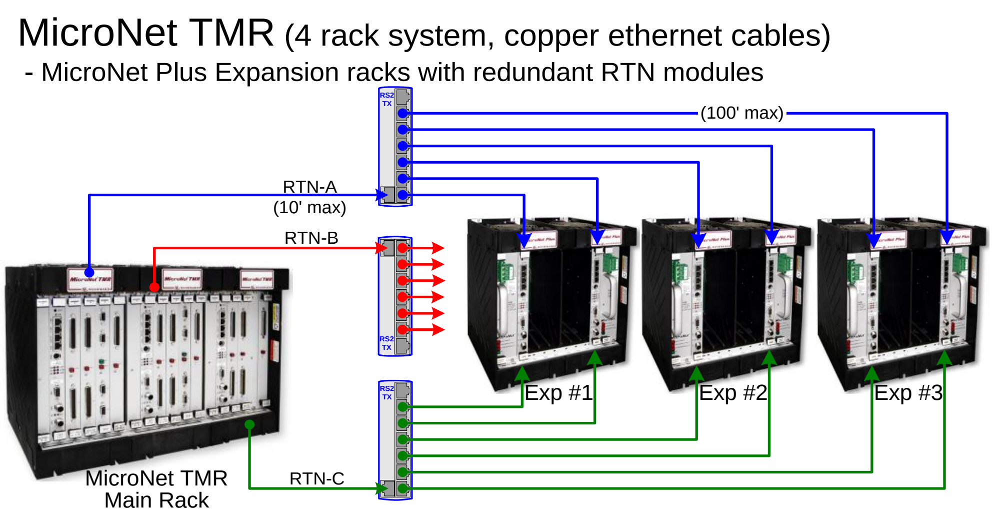


Figure 6-3. MicroNet TMR5200 System (copper, 3-rack)

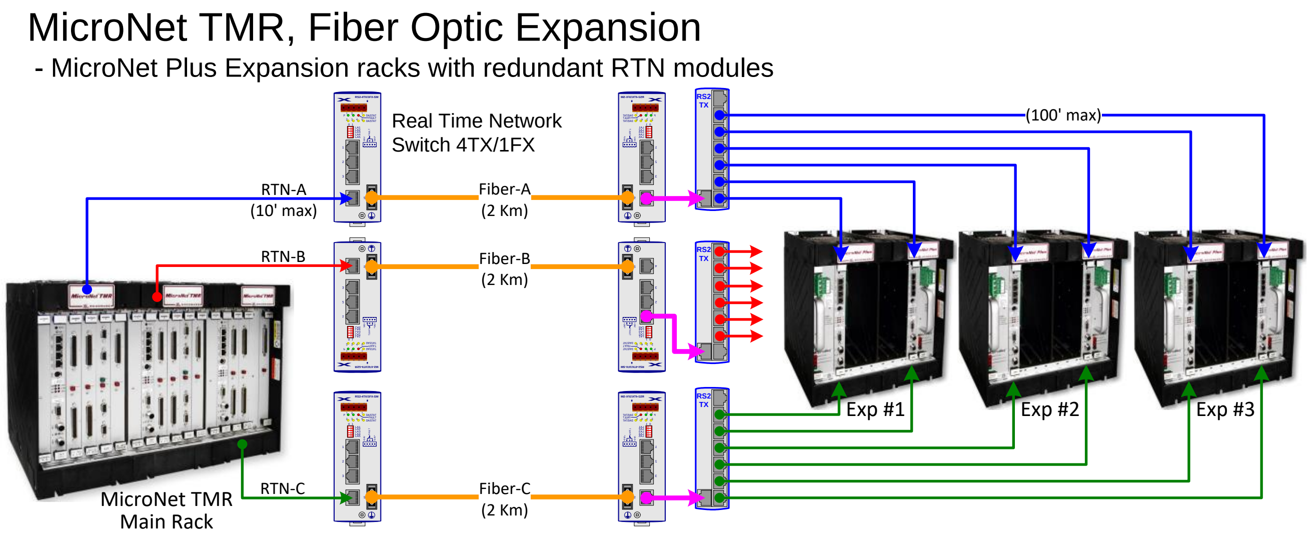


Figure 6-4. MicroNet TMR5200 System (fiber, 2 locations)

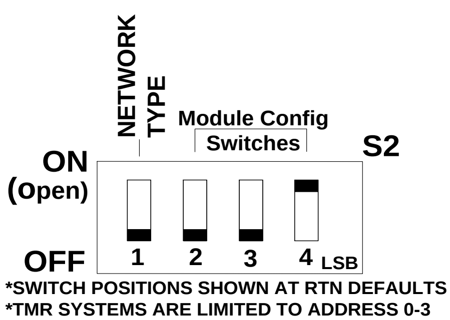
6.1.4 Module Configuration

6.1.4.1 Network Configuration

No network configuration is required. Only the RTN ports are active on this module. Ethernet port (ENET1) is disabled on the Remote RTN module by the Module Configuration switch (S2) and no IP address configuration is necessary.

6.1.4.2 Hardware Configuration

The Module Configuration Dip-Switch (S2) must be configured properly for RTN mode with the expansion chassis address set appropriately as X1-X7 for Plus systems or X1-X3 for TMR systems.



Network Type

Switch	Function
OFF	RTN Network 172.20.x.x
ON	RTN Network 10.250.x.x

Module Config

Addr	Switch	Function
0	000	CPU, MAIN CHASSIS
1	001	RTN, CHASSIS-X1
2	010	RTN, CHASSIS-X2
3	011	RTN, CHASSIS-X3
4	100	RTN, CHASSIS-X4
5	101	RTN, CHASSIS-X5
6	110	RTN, CHASSIS-X6
7	111	RTN, CHASSIS-X7

Figure 6-5. MicroNet TMR5200 Module Configuration Dip-Switch (S2)

- **RTN Mode.** The Module Config Switch (S2) is factory configured for RTN mode, expansion rack X1 operation (address **0x001)**. It may need to be
re-configured for expansion rack X1-X3 in TMR systems. **Note:** RTN mode will disable Ethernet port #1.

- **Network Type.** The Network Type setting is factory set OFF to automatically configure the RTN communication port IP addresses to the 172.20.x.x series.

IMPORTANT

It is recommended to verify proper switch settings before installing the module in the system and when troubleshooting RTN related issues.

The Network Type setting on all CPU and Remote RTN modules in the system must match for proper system operation.

The customer network attached to Ethernet #1 or #2 at the main chassis CPUs may already use the RTN port addresses of 172.20.x.x. In this case, the Network Type switch should be configured ON to use the alternate 10.250.x.x RTN port addresses.

IMPORTANT

If the Remote RTN module is incorrectly configured for CPU mode, Ethernet ports #1 and #2 are active and have been factory-set to fixed Ethernet IP addresses of:

- **Ethernet #1 (ENET1) = 172.16.100.1, Subnet Mask = 255.255.0.0**
- **Ethernet #2 (ENET2) = 192.168.128.20, Subnet Mask = 255.255.255.0**

6.1.5 Front Panel Indicators (LEDs)

The Real Time Network (RTN) module has the following front-panel LED's.

Table 6-1. MicroNet RTN Module Configuration Front Panel Indicators (LEDs)

LED	Name	Description
GR/RD RUN	RUN	RUN / RESET (GREEN/RED)—Active RED when the user pushes the reset switch. Active GREEN upon release and after the CPU Operating system is loaded and running.
ETH G TX/RX	TX/RX	TX/RX (GREEN)—Active GREEN when data is transmitted or received
ETH Y LINK	LINK	LINK ACTIVE (YELLOW)—A valid Ethernet connection to another device exists
SYSCON GR, YL STANDBY; LVCC RD, RD IOLOCK; FAULT RD, RD WDOG	SYSCON	System Controller (GREEN)—Active when the Remote RTN module is the VMEbus System Controller.
	STANDBY	Standby Ready (YELLOW)—Active when the STANDBY mode of this CPU or Remote RTN module is ready to release or take over the System Controller functions in a failover event.
	LVCC	Low VCC Power Fault (RED)—An RTN or VME power supply high or low tolerance fault has been detected. - Local CPU power faults could be 1.2 V, 1.5 V, 1.8 V, 2.5 V, or 3.3 V. - VME power faults could be VME_5V, VME_5VPC, or VME_24V.
	IOLOCK	IOLOCK (RED)—This LED indicates that an I/O LOCK condition exists either locally on the CPU itself and/or on the VMEbus. **Note:** IOLOCK is a condition driven by the SYSCON where all I/O modules are placed into a failsafe condition and outputs are driven to a known state. For an RTN expansion rack, IOLOCK is activated within 55 ms of a detected fault condition.
	FAULT	CPU FAULT (RED)—Actively flashes CPU fault codes as necessary.
	WATCHDOG	CPU Watchdog / Health Faults (RED)—The processor watchdog or Health monitor has tripped and the CPU or Remote RTN module is prevented from running. The CPU Watchdog includes a 1 ms failover event and an 18 ms timeout event. Health faults include GAP fault, Watchdog events, and local SYSCLK and MFT hardware faults.

6.1.6 Module Reset

6.1.6.1 Front Panel Reset Switch.

The Remote RTN module incorporates a pushbutton reset switch on the front panel to reset the module. This module will NOT automatically re-initialize to a running state after reset. The main-chassis CPU application can re-init this module upon request.

6.1.6.2 RTN1 and RTN2 Remote Reset

Each Remote RTN module will respond to a +24 V remote reset signal. The chassis provides a terminal-block with inputs RST1+, RST1-, RST2+, and RST2- for wiring the remote reset signals to each RTN. Each reset signal is routed to an opto-isolated input on the appropriate RTN that requires a +24 V signal to cause a reset.

6.1.6.3 Reset Notes:

- Resetting a Remote RTN module creates a HealthFault that immediately sets the WDOG light RED.
- <u>Any Expansion chassis running with one healthy RTN.</u> Reset detection will also drive IOLOCK and IORESET to place the expansion rack and all output signals into a known failsafe condition.
- <u>Any Expansion chassis running with two healthy RTNs.</u> Reset detection on the SYSCON (System Controller) causes an immediate "Failover" to the other STANDBY RTN who then becomes the new System Controller for this chassis. Reset detection on the STANDBY unit causes a HealthFault that removes it from STANDBY mode.
- The front-panel RUN/RESET led will be RED while reset is held and will turn GREEN for a few seconds after releasing reset. After turning OFF, it will again turn GREEN when the operating system starts to boot.

NOTICE

RESET MODULE BEFORE REMOVAL

This module should be reset immediately before removing it from the chassis. This notifies the module that it will be removed and provides a graceful failover to another healthy Remote RTN module if available.

6.1.7 RTN Ports

Three Real Time Network ports (RJ45) provide communications between the expansion chassis Remote RTN module and the main-chassis CPU A, B, and C modules. Through these ports, expansion chassis I/O data is made available to the GAP Application running in the main-chassis CPUs.

IMPORTANT

REMOTE RTN CABLES (COPPER)

- **Double shielded, Cat 5 Ethernet cables (SSTP) are required for customer installations.**
- **Cable length between the Main rack and RTN switch is 3 m (10 ft) max.**
- **Cable length between the RTN switch and Expansion rack is 30 m (100 ft) max.**

6.1.8 Ethernet Switch Hardware

For systems with more than a single RTN module, copper or fiber optic Ethernet switches are required to achieve communication and hardware redundancy. Specific Ethernet switches have been tested and approved to obtain expansion chassis real time performance and redundancy.

Due to the critical nature of communications with an RTN expansion rack, it is required to use Woodward approved copper and fiber Ethernet switches for robust system operation. At the time of this writing, the following hardware part numbers are approved.

Notes:

- The Real Time Network (RTN) is a dedicated Woodward I/O expansion network-- no external Ethernet devices are allowed.
- Each RTN Switch on the dedicated RTN network must be the same Make and Series. No mixing and matching the on the RTN network is allowed.
- 1752-423, Hirschmann copper Ethernet switch (RS2-TX, 8 port) **Obsolete Dec 2016**
- 1711-1069, Hirschmann Fiber Optic Switch (RS2-4TX/1FX) **Obsolete Dec 2016**
- 1751-6077, Hirschmann Fiber Optic Switch (RS2-3TX/2FX) **Obsolete Dec 2016**
- 1711-1350, Phoenix copper Ethernet switch (FL SWITCH SFNT 8TX)
- 1711-1351, Phoenix Fiber Optic Switch (FL SWITCH SFNT 7TX/FX) **Obsolete Aug 2022**
- 1711-1349, Hirschmann Fiber Optic Switch (Spider III Premium 7TX/2FX) **Obsolete Sept 2023**
- 1711-1410, Phoenix Fiber Optic Single Mode Switch (FL SWITCH 2206-7TX/2FX SM) **Available Apr 2021**
- 1711-1424, Red Lion Fiber Optic Switch (SLX 4TX/2FX) **Available Jun 2024**

6.1.9. Expansion Racks using Copper or Fiber cables

MicroNet TMR5200 multiple-rack systems are supported by locating expansion racks locally with the main chassis or in different remote locations using fiber optic cables and Ethernet switches. A maximum of 3 MicroNet Plus expansion racks (14 slot or 8 slot versions) or MicroNet Simplex expansion racks (6 or 12 slot versions) are supported in up to 3 different remote locations using fiber optic Ethernet switches. It is required to use Woodward approved hardware for robust operation.

Configuration Notes
A combination of approved copper and fiber optic Ethernet switches are allowed.
A maximum of 4 switches and 2 km of fiber cable shall be allowed in any communication path.
RTN cables from the main CPU rack to the local RTN switch hardware shall be 3 m (10') max.

Copper Expansion
Using copper Ethernet cables and switches, each expansion rack may be located up to 30 meters away from the main CPU chassis.

Fiber Optic Expansion
Using fiber optic cables and switches, each expansion rack may be located up to 2 km away from the main CPU chassis.

Fiber Optic Cable Specification

- 62.5 / 125 µm multi-mode, duplex fiber
- Standard SC Type connectors
- Wavelength : 850 nm, 1300 nm
- Attenuation @ 1300 nm : < 1.5 db/km
- Bandwidth @ 1300 nm : > 500 MHz – km
- Flammability type OFNR (riser, UL-1666)
- Minimum bend radius of 7 cm
- Refer to Woodward reference dwg 9097-2077

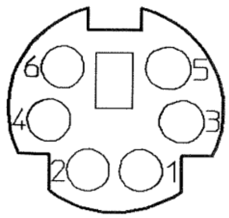
Figure 6-7. MicroNet RTN Module Fiber Optic Cable Specification

6.1.10 RS-232 Service Port

An isolated RS-232 service port is located on the front of the Remote RTN module. This port is for VxWorks operating system use only and cannot be configured for application software use. The communication settings are fixed at 38.4 Kbaud, 8 data bits, no parity, 1 stop-bit, and no flow control.

For debug use, a null-modem cable and 5450–1065 Serial Adapter cable (PS2M to DB9F) is required to attach this port to a PC. ***Trained Field Service personnel use this port only!***

Shielded cable is required when connecting to the Remote RTN module's serial port. Using shielded cable will help ensure the robustness of the serial communications.



Pin 1 – RS-232 Receive
Pin 2 – RS-232 Transmit
Pin 3 – Signal Ground
Pin 4 – Not Used
Pin 5 – Signal Ground
Pin 6 – Not Used

Figure 6-8. RTN Service Port (mini-DIN6F)

6.1.11 Troubleshooting / Flash Codes

The MicroNet Remote RTN module runs off-line and on-line diagnostics that display troubleshooting messages through the debug Service Port and AppManager. Off-line diagnostics run automatically on power-up and when the Reset switch is asserted. On-line diagnostics run during normal Control System operation when the GAP application is active. More information on diagnostics tests, subsequent LED flash codes, and serial port messages is contained in the VxWorks manual.

Table 6-2. RTN fault LED flash codes

Failure	**Flash Code**
RAM Test Failure	1, 4
Real Time Clock Test Failure	2, 2
Floating Point Unit Test Failure	2, 3
Flash Test Failure	2, 4
HD1 Flash Test Failure	2, 5
I2C Bus Test Failure	2, 6
Module Installed in wrong slot	2, 7
Main Chassis CPU switch must be set to 0	3,5
Remote RTN Rate Group 5 Slip	3, 7
Remote RTN Rate Group 10 Slip	3, 8
Remote RTN Rate Group 20 Slip	3, 9
Remote RTN Rate Group 40 Slip	3, 10
Remote RTN Rate Group 80 Slip	3, 11
Remote RTN Rate Group 160 Slip	3, 12
Remote RTN Chassis Switch Invalid	4, 5
Backup Remote RTN Chassis Switch different from Primary Remote RTN	4, 6
This module does not support the CAN port(s)	4, 7
This module needs a “footprint” update	4, 9

6.2. Main Transceiver (XCVR) Module

Information regarding the Ethernet Module is located In Volume 3, Chapter 3.

6.3. Remote Transceiver (XCVR) Module

Information regarding the Ethernet Module is located in Volume 3, Chapter 3.

6.4. Transceiver Accessories

Information regarding the Ethernet Module is located in Volume 3, Chapter 3.

6.5. Ethernet Module

Information regarding the Ethernet Module is located In Volume 3, Chapter 3.

6.6. SIO Module

6.6.1. Module Description

Figure 6-9. SIO Module

The SIO (Serial In/Out) Module interfaces four serial communication ports to the VME bus.

Figure 6-17 is a block diagram of the SIO module. The module manages four serial ports. Port A(J1) and port B(J2) are RS-232 ports. Port C(J3) and Port D(J4) are for RS-232, RS-422, or RS-485 communication protocols. Ports C and D must be at the same baud rate when using 38.4 Kbaud or 57.6 Kbaud.

The processor on this module is a 68030. It controls the transfer of data between the ports and the VME bus.

This module can have as much as 4 KB of Dual-Port RAM and 64 KB of PROM. The local memory supports the 68030 processor on this module.

The SIO module has one LED (FAULT) and no switches.

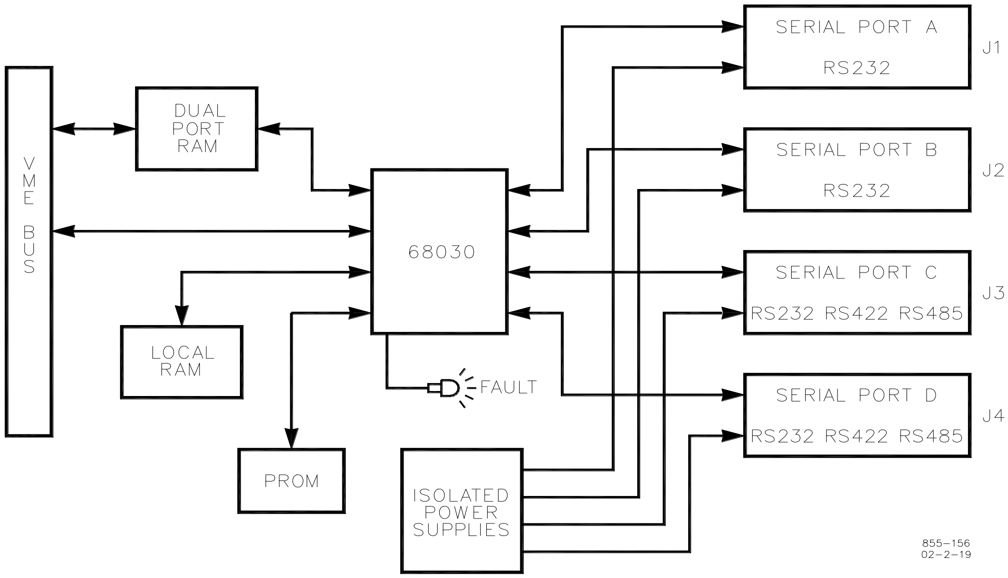


Figure 6-10. SIO Module Block Diagram

Table 6-3. Module Specification

Ports 1 and 2:	RS-232 @ 110–38.4 Kbaud
Ports 3 and 4:	RS-232, RS-422, and RS-485 (software selectable) @ 110–57.6 Kbaud
Software Support:	Modbus RTU
	Modbus ASCII
	Woodward-specific service interface

6.6.3 Installation

6.6.3.1 Termination

For RS-422, termination should be located at the receiver when one or more transmitters are connected to a single receiver. When a single transmitter is connected to one or more receivers, termination should be at the receiver farthest from the transmitter. Figure 6-18 is an example.

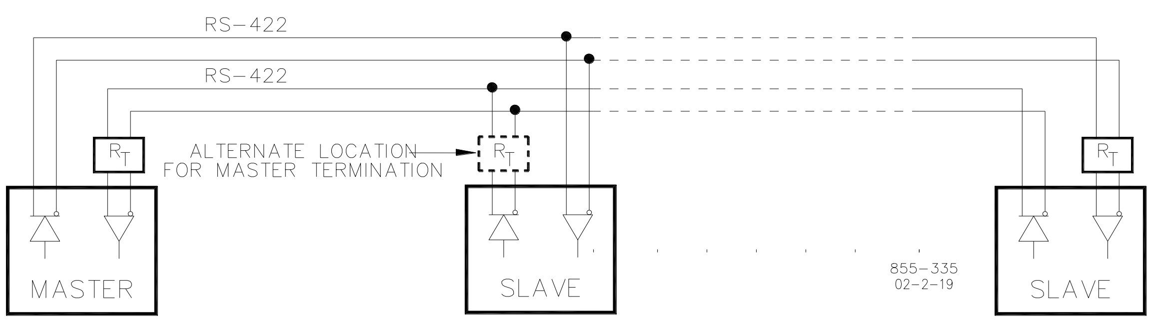


Figure 6-11. RS-422 Terminator Locations

For RS-485, termination should be at each end of the cable. If termination cannot be located at the end of a cable, put it as close as possible to the ends. Figure 6-22 is an example.

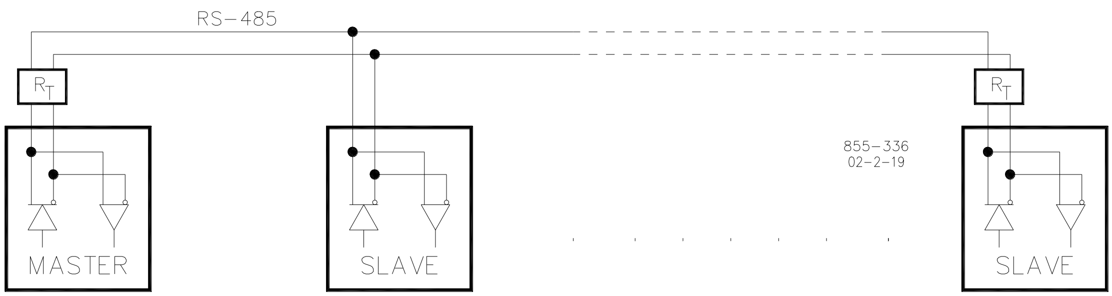


Figure 6-12. RS-485 Terminator Locations

Termination is accomplished using a three-resistor voltage divider between a positive voltage and ground. The impedance of the resistor network should be equal to the characteristic impedance of the cable. This is usually about 100 to 120 Ω. The purpose is to maintain a voltage level between the two differential lines so that the receiver will be in a stable condition. The differential voltage can range between 0.2 and 6 V; the maximum voltage between either receiver input and circuit ground must be less than 10 V. There is one termination resistor network for each port located on the SIO board. Connection to this resistor network is made through the 9-pin connectors on pins 6 and 9. See Figure 6-20 for termination and cable connection examples.

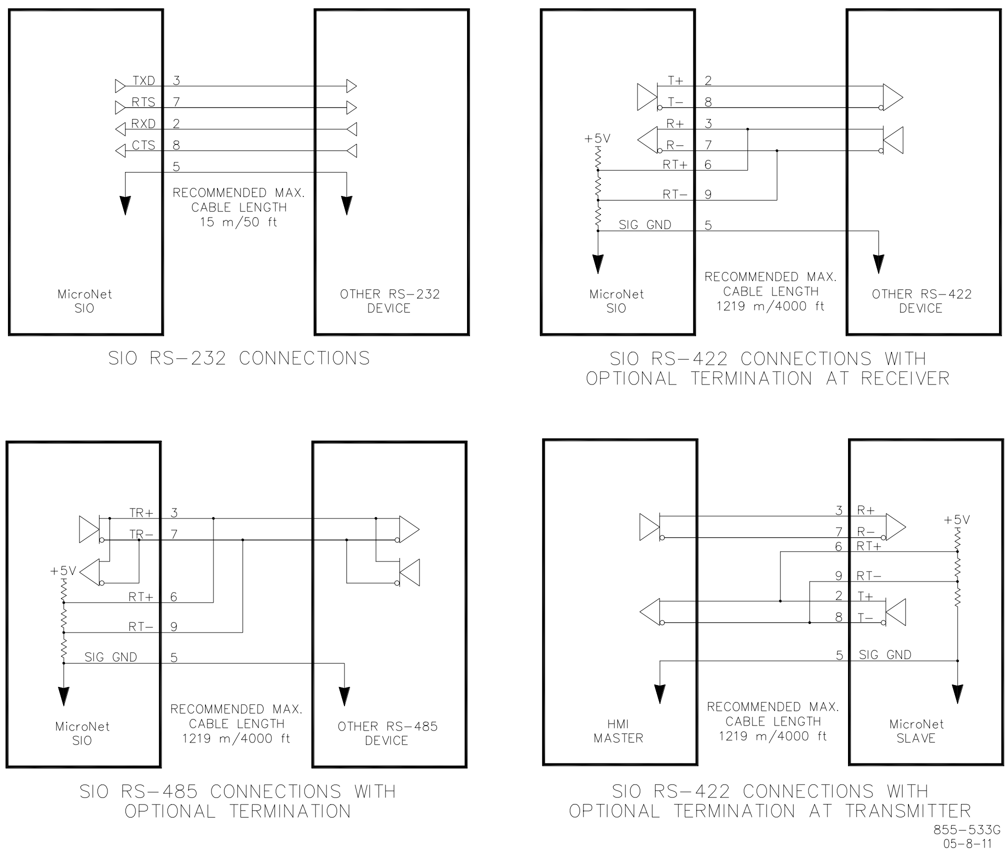


Figure 6-13. Termination and Cable Connection Examples

6.6.3.2 Grounding and Shielding

The RS-422 and RS-485 specifications state that a ground wire is needed if there is no other ground path between units. The preferred method to do this is to include a separate wire in the cable that connects the circuit grounds together. Connect the shield to earth ground at one point only. The alternate way is to connect all circuit grounds to the shield, and then connect the shield to earth ground at one point only. If the latter method is used, and there are non-isolated nodes on the party line, connect the shield to ground at a non-isolated node, not an isolated node. Figures 6-25 and 6-26 illustrate these cabling approaches.

IMPORTANT	**Non-isolated nodes may not have a signal ground available. If a signal ground is not available, use the alternate wiring scheme in Figure 6-21 with the signal ground connection removed on those nodes only.**

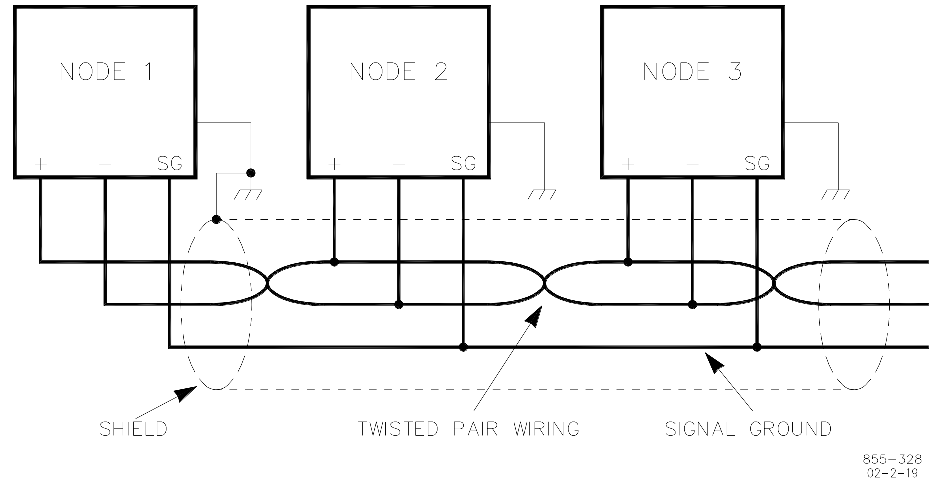


Figure 6-14. Preferred Multipoint Wiring Using Shielded Twisted-Pair Cable with a Separate Signal Ground Wire

IMPORTANT	**The SG (signal ground) connection is not required if signal ground is unavailable.**

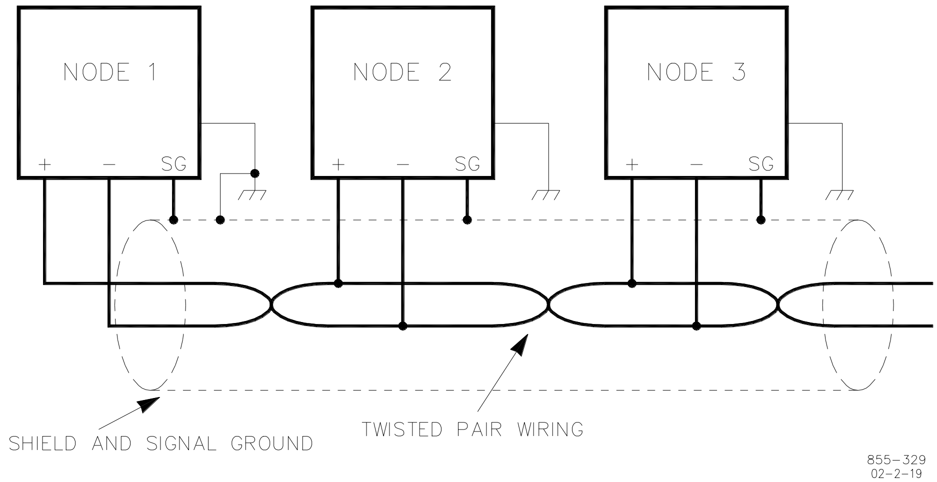


Figure 6-15. Alternate Multipoint Wiring Using Shielded Twisted-Pair Cable without a Separate Signal Ground Wire

6.6.4 Troubleshooting

1. If the SIO module is not functioning or not functioning properly, verify the cable connections.
2. If the module is still not functioning properly after verifying the cable connections, replace the cables connecting to module.
3. If the module is still not functioning properly after replacing cables, replace the module.

Chapter 7. Discrete I/O Modules

7.1. Introduction

There are seven types of discrete I/O modules currently available with the MicroNet system. These include the MicroNet TMR Discrete I/O Smart-Plus module (24 discrete inputs, 12 discrete outputs), 24/12 TMR Discrete Combo module (24 discrete inputs, 12 discrete outputs); MicroNet Discrete I/O Smart-Plus module (48 discrete inputs, 24 discrete outputs), 48/24 Discrete Combo module (48 discrete inputs, 24 discrete outputs), 48 Ch. DI module, 32 Ch. DO module, and the 64 Ch. DO module.

Discrete I/O field wiring requirement are detailed in Chapters 12 & 14.

Unshielded field I/O cables may only be used inside the cabinet or for cabling that is restricted to very short distances near the cabinet. Also short, on engine, sections of Discrete Input (DI) & Output (DO) wires/cabling may be used from the engine junction box were they are restricted to be on the engine/turbine. In addition, coil or wetting voltage commons, as applicable, must be routed with the field I/O wire bundles inside the shielding. Shielding may be electrically continuous metal conduit, cable armor, or completely enclosed metal cableways, as well as shielded cable, as long as the items listed, are grounded only to the cabinet housing the MicroNet system and are electrically continuous between the field termination and cabinet.

Routing coil & wetting voltage common wires with signal wires & shielding of DI/DO field wires are required due to the possibility of large transients from load dump of high current inductive loads and indirect lightning strike currents flowing in Protective Earth (PE) ground. If wires are routed separately from commons and are not shielded, transients that are large enough will be coupled into the input or output wiring and cause state changes to the signals for a short time.

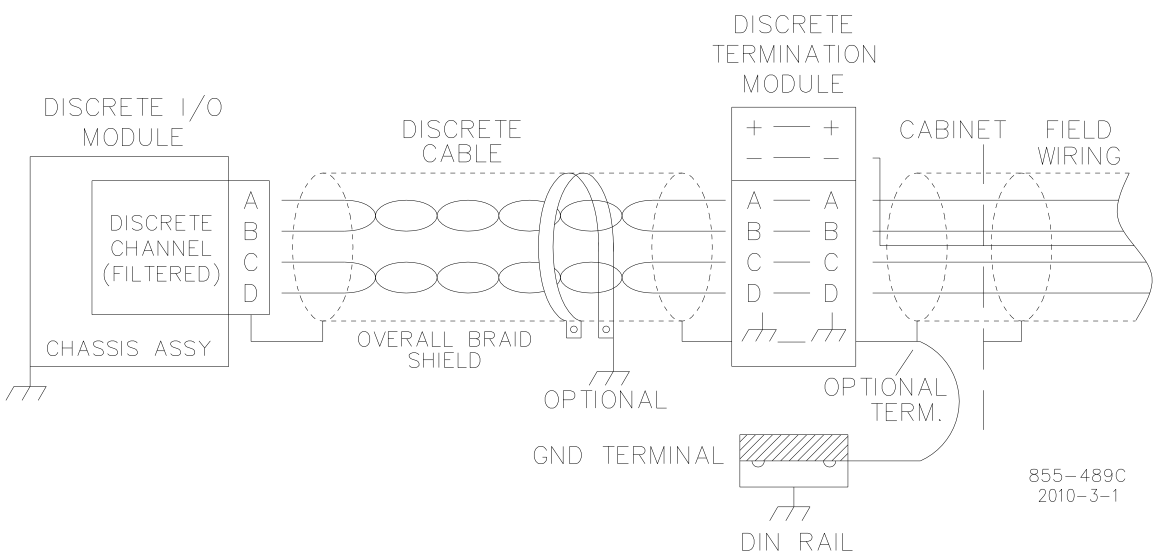


Figure 7-1. DI/DO Field Wire Shielding Example

7.2. MicroNet TMR Discrete I/O Smart-Plus Module

Each MicroNet TMR Discrete I/O Smart-Plus module contains circuitry for twenty-four (24) discrete inputs and twelve (12) TMR discrete outputs, and provides latent fault detection for each relay output. Each discrete input may be 24 Vdc. Each relay output provides the option of using a normally open contact, or a normally closed contact.

7.2.1 Physical Description

The modules slide into card guides in the control’s chassis and plug into the motherboard. The modules are held in place by two screws, one at the top and one at the bottom of the front panel. Also at the top and bottom of the module are two handles which, when toggled (pushed outward), move the modules out just far enough for the boards to disengage the motherboard connectors.

Figure 7-2. MicroNet TMR Discrete I/O Smart-Plus Module

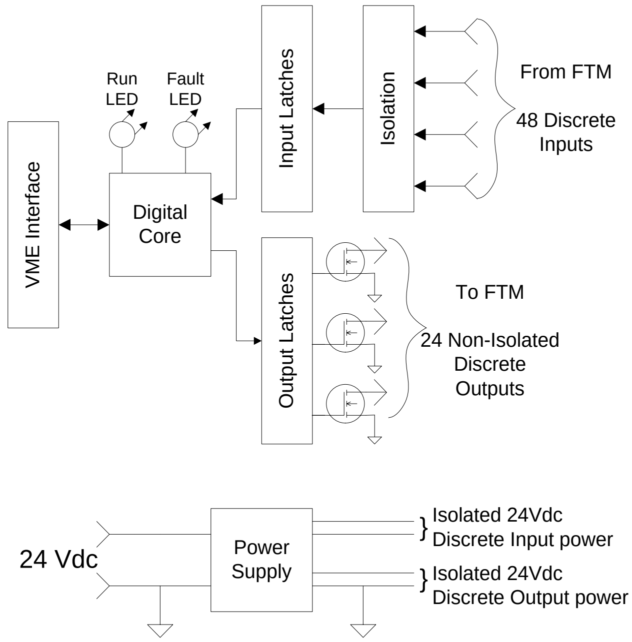


Figure 7-3. MicroNet TMR Discrete I/O Smart-Plus Module Block Diagram

7.2.2 Specifications

7.2.2.1 Discrete Inputs

Number of channels:	24
Update time:	5 ms
Input type:	Optically isolated discrete input
24 V Input thresholds:	<8 Vdc = “OFF”, at .7 mA >16 Vdc = “ON”, at 1.2 mA
Input current:	3.5 mA @ 24 Vdc ; 8 mA @ 125 Vdc
External input voltage:	18–32 Vdc (LVD and UL)
Isolation voltage:	500 Vdc to earth ground, 1000 Vdc to control common
Time stamping:	500 µs resolution
Isolated 24 Vdc contact supply:	400 mA maximum

7.2.2.2 Discrete Outputs

Number of channels:	12
Update time:	5 ms
Relay type:	Dust-tight, magnetic blow-out
Coil rating:	80 mA @ 24 Vdc, suppressor located on circuit board
Minimum load:	50 mA @ 125 Vdc
Relay response time:	15 ms (operate and release)
Relay life expectancy:	50,000 operations @ rated load
Replaceability:	Relays are socket mounted and retained by a hold down spring
Contact ratings:	5.0 A @ 240 Vac, 50/60 Hz (resistive) (meets UL ratings only) 3.0 A @ 240 Vac, 50/60 Hz (inductive) ·(meets UL ratings only) 10.0 A @ 120 Vac, 50/60 Hz (resistive) (meets UL ratings only) 6.0 A @ 120 Vac, 50/60 Hz (inductive) (meets UL ratings only) 600 watt @ 120 Vac, 50/60 Hz (lamp) (meets UL ratings only) 3.0 A @ 150 Vdc (resistive) (meets UL ratings only) 1.2 A @ 150 Vdc (inductive) (meets UL ratings only) 10.0 A @ 28 Vdc (resistive) (meets LVD and UL ratings) 3.0 A @ 28 Vdc (inductive) (meets LVD and UL ratings)

7.2.3. MicroNet TMR Discrete I/O Smart-Plus Module and Associated Components

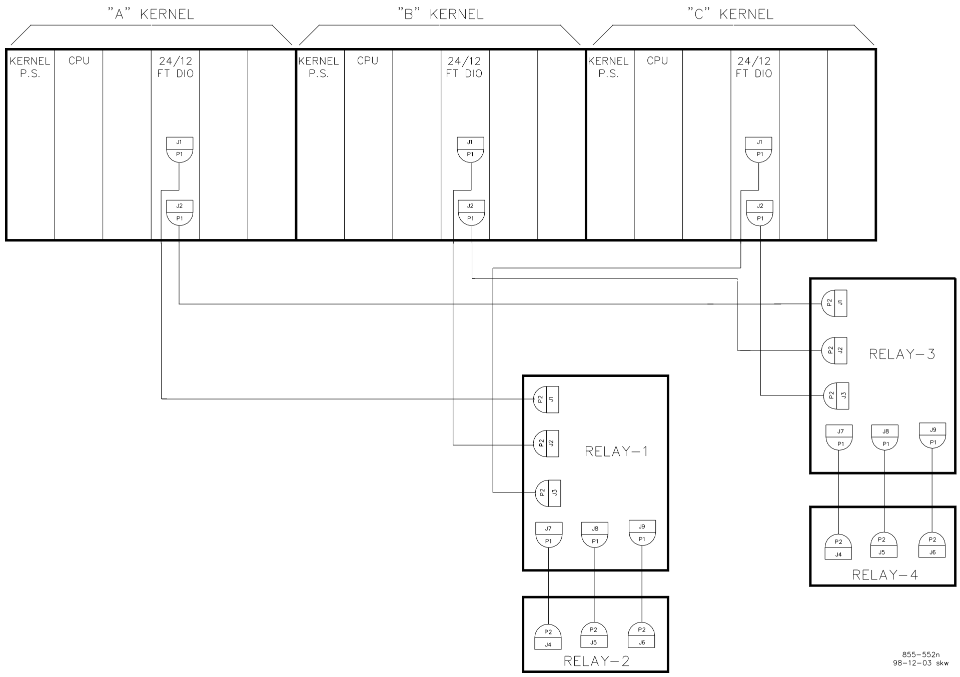


Figure 7-4. Example TMR System Configuration

In a TMR system, each MicroNet TMR Discrete I/O Smart-Plus module is connected through two high-density 62 conductor discrete cables to four FT Relay/Discrete Input modules. All of the I/O on MicroNet TMR Discrete I/O Smart-Plus module is accessible on the relay modules. See Figure 7-4 for an example.

7.2.4 MicroNet TMR Discrete I/O Smart-Plus Module Operation

This module includes no potentiometers and requires no calibration. A MicroNet TMR Discrete I/O Smart-Plus module may be replaced with another module of the same part number without any adjustment.

7.2.4.1 Field Wiring

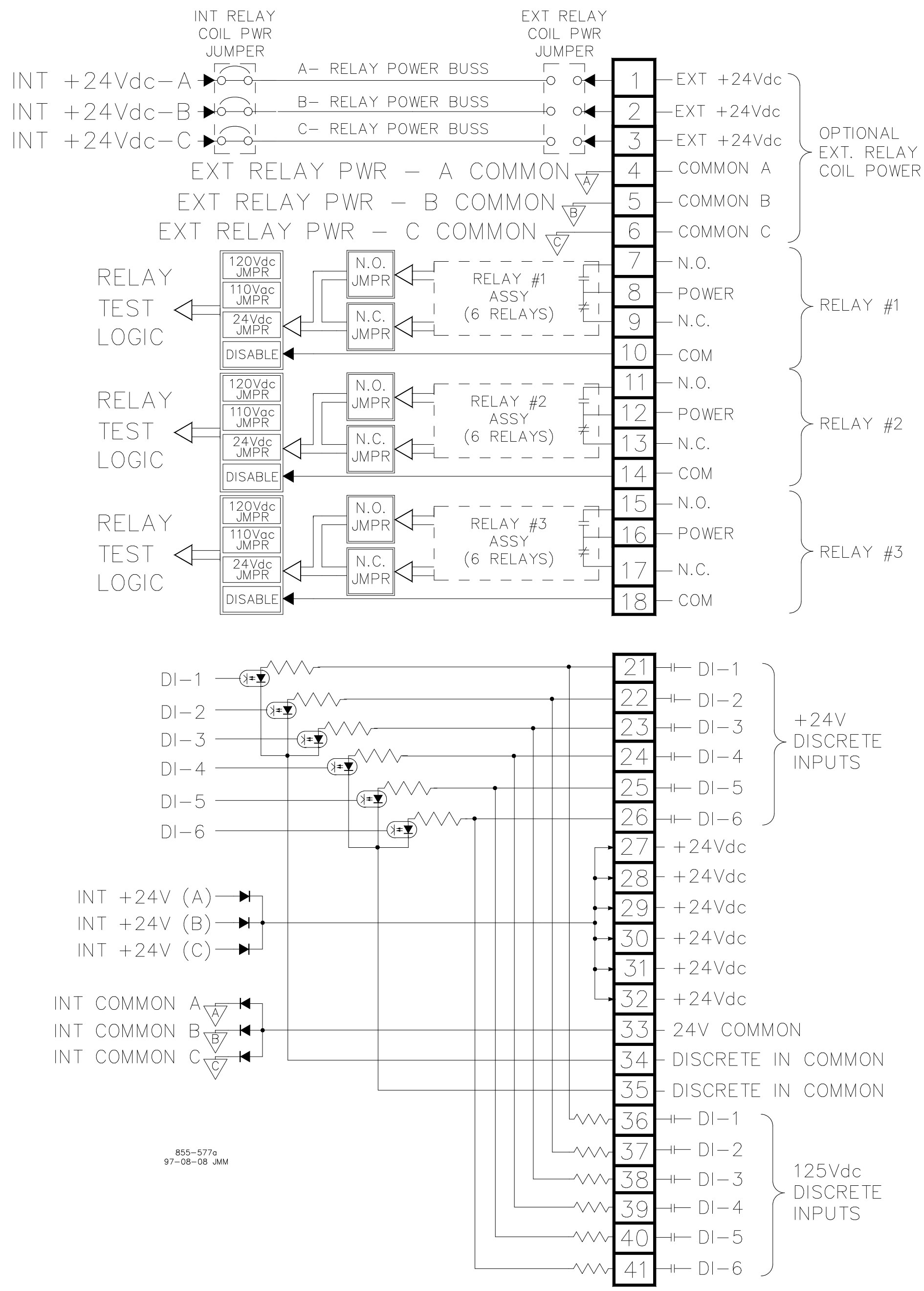


Figure 7-5. Wiring Diagram for a FT Relay/Discrete Input Module

7.2.4.2 Discrete Inputs

The MicroNet TMR Discrete I/O Smart-Plus module accepts 24 discrete inputs. Each of the control's four FT Relay/Discrete Input modules accepts six contact inputs. Contact wetting voltage can be supplied by the control or from an external source. 24 Vdc contact wetting voltage is available on each relay module. An external 18-32 Vdc power source can be used to source the voltage. Because all discrete inputs are fully isolated, a common reference point must be established between the inputs and the contact power source. If the 24 Vdc internal power source is used for contact wetting, jumpers are required between relay module terminals 33, 34, and 35. If an external power source is used for contact wetting, the external source's common must be connected to the relay module's discrete input commons (terminals 34 and 35).

The inputs have components which establish a voltage threshold and a current threshold, to prevent a closed indication due to the leakage current of most solid state relays. The discrete inputs also have time stamping on a change of state, with 1 millisecond resolution.

Figure 7-6 illustrates the different discrete input wiring configurations based on the input voltage.

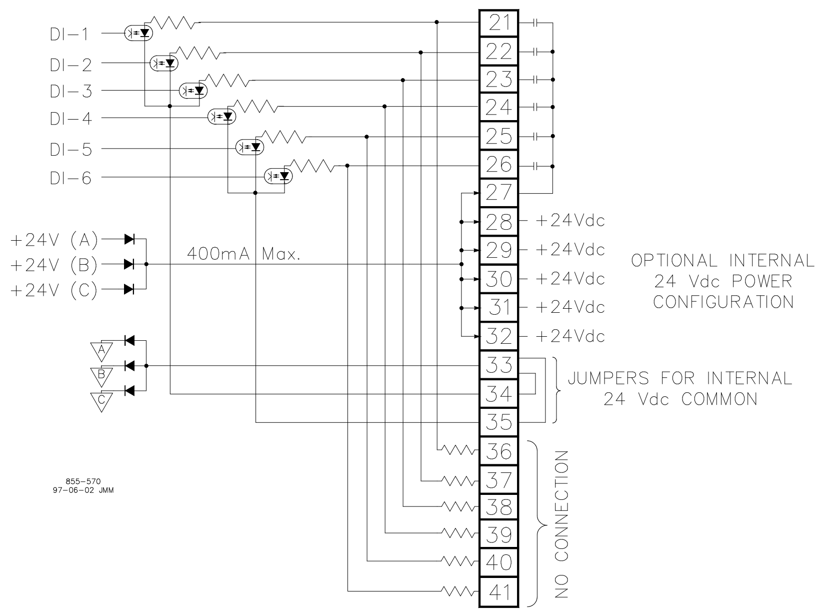


Figure 7-6. Optional Internal 24 Vdc Contact Wetting Configuration

7.2.4.3 Configuration Notes

Refer to Figure 7-6 for contact input wiring.

- All contact inputs accept dry contacts.
- The internal 24 Vdc power source or an external 18-36 Vdc (UL and LVD) power source can be used for circuit wetting.
- If the 24 Vdc internal power source is used, jumpers are required between FT Relay/Discrete Input module terminals 33 and 34, and terminals 33 and 35.
- If an external power source is used for contact wetting, the external source's common must be connected to the relay module's discrete input commons (terminals 34 and 35). Power for sensors and contacts must be supplied by the control's power supplies, or the external power supply must be Class II at 30 Vdc or less and outputs must be fused with appropriately sized fuses (a maximum current rating of 100÷V, where V is the supply's rated voltage or 5 A, whichever is less).
- Verify that the correct discrete input terminals are used, for low or high voltage inputs.

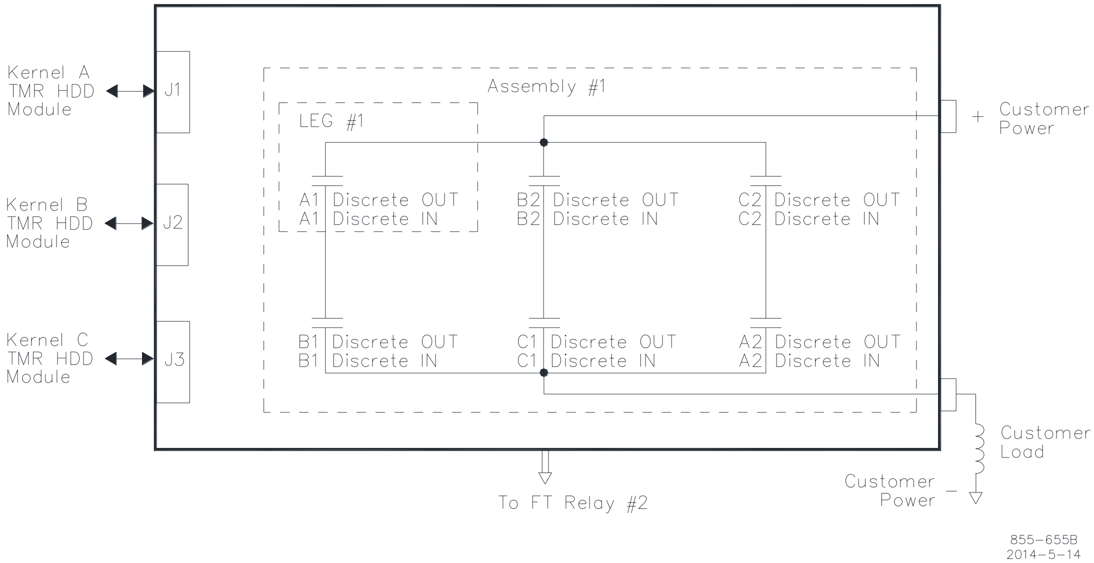


Figure 7-7. TMR Discrete Output

7.2.4.4 Latent Fault Detection

It is important to detect latent faults in a fault tolerant system, because although a single fault may go undetected, if another fault occurs it could cause a shutdown.

Discrete outputs can be configured to use latent fault detection to identify relay failures without affecting a relay output’s state. Six individual relays make up one relay output. When a relay output is closed, the contacts of all six relays are closed. Because of the series-parallel configuration of the relays, the failure of any two individual relays will not cause the output to open. The individual relays are opened and reclosed in pairs to ensure that they are in the correct state and that they change state.

When a relay output is open, the contacts of all six relays are open. Because of the series-parallel configuration of the relays, the failure of any one relay will not cause the output to close. The individual relays are periodically closed and reopened one by one to ensure that they change state.

Readback circuitry allows the state of each relay contact to be detected. Any failures are annunciated, and further testing is disabled without affecting the state of the relay output contact or control operation.

Latent fault detection is not appropriate for all applications or circuits. The control’s latent fault detection logic can only work with circuits using voltages between 18–32 Vdc. For latent fault detection to work, a small leakage current is passed through the circuit’s load. Depending on the size of the load, the leakage current may be enough to cause a load to be on or active when a relay contact is open. In this case, the individual relay’s latent fault detection logic may be disabled, eliminating the leakage current.

With latent fault detection, when a relay contact is closed, no difference in operation is experienced; the relay output appears as a closed contact. However, when a relay contact is open, it appears to the interfaced circuit as a large resistor instead of an open contact. A small amount of current is leaked to the load, resulting in a developed voltage across the load. In most cases this has no bearing on the circuitry, because only a small amount of voltage is developed across its load. However, when a relay output is used with a very high resistance load (low current load), enough voltage may be developed across the load to prevent it from de-energizing.

Verifying That Latent Fault Detection Can Be Used With a Relay Output

1. Verify that the circuit the relay output is used with has a voltage level of 18–32 Vdc.
2. Use graph which corresponds to the circuit's voltage level to determine if the voltage developed across the load (due to the leakage current) is lower than the load's drop-out voltage level.

- Acquire the resistance of the load (relay, motor, solenoid, etc.) to be driven by the relay.
- Acquire the load's minimum dropout voltage.
- From the bottom of the graph, follow the line corresponding to the load's resistance up to the point at which it intersects the circuit power line. At this point the corresponding voltage level (on the left of the graph) is the level of voltage that will be developed across the load due to leakage current.

If circuit voltage is acceptable, and the developed load voltage (from the graph) is less than the load's drop-out voltage, latent fault detection can be used with the circuit.

If the developed load voltage is greater than the load's dropout voltage, it is recommended that latent fault detection be disabled or that a resistor be connected in parallel (shunt) with the load. A correctly sized resistor connected in parallel with the circuit load will decrease the developed load voltage below the load's dropout voltage level. Using the corresponding latent fault detection graph and the load's minimum dropout voltage, perform the above procedure in reverse (see Step #2) to determine an acceptable shunt resistance. When selecting a shunt resistor, also verify that its voltage and wattage ratings meet that of the circuit.

Latent Fault Detection Verification Example
(Figure 7-9)
Circuit power = 110 Vac; load resistance = 200 ohms; load drop-out voltage = 25 Vac

Using the graph below, the intersection point between the 200 ohm load resistance line and the 110 Vac line was found. From this intersection point it was determined that the voltage developed across the load due to leakage current when the relay is open, is approximately 7.5 Vac. This voltage level is lower than the load's 25 Vac drop-out voltage, so latent fault detection can be used.

If, however, the load resistance were 1200 ohms, the intersection would be approximately 29.5 Vac, too high for latent fault detection. By following the graph along the allowable drop-out voltage, 25 Vac, it can be determined that a total load resistance of 900 Ohms or less is needed. By placing a properly rated 3600 ohm resistor in shunt with the load, (1200 ohms//3600 ohms=>900 ohms) latent fault detection can be used.

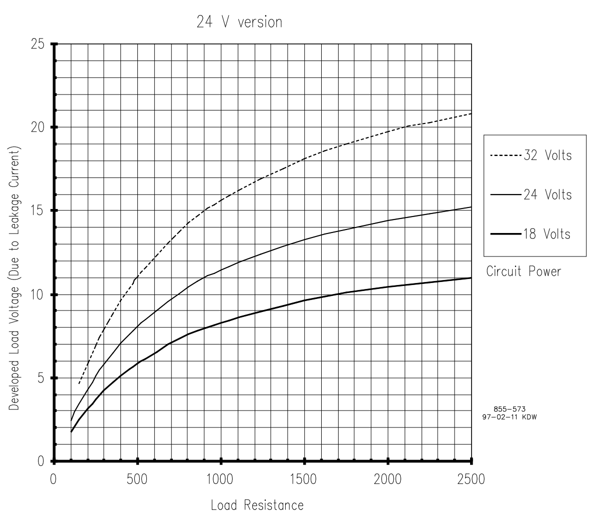


Figure 7-8. Latent Fault Detection Verification Graph–18-32 Vdc Circuitry

7.2.4.5 Relay Jumper Configurations

Relay coil power should be supplied by the control, because this supply is fault tolerant. Jumper banks (four jumpers in one package) are provided on each relay module to allow field selection of internal or external relay coil power. See Figure 7-9. If it is necessary to supply external relay coil power, the relay coil power jumper bank must be moved from its defaulted INT. position to the EXT. position.

To retain circuit integrity if an external power supply is used for relay coil power, the external power supply must be an isolated 24 Vdc source with +5% regulation. Recommend that a start-up routine be utilized to remove the source during system power-up and power-down. This routine will guarantee that no relay is inadvertently energized due to system power-up surges. (By using the relay module's internal relay coil power this start-up routine is automatically performed.)

Each relay output has two banks of jumpers. One jumper-bank (a set of nine jumpers) is used to match the latent fault detection circuit with the circuit voltage to which it is being interfaced. The second jumper bank (a set of four jumpers) is used to select which set of relay contacts (N.O. or N.C.) is tested by the latent fault detection logic. During operation, only one set of relay contacts (normally open or normally closed) can be tested. The set of relay contacts tested should be same set of relay contacts used by the load. Refer to [Figure 7-9 and 7-10]. Latent fault detection circuitry can be jumper configured to be compatible with the following circuit voltage:
18-32 Vdc circuit power

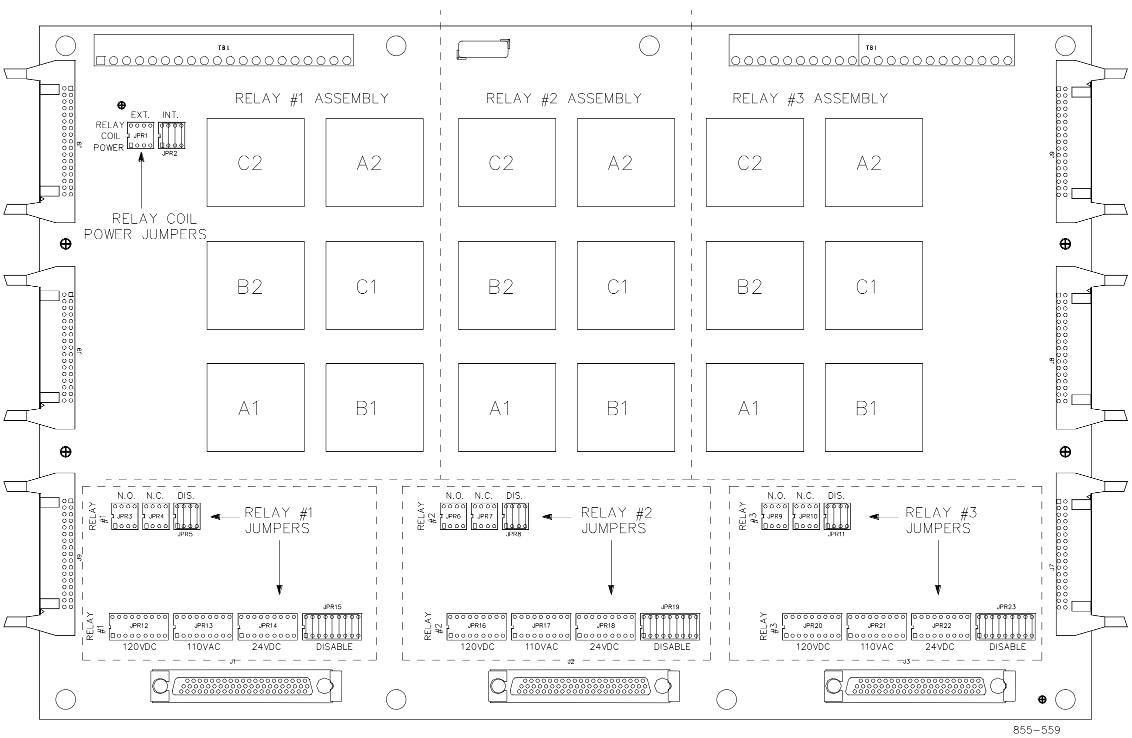


Figure 7-9. Jumper and Relay Location Diagram

After all jumper-banks have been correctly positioned, mark the placement of each jumper-bank on the FT Relay/Discrete Input module covers labels. See the figure below.

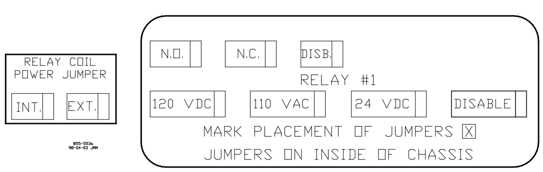


Figure 7-10. FT Relay/Discrete Input Module Labels

Configuration Notes

- Refer to Figure 7-11 for relay output wiring.
- Verify that each set of relay contacts meets the power requirements of the circuit with which it is being used. Interposing relays are required in cases where the interfaced circuit demands relay contacts with a higher power rating. If interposing relays or other inductive loads are required, it is recommended that interposing relays with surge (inductive kickback) protection be used. Improper connection could cause equipment damage.
- Verify that system power is off before removing or installing any relay module jumper. Use ESD precautions when removing and installing relay module jumper-banks.
- Select internal or external relay coil power. If the control's internal power is used, verify that the relay module's "Relay Coil Power Jumper" bank is in the INT. position. If external relay coil power is supplied, move the relay module's "Relay Coil Power Jumper" bank to the EXT. position and verify that the external source is fully isolated. (Mark the module's label to indicate jumper position.)
- Verify that latent fault detection can be used with each relay output.
- If latent fault detection cannot be used with the relay output, verify that the relay's latent fault detection jumper-banks are in their disabled positions. (Mark the module's label to indicate jumper position.) Alternatively, an external resistor can be wired in parallel with the load to allow latent fault detection to be used with the relay output. In this case it is the customer's responsibility to calculate the required resistor ratings and install the resistor.
- If latent fault detection can be used with the relay output, move the relay's latent fault detection jumper-bank to the correct position for the circuit power. Also, select which set of relay contacts (N.O. or N.C.) are to be tested by the latent fault detection logic. (Mark the module's labels to indicate jumper positions.)

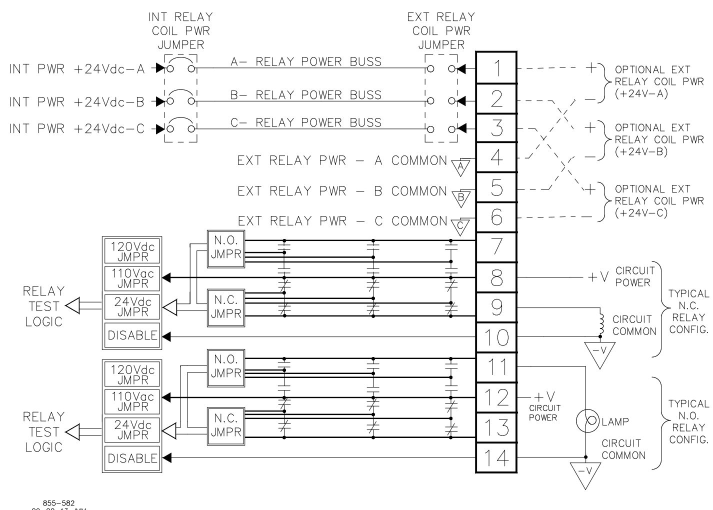


Figure 7-11. Example Relay Output Wiring Diagram

7.2.4.6 Fault Detection (Module Hardware)

Each MicroNet TMR Discrete I/O Smart-Plus module has a red Fault LED that is turned on when the system is reset. During initialization of a MicroNet TMR Discrete I/O Smart-Plus module, which occurs after every CPU reset, the CPU turns the Fault LED on. The CPU then tests each MicroNet TMR Discrete I/O Smart-Plus module using diagnostic routines built into the software. If the diagnostic test is not passed, the LED remains on or blinks. If the test is successful, the LED goes off and the RUN LED turns on. If the Fault LED on a MicroNet TMR Discrete I/O Smart-Plus module is illuminated after the diagnostics and initialization have been run, the module may be faulty or may be located in the wrong slot.

Table 7-1. LED Indications of Failure

Number of Fault LED Flashes	Failure
1	Watchdog Failure
2	No Application
3	Flash Memory Failure
4	Exception Failure
5	FPGA Failure
6	Non-Volatile Memory Error
7	Kernel Watchdog Error
8	MFT Failure
9	Software Slip
10	Ram Memory Failure
11	Software Failure

Fault Detection (I/O)
In addition to detecting MicroNet TMR Discrete I/O Smart-Plus module hardware faults, the application software may detect I/O faults.

Discrete Input Faults. The application software can detect faults by comparing the inputs from the three kernels.

Discrete Output Faults. The module monitors relay coil voltage and contact states. The contacts change state periodically to allow latent fault detection. The application determines the course of action in the event of a fault.

Microcontroller Faults. The system monitors a software watchdog, a hardware watchdog, and a software watchdog on the VME bus communications. All outputs are shut down in the event of a microcontroller fault.

7.2.4.7 24/12 TMR Discrete I/O Module Troubleshooting Guide

If during normal control operation, all of a chassis' MicroNet TMR Discrete I/O Smart-Plus modules have Fault LEDs on, check the chassis' CPU module for a failure. If during normal control operation, only the MicroNet TMR Discrete I/O Smart-Plus module's Fault LED is on or flashing, insure that it is installed in the correct slot. If it is, then replace that MicroNet TMR Discrete I/O Smart-Plus module. See instructions for module replacement in Chapter 15, Installation and Service. When a MicroNet TMR Discrete I/O Smart-Plus module fault is detected, its outputs should be disabled or de-energized.

Discrete Inputs
If a discrete input is not functioning properly, verify the following:
- Measure the input voltage on the terminal block. It should be in the range of 18-32 Vdc for the low voltage input terminal blocks.
- Check the wiring. If the inputs are reading open, look for a loose connection on the terminal blocks, disconnected or misconnected cables, or a missing jumper on the terminal block.
- Check the software configuration to ensure that the input is configured properly.

After verifying all of the above, remove the MicroNet TMR Discrete I/O Smart-Plus module and exchange the J1 and J2 cables. See instructions for replacing the module in Chapter 15 Installation and Service. If the problem moves to a different channel, replace the cable. If not, exchange the cables at the FT Relay/Discrete Input modules so J1 is driving J2 and vice versa. If the problem moves to a different input, replace the MicroNet TMR Discrete I/O Smart-Plus module. If the fault remains with the same input, replace the FT Relay/Discrete Input module. See instructions for replacing the FT Relay/Discrete Input modules in Chapter 15, Installation and Service.

Discrete Outputs

If a discrete output is not functioning properly, verify the following:

- Check the wiring for a loose connection on the terminal blocks and disconnected or misconnected cables.
- Verify that the current through the relay contact does not exceed the contact rating.
- Make sure that if latent fault detection is being used, the trickle current through the relay is insufficient to energize the relay load. See Figures 15-8 through 15-10.
- Check the software configuration to ensure that the output is configured properly.

After verifying all of the above, remove the MicroNet TMR Discrete I/O Smart-Plus module and exchange the J1 and J2 cables. See instructions for replacing the module in Chapter 15, Installation and Service. If the problem moves to a different channel, replace the cable. If not, exchange the cables at the FT Relay/Discrete Input modules so J1 is driving J2 and vice versa. See instructions for replacing the module in Chapter 15, Installation and Service. If the problem moves to a different relay, replace the MicroNet TMR Discrete I/O Smart-Plus module or the relay. See instructions for replacing the FT Relay/Discrete Input modules and relays in Chapter 14 Installation and Service. If the fault remains with the same relay, replace the relay or the FT Relay/Discrete Input module.

7.3. 24/12 TMR Discrete I/O Module

Information regarding this module is found in Volume 3, Chapter 4.

7.4. MicroNet Discrete I/O Smart-Plus Module (HDDIO)

7.4.1 Module Description

The HDDIO module is a MicroNet Plus module that will allow the customer to access information about the module during operation via AppManager.

A 48/24 Discrete Combo module contains circuitry for forty-eight optically isolated discrete inputs and twenty-four discrete outputs. These modules require no calibration; a module may be replaced with another module of the same part number without any adjustment. There are two different FTM I/O configurations for the MicroNet Discrete I/O Smart-Plus Module.

Configuration 1 consists of one 48/24 Discrete FTM connected to the MicroNet Discrete I/O Smart-Plus module via two High Density Analog/Discrete cables. The 48/24 Discrete FTM is then connected to either two 16Ch Relay Modules or one 32Ch Relay Module via a Low Density Discrete Cable(s).

Configuration 2 consists of two 24/12 Discrete FTMs (DIN rail mounted) connected to the MicroNet Discrete I/O Smart-Plus module via two High Density Analog/Discrete cables.

See Figure 7-3 for examples of configurations.

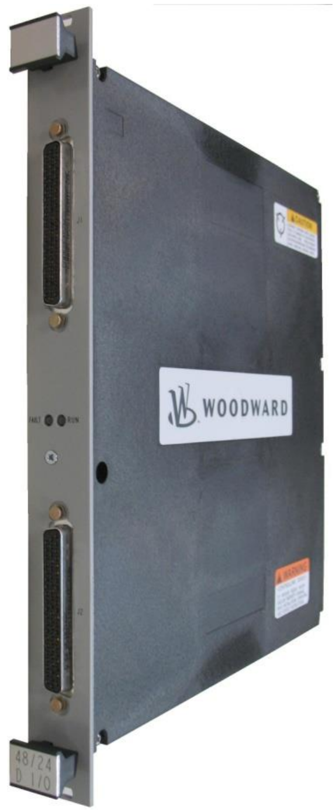


Figure 7-12. Discrete Combo Module (HDDIO)

7.4.2 Module Specification

7.4.2.1 Discrete Inputs

Number of channels: 48
Update time: 5 ms
Input type: Optically isolated discrete input (galvanically isolated)

7.4.2.2 48/24 Discrete FTM

Input thresholds: Input voltage: 8 Vdc at 1.5 mA = "OFF"
> 16 Vdc at 3 mA = "ON"
Input current: 4 mA @ 24 Vdc
External input voltage: 18–32 Vdc (UL and LVD) FTM
Isolation voltage: 500 Vdc to earth ground, 1000 Vdc to control common
Time stamping: 500 µs resolution
Isolated 24 Vdc contact supply: 400 mA maximum

For the 24/12 Discrete FTM input specifications, see Chapter 12.

7.4.2.3 Discrete Outputs

Number of channels: 24
Update time: 5 ms

For the 24/12 Discrete FTM, 16Ch Relay Module, and the 32Ch Relay Module output specifications, see Chapter 12.

Note: This module must be used with Coder Version 5.03 or later. The Coder 4.06 compatible versions are 5466-1156 (TMR) and 5466-1158.

7.4.3 Installation

The modules slide into card guides in the control's chassis and plug into the motherboard. The modules are held in place by two screws, one at the top and one at the bottom of the front panel. Also at the top and bottom of the module are two handles which, when toggled (pushed outward), move the modules out just far enough for the boards to disengage the motherboard connectors.

There are two different FTM I/O configurations for the MicroNet Discrete I/O Smart-Plus Module.

7.4.3.1 Configuration 1

Configuration 1 consists of one 24 Vdc 48/24 Discrete FTM connected to the MicroNet Discrete I/O Smart-Plus module via two High Density Analog/Discrete cables. The top connector on the MicroNet Discrete I/O Smart-Plus module, which is labeled J1, connects to J1 on the 48/24 Discrete FTM, and J2 connects to J2. The 24 Vdc 48/24 Discrete FTM handles 24 Vdc input signals. The 48/24 Discrete FTM is then connected to either two 16Ch Relay Modules or one 32Ch Relay Module via a Low Density Discrete Cable(s) via the third connector. See Figure 8-3 for an example of configuration.

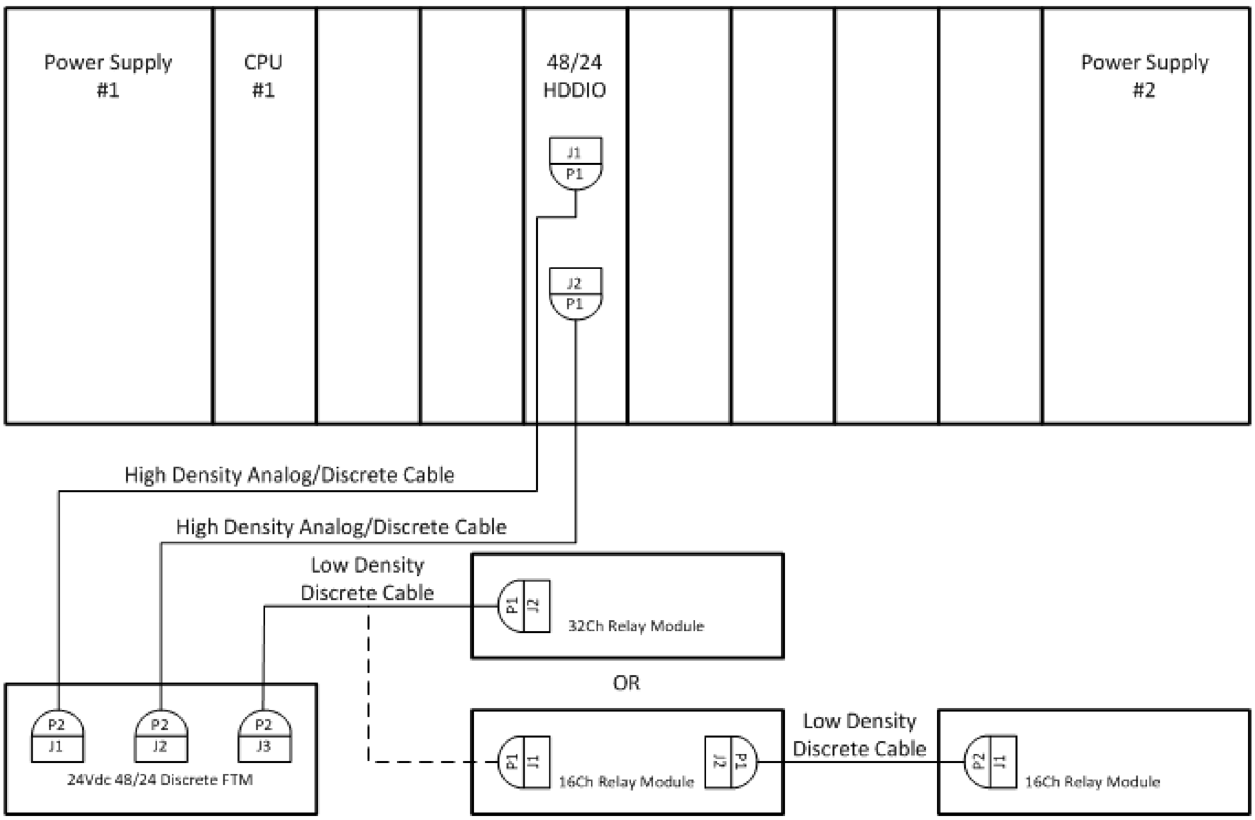


Figure 7-13. Configuration 1, One 48/24 Discrete FTM with Relay Module(s)

All of the discrete inputs on the module are accessible on the 48/24 Discrete FTM, and the channels are labeled to correspond to their designation in the application software (discrete input 1 on the FTM will be discrete input 1 in the application software).

Discrete Inputs

Each MicroNet Discrete I/O Smart-Plus module accepts 48 contact inputs. The 48/24 Discrete FTM may supply contact-wetting voltage. Optionally, an external 18–32 Vdc power source. If the 24 Vdc internal power source is used for contact wetting, a jumper is required between FTM terminals 98 and 99. If an external power source is used for contact wetting, the external sources common must be connected to the FTM's discrete input common, terminal 49. The FTM provides a common cage-clamp terminal connection for customer field wiring. Figure 8-4 illustrates different discrete input wiring configurations based on the input voltage.

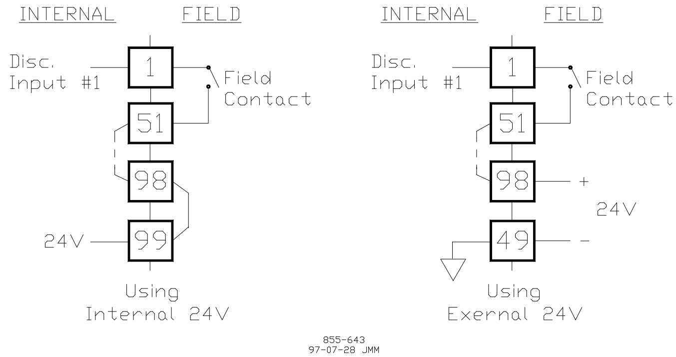


Figure 7-14. Discrete Input Interface Wiring to a 24 Vdc 48/24 Discrete FTM

Configuration Notes:

- Refer to Chapter 12 for Discrete Input wiring.
- Each MicroNet Discrete I/O Smart-Plus module can only accept one input voltage range, 24 Vdc (LVD and UL).
- All contact inputs accept dry contacts.
- 24 Vdc FTM only—If the internal 24 Vdc is used, a jumper must be added to tie the internal 24 Vdc to the bussed power terminal blocks (see Figure 8-4).
- 24 Vdc FTM only—If an external 24 Vdc is used, the common for the external 24 Vdc must be tied to the discrete input common (see Figure 8-4). Power for contacts must be supplied by the control's power supplies, or the external power supply outputs must be rated to Class II at 30 Vdc or less and outputs must be fused with appropriately sized fuses (a maximum current rating of 100 ÷ V, where V is the supply's rated voltage or 5 A, whichever is less).

Discrete Outputs

For the 48/24 Discrete Combo FTM configuration, there are three types of relay output boxes that can be used. These consist of the 16Ch Relay (Phoenix) Module, 16Ch Relay Module, and the 32Ch Relay Module (see Chapter 12 for a description of the available modules). The relay modules connect to the 48/24 Discrete FTM through individual cables and provide a common cage-clamp terminal connection for customer field wiring. The discrete outputs on the 48/24 Discrete I/O module are non-isolated; the isolation takes place in the relay boxes.

Discrete outputs 9, 10, 11, 12, 21, 22, 23, and 24, drive two relays per output (see Table 8-1). Internal wiring on the 48/24 Discrete I/O FTM provides this dual relay functionality. The application software may use these relays for outputs where extra relay contacts are needed, such as alarm or shutdown outputs.

Table 7-2. Discrete Outputs/Relay Module Configuration

Discrete Outputs	16 Channel Relay Mod.(s)	32 Channel Relay Mod.
1-8	Mod. 1 Ch. 1-8	Ch. 1-8
9	Mod. 1 Ch. 9, 10	Ch. 9,10
10	Mod. 1 Ch. 11, 12	Ch. 11, 12
11	Mod. 1 Ch. 13, 14	Ch. 13, 14
12	Mod. 1 Ch. 15, 16	Ch. 15, 16
13-20	Mod. 2 Ch. 1-8	Ch. 17-24
21	Mod. 2 Ch. 9, 10	Ch. 25, 26
22	Mod. 2 Ch. 11, 12	Ch. 27, 28
23	Mod. 2 Ch. 13, 14	Ch. 29, 30
24	Mod. 2 Ch. 15, 16	Ch. 31, 32

See Chapter 12 for field wiring of discrete output relays.

Figures 7-17 and 7-18 illustrate examples of different discrete output wiring configurations.

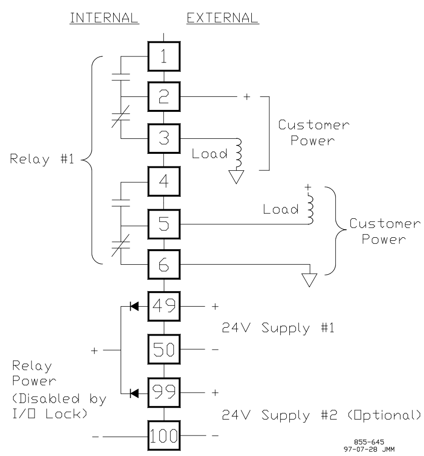


Figure 7-15. Relay Output Interface Wiring to a 16Ch Relay Module

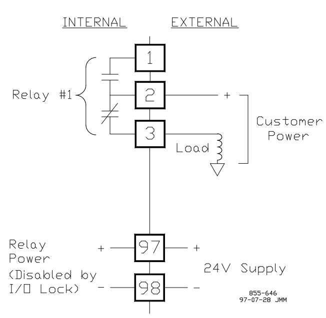


Figure 7-16. Relay Output Interface Wiring to a 32Ch Relay Module

Configuration Note

Verify that each set of relay contacts meets the power requirements of the circuit with which it is being used. Interposing relays are required when the interfaced circuit demands relay contacts with a higher power rating. If interposing relays or other inductive loads are required, it is recommended that interposing relays with surge (inductive kickback) protection be used. Improper connection could cause serious equipment damage.

7.4.3.2 Configuration 2

Configuration 2 consist of two 24/12 Discrete FTMs (DIN rail mounted) connected to the MicroNet Discrete I/O Smart-Plus module via two High Density Analog/Discrete cables. See Figure 8-7 for an example of configuration.

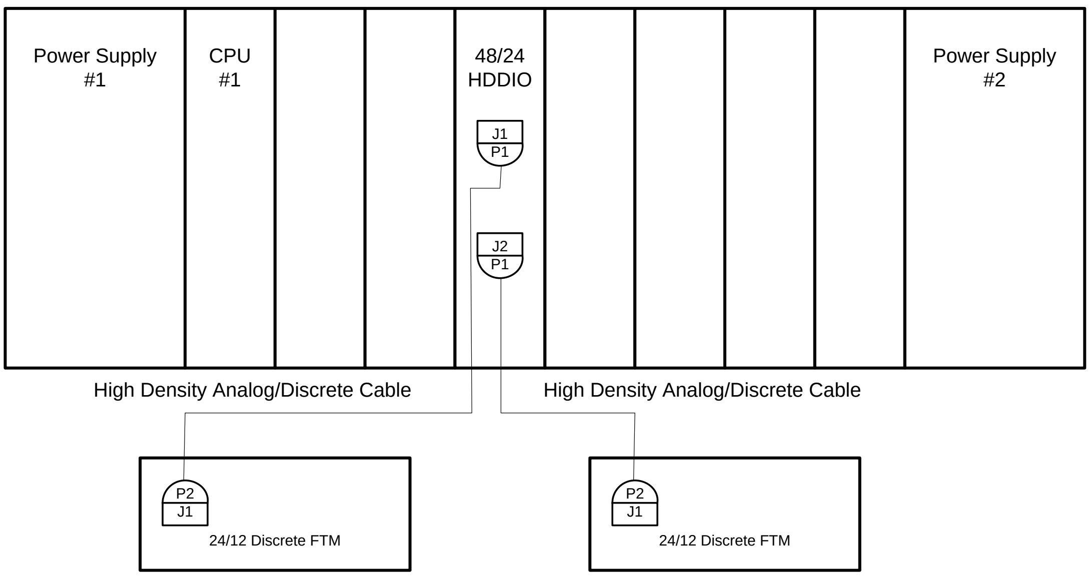


Figure 7-17. Configuration 2, Two 24/12 Discrete FTMs

Both the 48 discrete inputs and 24 discrete outputs are wired to the 24/12 Discrete FTM. An external 24 Vdc source connection to the FTM is required for discrete input contact sensing and relay coil energizing. For wiring information on the 24/12 Discrete FTM, see Chapter 12.

Discrete Inputs

Each 24/12 Discrete FTM accepts 24 contact inputs. The 24/12 Discrete FTM may supply contact wetting voltage. Optionally, an external 18–32 Vdc power source can be used to source the circuit wetting voltage. If the 24 Vdc internal power source is used for contact wetting, a jumper is required between FTM terminals on TB9. If an external power source is used for contact wetting, the external source's common must be connected to the FTM's discrete input common, terminal 49 (see Figure 8-8).

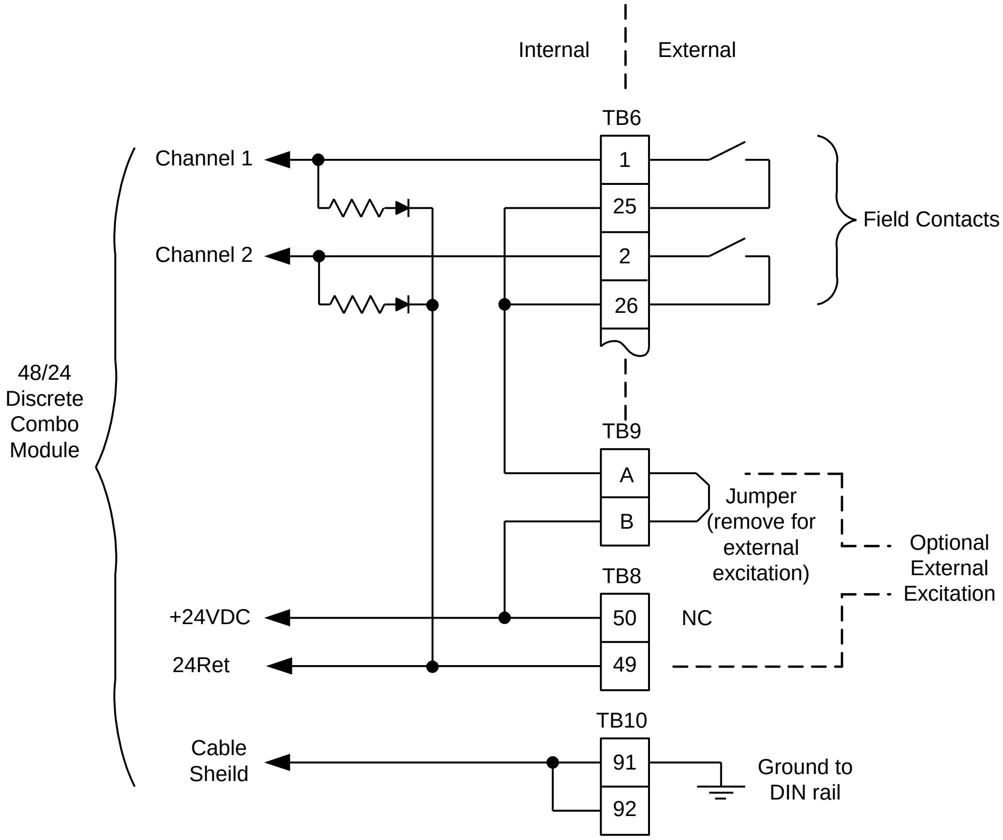


Figure 7-18. Discrete Input Interface Wiring to a 24/12 Discrete FTM

Configuration Notes:

- Refer to Chapter 12 for Discrete Input wiring.
- All contact inputs accept dry contacts.
- If the internal 24 Vdc is used, a jumper must be added to tie the internal 24 Vdc to the bussed power terminal blocks (see Figure 7-31).
- If an external 24 Vdc is used, the common for the external 24 Vdc must be tied to the discrete input common (see Figure 7-31). Power for contacts must be supplied by the control's power supplies, or the external power supply outputs must be rated to Class II at 30 Vdc or less and outputs must be fused with appropriately sized fuses (a maximum current rating of 100/V, where V is the supply's rated voltage, or 5 A, whichever is less).

Discrete Outputs

The discrete outputs on the MicroNet Discrete I/O Smart-Plus module are non-isolated; the isolation takes place in the 24/12 Discrete FTM. See Chapter 12 for field wiring of discrete output relays. Figure 8-9 illustrates an example of a discrete output wiring configuration.

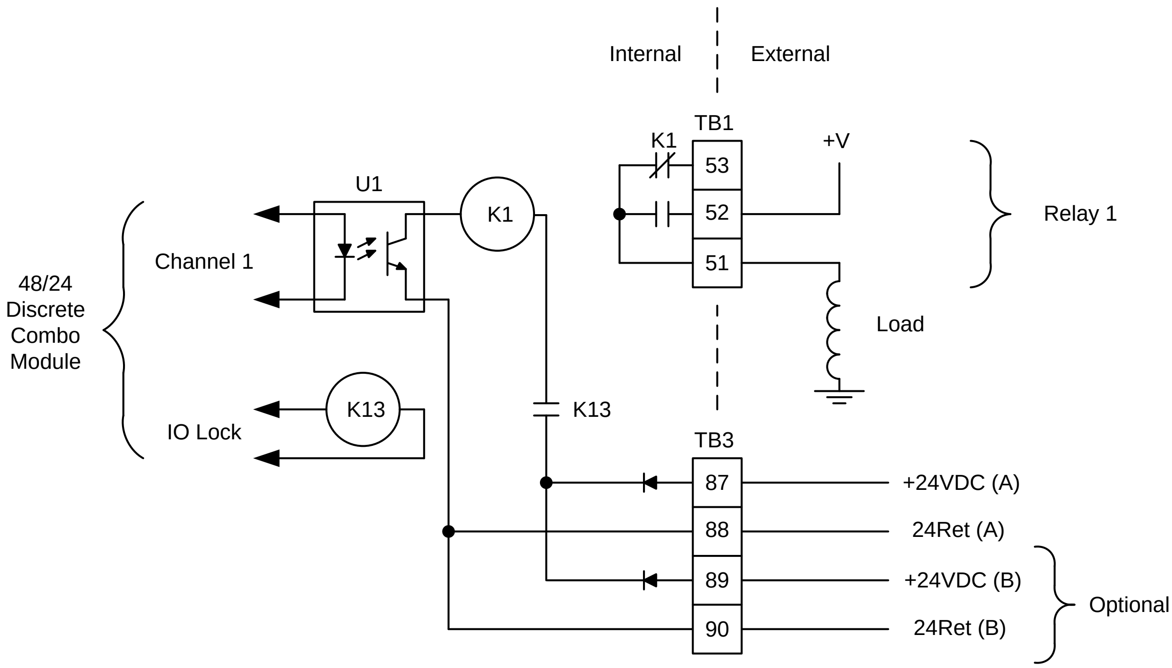


Figure 7-19. Relay Output Interface Wiring to a 24/12 Discrete FTM

Configuration Notes

- Verify that each set of relay contacts meets the power requirements of the circuit with which it is being used.
- Interposing relays are required when the interfaced circuit demands relay contacts with a higher power rating.
- If interposing relays or other inductive loads are required, it is recommended that interposing relays with surge (inductive kickback) protection be used. Improper connection could cause serious equipment damage.

7.4.4 FTM Reference

See Chapter 12 for detailed wiring of FTMs. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

7.4.5—Troubleshooting

7.4.5.1 Fault Detection (Module Hardware)

Each MicroNet Discrete I/O Smart-Plus module has a red Fault LED that is turned on when the system is reset. During initialization of a MicroNet Discrete I/O Smart-Plus module, which occurs after every CPU reset, the CPU turns the Fault LED on. The CPU then tests each MicroNet Discrete I/O Smart-Plus module using diagnostic routines built into the software. If the diagnostic test is not passed, the Fault LED remains on or blinks. If the test is successful, the Fault LED goes off and the RUN LED. If the Fault LED on a MicroNet Discrete I/O Smart-Plus module is illuminated after the diagnostics and initialization have been run, the module may be faulty or may be located in the wrong slot.

Table 7-3. LED Indications of Failure

Number of Fault LED Flashes	Failure
1	Watchdog Failure
2	No Application
3	Flash Memory Failure
4	Exception Failure
5	FPGA Failure
6	Non-Volatile Memory Error
7	Kernel Watchdog Error
8	MFT Failure
9	Software Slip
10	Ram Memory Failure
11	Software Failure

7.4.5.2 Fault Detection (I/O)

In addition to detecting MicroNet Discrete I/O Smart-Plus module hardware faults, the application software may detect I/O faults.

Discrete Output Faults: The module monitors the FTM control voltage and annunciates faults. The application software determines the course of action in the event of a fault.

Microcontroller Faults: The system monitors a software watchdog, a hardware watchdog, and a software watchdog on the VME bus communications. All outputs are shut down in the event of a microcontroller fault.

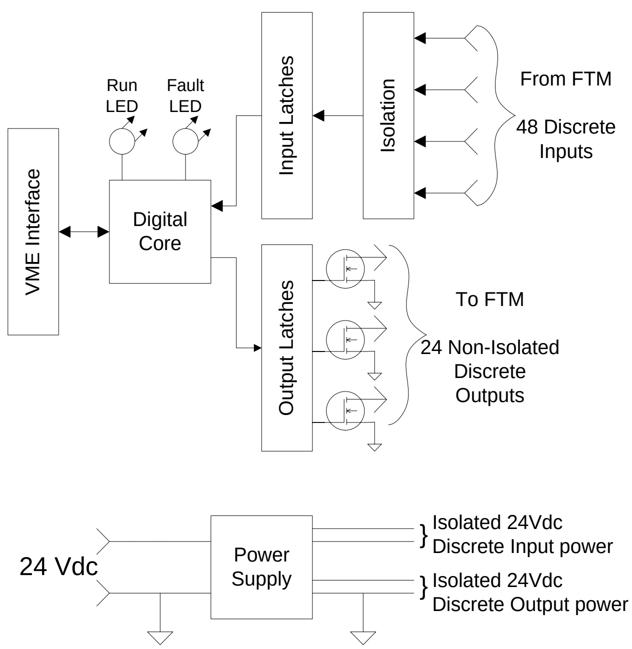


Figure 7-20. MicroNet Discrete I/O Smart-Plus Module Block Diagram

If during normal control operation, all of a chassis' MicroNet Discrete I/O Smart-Plus modules have Fault LEDs on, check the chassis' CPU module for a failure. If during normal control operation, only the MicroNet Discrete I/O Smart-Plus module's Fault LED is on or flashing, insure that it is installed in the correct slot. If it is, then replace that MicroNet Discrete I/O Smart-Plus module. When a module fault is detected, its outputs should be disabled or de-energized.

7.4.5.3 Discrete Inputs

If a discrete input is not functioning properly, verify the following:

1. Measure the input voltage on the terminal block. It should be in the range of 16–32 Vdc for the low voltage FTM or 100–150 Vdc for the high voltage FTM.
2. Check the wiring. If the inputs are reading open, look for a loose connection on the terminal blocks, disconnected or misconnected cables, or a missing jumper on the terminal block.
3. Check the application software configuration to ensure that the input is configured properly.
4. After verifying all of the above, exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the MicroNet Discrete I/O Smart-Plus module.
5. If the readings are incorrect on several channels of the MicroNet Discrete Smart-Plus module, corresponding to both cables, replace the MicroNet Discrete I/O Smart-Plus module.
6. If replacing the module does not fix the problem, replace the FTM. See the instructions in Chapter 15, Installation, for replacing the FTM.

7.4.5.4 Discrete Outputs

If a discrete output is not functioning properly, verify the following:

1. Check the wiring for a loose connection on the terminal blocks, or disconnected or misconnected cables.
2. Verify that the current through the relay contacts is not greater than the relay contact rating.
3. Check the software configuration to ensure that the output is configured properly.
4. After verifying all of the above, exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, exchange the cables at the FTM, so J1 is driving J2 and vice versa. If the problem moves to a different relay, replace the MicroNet Discrete I/O Smart-Plus module. If the fault stays with the same relay, replace the relay or the relay module. See instructions for replacing the relay modules in Chapter 15. If replacing the relay module does not fix the problem, replace the cable between the relay module and the FTM, or replace the FTM itself. See the instructions in Chapters 15 for replacing the FTM.

7.5. 48/24 Discrete Combo Module

Information on this module is found in Volume 3, Chapter 4.

7.6. 48 Channel Discrete Input Module

7.6.1 Module Description

Each 48 Channel Discrete Input (48 Ch. DI) Module is connected through two low-density discrete cables to two separate FTMs. There are two types of FTMs available for use with the 48 Ch. DI Module; the 24 Vdc Discrete Input/Output FTM and the Discrete Input (With LEDs) FTM (see Chapter 12 for additional information on this FTM module). The 24 Vdc Discrete Input/Output FTM does not have LEDs and the Discrete Input (with LEDs) FTM has LEDs. All I/Os on the module are accessible on the FTMs, and the channels are labeled sequentially to correspond to their software locations (for example, discrete input 1 on the FTM will be discrete input 1 in the application software).

Figure 7-21. Discrete Input Module

This module receives discrete signals from 48 separate switches or relay contacts, and sends this data to the CPU. The inputs are optically isolated from the balance of the MicroNet control circuitry. The module system provides isolated +24 Vdc power for these external contacts on the 24 Vdc Discrete Input/Output FTM. The Discrete Input (With LEDs) FTM requires an external contact wetting power supply.

There are no potentiometers for tuning and requires no calibration. A module may be replaced with another 48 Ch. DI Module of the same part number without any adjustment.

7.6.2 Module Specification

Number of Channels:	48
Input Type:	Optically isolated discrete input
Input Thresholds:	< 8 Vdc = "OFF"
	> 16 Vdc = "ON"
Input Current:	3 mA @ 24 Vdc
Contact Power:	Module provides isolated 24 Vdc, 0.3 A

7.6.3 Installation

The modules slide into card guides in the control's chassis and plug into the motherboard. The modules are held in place by two screws, one at the top and one at the bottom of the front panel. Also at the top and bottom of the module are two handles which, when toggled (pushed outward), move the modules out just far enough for the boards to disengage the motherboard connectors.

Each 48 Ch. DI Module is connected through two low density discrete cables to two 24 Vdc Discrete Input/Output FTMs or Discrete Input (With LEDs) FTMs. All I/Os on the module are accessible on the FTMs, and the channels are labeled sequentially to correspond to their software locations (for example, discrete input 1 on the FTM will be discrete input 1 in the application software). The FTM plugged into J1 handles channels 1–24, and the FTM plugged into J2 handles channels 25–48. See Figure 7-45 for system installation configuration.

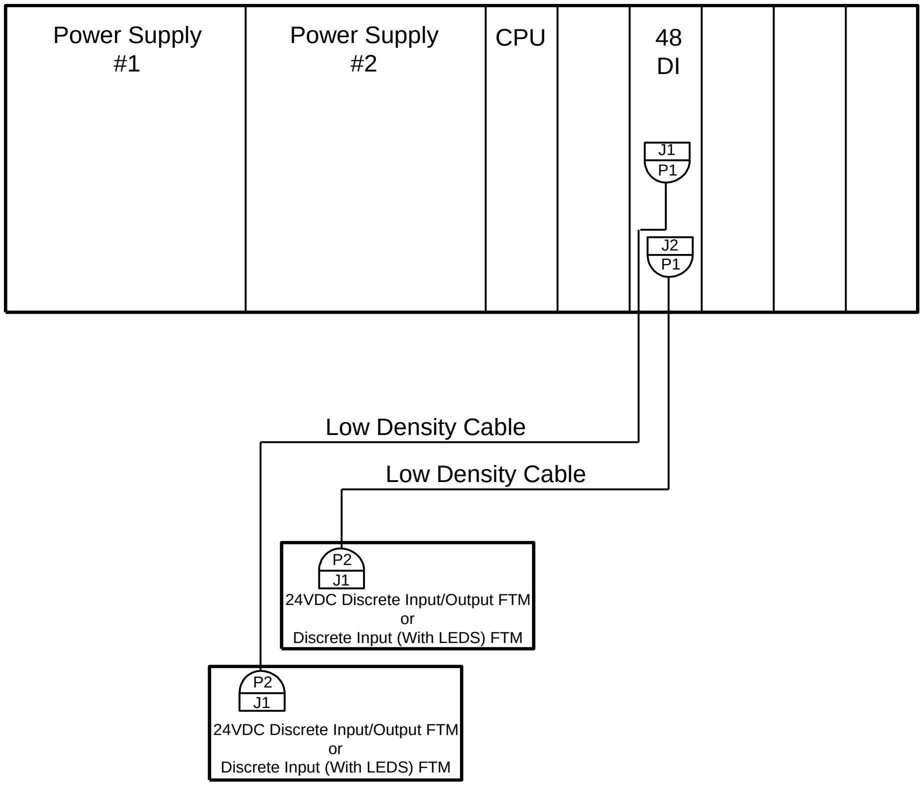


Figure 7-22. 48 Ch. DI Module with two FTMs

Each 48 Ch. DI Module accepts 48 contact inputs. Contact wetting voltage may be supplied by the 48 Ch. DI Module internal power supply. The supply can only supply 300 mA and therefore should not be used with the Discrete Input (with LEDs) FTM. If an external power source (18–32 Vdc) is supplied, the Discrete Input (with LEDs) FTM may be used. Figures 7-40 and 7-41 illustrate different discrete input wiring configurations based on internal or external power source.

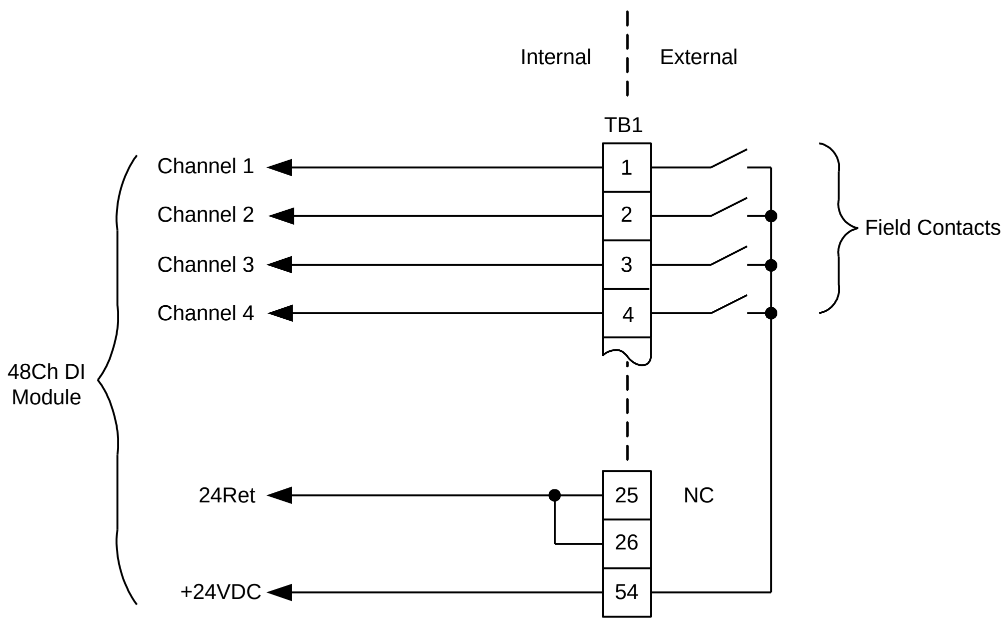


Figure 7-23. Discrete Input Interface Wiring with Internal Power Source
to a 24 Vdc Discrete Input/Output FTM

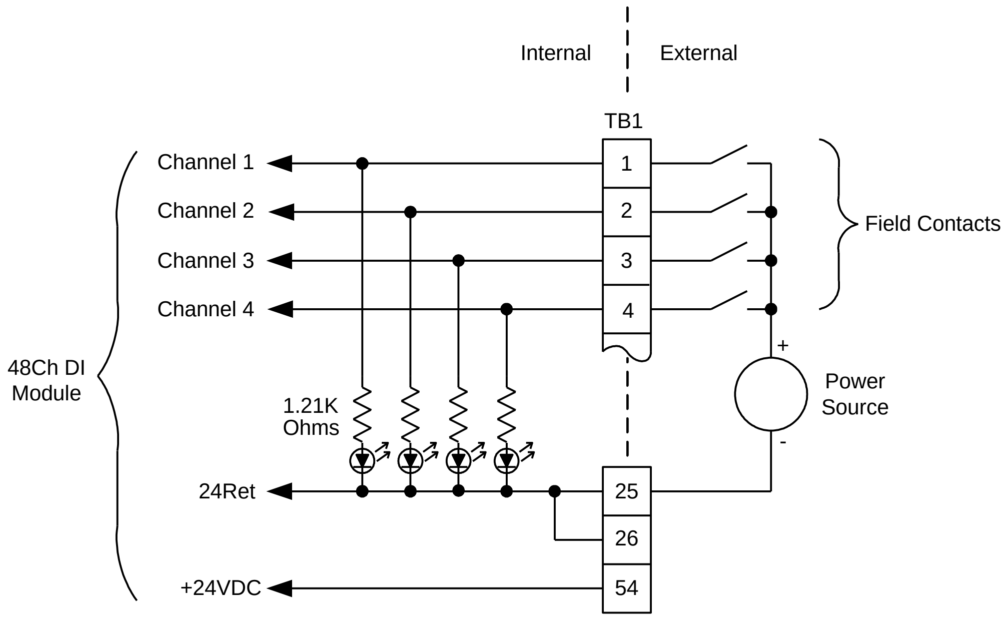


Figure 7-24. Discrete Input Interface Wiring with External Power Source to a Discrete Input (with LEDs) FTM

Configuration Notes:

- Refer to Chapter 12 for Discrete Input wiring.
- All contact inputs accept dry contacts.

7.6.4 FTM Reference

See Chapter 12 for detailed wiring of FTMs. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

7.6.5 Troubleshooting

Fault Detection (Module Hardware)

Each 48 Ch. DI module has a red Fault LED that is turned on when the system is reset. During initialization of a 48 Ch. DI module, which occurs after every CPU module reset, the CPU turns the Fault LED on. The CPU module via the VME bus turns off the Fault LED when the CPU has started execution of the application program and verified that the board is present.

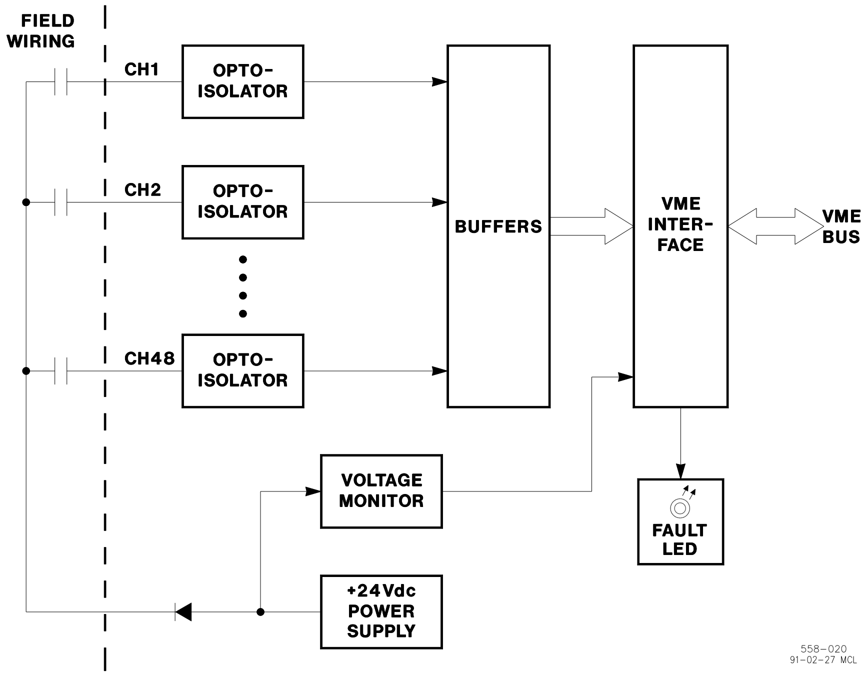


Figure 7-25. Discrete Input Module Block Diagram

Figure 7-48 is a block diagram of the Discrete Input module. The module receives information from as many as 48 field switches and relays. Field wiring is isolated from the MicroNet circuitry by optical isolators in each channel; the state of each discrete input is passed through an optoisolator to the buffers. The CPU then obtains the data for each channel through the VME interface.

If during normal control operation all of a chassis' 48 DI modules have Fault LEDs on, check the chassis' CPU module for a failure.

If a discrete input is not functioning properly, verify the following:

1. Measure the input voltage on the terminal block of the FTM. It should be in the range of 16–32 Vdc.
2. Check the wiring. If the inputs are reading open, look for a loose connection on the terminal blocks, disconnected or misconnected cables, or a missing jumper on the terminal block.
3. Check the application software configuration to ensure that the input is configured properly.
4. If the other channels on the 48 DI module are not working either, check the fuse on the 48 DI module. See the instructions in Chapter 15 for replacing the module. This fuse is visible and can be changed through the bottom of the module. If this fuse is blown, fix the wiring problem and replace the fuse with another fuse of the same type and rating.
5. After verifying all of the above, exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the 48 DI module.
6. If replacing the module does not fix the problem, replace the FTM. See the instructions in Chapter 15 for replacing the FTM.

7.7. 32 Channel Discrete Output Module

Information on this module is found in Volume 3, Chapter 4.

7.8. 64 Channel Discrete Output Module

7.8.1. Module Description

Figure 7-26. Discrete Output Module

The MicroNet control can provide discrete outputs to the prime mover from field wiring. Each of this type Discrete Output (DO) module can individually control 64 outputs according to commands from the CPU module. These modules have no potentiometers and require no calibration. A module may be replaced with another module of the same part number without any adjustment. There are several different FTM I/O configurations for the 64 Ch. DO Module. The module can be connected to two 32 Ch. Relay Module, four 16 Ch. Relay Modules, or a combination of the two types (see Chapter 12 for additional information on the relay modules).

7.8.2 Module Specification

Number of channels: 64
Update time: 5 ms
Output Type: Open drain drivers, intended for use with Woodward relay interface modules.
Fault Detection Readback: Output channel status, relay status is not available
System Faults: Outputs are turned off if communications with the CPU is lost.

For the 16 Ch. Relay Module, and the 32 Ch. Relay Module output specifications, see Chapter 12.

7.8.3 Installation

The modules slide into card guides in the control's chassis and plug into the motherboard. The modules are held in place by two screws, one at the top and one at the bottom of the front panel. Also at the top and bottom of the module are two handles which, when toggled (pushed outward), move the modules out just far enough for the boards to disengage the motherboard connectors.

This module receives digital data from the CPU and generates 64 non-isolated relay driver signals. All discrete output modules in the system interface to one or more Woodward Relay Modules, each with 16 or 32 relays. The contacts of these relays then connect to the field wiring.

A separate 24 Vdc power source must be provided for the relays; this module does not furnish this power. A section of a multi-output Main Power Supply can be used, or power from a single-output Main Power Supply can be used, as long as sufficient current is available.

Each 64 Ch. DO Module is connected through two low-density discrete cables to two 32 Ch. Relay modules or two 16 Ch. Relay modules daisy chained to two additional 16 Ch. Relay modules with two additional low density cables. See Figure 7-55 for system installation configuration.

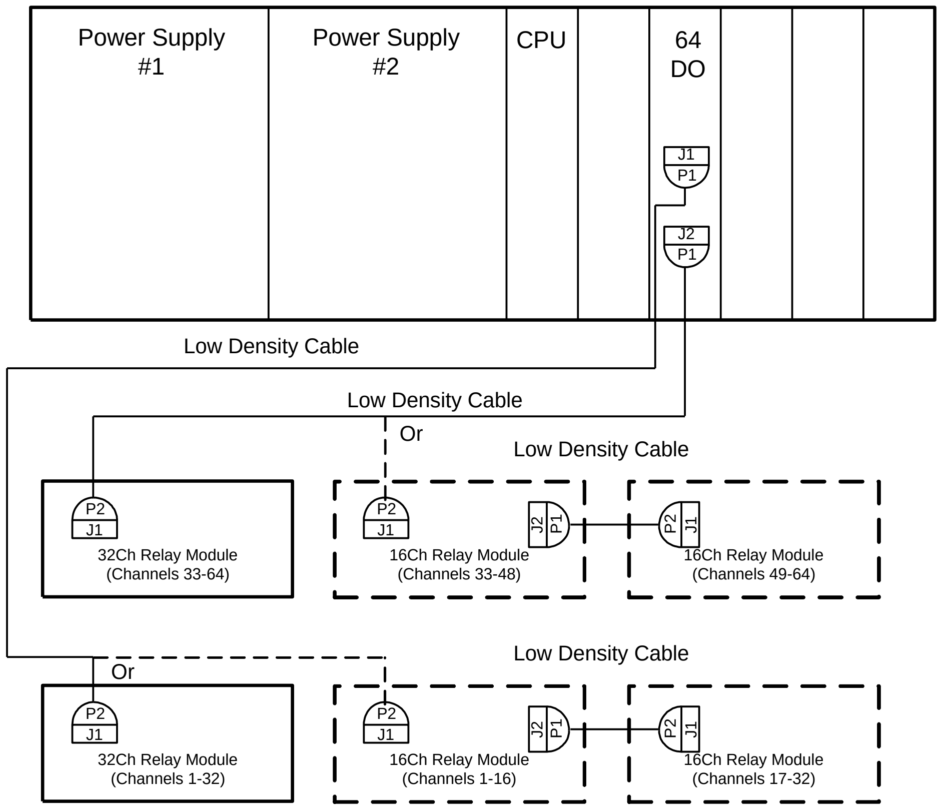


Figure 7-27. 64 Ch. DO Module with Relay Modules

See Chapter 12 for field wiring of discrete output relays.

Figures 7-58 and 7-59 illustrate examples different discrete output wiring configurations.

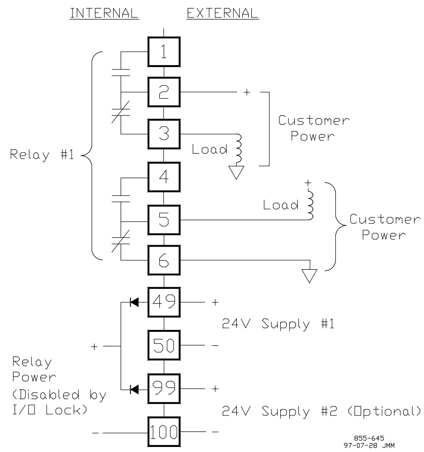


Figure 7-28. Relay Output Interface Wiring to a 16 Ch. Relay Module

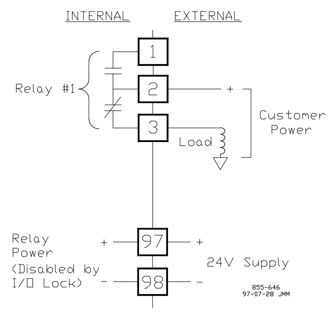


Figure 7-29. Relay Output Interface Wiring to a 32 Ch. Relay Module

Configuration Notes

Verify that each set of relay contacts meets the power requirements of the circuit with which it is being used. Interposing relays are required when the interfaced circuit demands relay contacts with a higher power rating. If interposing relays or other inductive loads are required, it is recommended that interposing relays with surge (inductive kickback) protection be used. Improper connection could cause serious equipment damage.

7.8.4 FTM Reference

The 64 Ch. DO Module uses the same relay modules as the 32 Ch. DO Module. See the previous section.

7.8.5 Troubleshooting

The 64 Ch. DO Module uses the same relay modules as the 32 Ch. DO Module and therefore has the same troubleshooting approach as the 32 Ch. DO Module. See the previous section.

Chapter 8.
Analog I/O Modules

8.1. Introduction

This chapter contains information on those modules that are classified as analog I/O modules. There are two types of analog I/O modules. There are the single function type modules and the combination modules. The combination modules consist of more than one type of input or output. The single type modules consist of a single type of I/O, such as all 4–20 mA inputs.

8.2. Combination I/O Modules

There are seven Analog Combination I/O modules available from Woodward. These are described in sections 8.3 through 8.8 and 8.31.

8.3. TMR 24/8 Analog Module

Information on this module is found in Volume 3, Chapter 5.

8.4. TMR Analog Combo Module

8.4.1 Module Description

Each High Density Analog Combo module contains circuitry for four speed sensor inputs, eight analog inputs, four analog outputs, and two proportional actuator driver outputs. Each speed sensor input may be from a magnetic pick-up or from a proximity probe, each analog input must be 4–20 mA, and each actuator driver may be configured as 4–20 mA or 20–160 mA.

There are three configurations of the Analog Combo Modules. One has the analog inputs configured for 4–20 mA and the other two are configured for 0–5 V. 0–5 V modules are the ones used for TMR, see Appendix A for specific part numbers. In addition to the module, the FTM configuration determines if the 0–5 V or 4–20 mA AI's are available. In a simplex system, either Analog Combo module, 4–20 mA or 0–5 V, is connected through two analog cables to one Analog Combo FTM. All of the I/O are accessible on the FTM, and the channels are labeled to correspond to their software locations, e.g. analog input 1 on the FTM will be analog input 1 in the application software.

This module includes no potentiometers and requires no calibration. An Analog Combo module may be replaced with another module of the same part number without any adjustment.

Figure 8-1. Analog Combo Module

8.4.2 Module Specifications

Digital Speed Sensor Inputs

Number of channels:	4
Update time:	5 ms

MPU Input Ratings

Input frequency:	100 - 25000 Hz
Input amplitude:	1-25 Vrms
Input impedance:	2000 Ohms
Isolation voltage:	500 Vrms
Resolution:	12 bits minimum over chosen frequency range
Accuracy:	0.03% full scale, minimum

Proximity Probe Input Ratings

Input frequency:	0.5 - 25000 Hz
Input amplitude:	3.5 - 32 Vdc input to the module
Available power:	12 Vdc or 24 Vdc, 50 mA maximum
Isolation voltage:	0 Vrms
Resolution:	12 bits minimum over chosen frequency range
Accuracy:	Software calibrated to 0.03% full scale
Fuse:	24 Vdc 100 mA fuse/channel, 12 Vdc short circuit protected
Time Stamping:	5 millisecond resolution on low event and low latch

Analog Input Ratings

Number of channels:	8
Update time:	5 millisecond
Input range:	0–25 mA

IMPORTANT **The maximum input voltage range may vary between 4.975 and 5.025 Volts from module to module.**

Isolation:	0 VRMS, -60 dB CMRR, 200 Vdc common mode rejection voltage; no galvanic isolation
Input impedance:	200 ohms
Anti-aliasing filter:	2 poles at 10 ms

Resolution:	16 bits
Accuracy:	Software calibrated to 0.1%, over 25 mA full scale
Temp drift:	275 ppm/C, maximum
Fuse:	100 mA fuse per channel
Time stamping:	5 ms resolution on low event and latch, and high event and latch

4–20 mA Analog Output Ratings

Number of channels:	4
Update time:	5 ms
Driver:	Pulse Width Modulated (PWM)
PWM frequency:	6.14 kHz
Filter:	3 poles at 500 µs
Current output:	4–20 mA current output range: 0 - 25 mA
Isolation:	0 Vrms
Max load resistance:	600 ohms (load + wire resistance)
Current readback:	11 bits
Readback isolation:	-60 dB CMRR, 200 Vdc common mode
Resolution:	11 bits
Accuracy:	Software calibrated to 0.2%, over 25 mA full scale
Temperature drift:	125 ppm/C, maximum
Readback accuracy:	0.2%, over 25 mA full scale
Readback temp drift:	400 ppm/C, maximum

Actuator Driver Output Ratings

Number of channels:	2
Update time:	5 millisecond
Driver:	PWM (proportional only), single or dual coil
PWM frequency:	6.14 kHz
Filter:	3 poles at 500 microseconds
Current output:	4–20 mA or 20–160 mA, software selectable
Current output range:	0-24 mA or 0–196 mA, depending on the selected range
Isolation:	0 Vrms
Max. act resistance	45 ohms on the 20–160 mA output, 360 ohms on the 4–20 mA output
Readback	Actuator source and return currents
Readback isolation	-60 dB CMRR, 200 Vdc common mode
Dither current	25 Hz, fixed duty cycle, software variable amplitude
Resolution	11 bits over 25 or 200 mA range
Accuracy	Software calibrated to 0.2% of 25 or 200 mA range
Temperature drift	125 ppm/C, maximum
Readback accuracy	0.1% of 25 or 200 mA range
Readback temp drift	150 ppm/C, maximum

8.4.3. Installation

The modules slide into card guides in the control's chassis and plug into the motherboard. The modules are held in place by two screws, one at the top and one at the bottom of the front panel. Also at the top and bottom of the module are two handles which, when toggled (pushed outward), move the modules out just far enough for the boards to disengage the motherboard connectors.

Three TMR Analog Combo Modules (MPU and Analog I/O modules) are connected through six analog cables (two from each module) to two FTMs. Each MPU and Analog I/O module has two sub D connectors on the front panel. The top sub D connector contains the first half of the channels (speed sensor channels 1 and 2, actuator channel 1, analog output channels 1 and 2, and analog input channels 1-4), and the bottom sub D connector contains the second half of the I/O channels. See Figure 8-6 for an example.

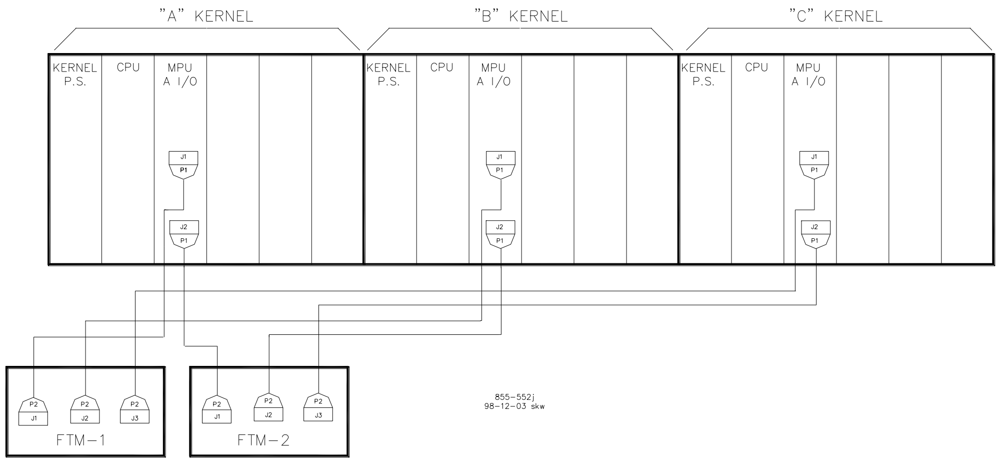


Figure 8-2. Example Fault Tolerant System Configuration

8.4.3.1. Field Wiring

See Chapter 12 for complete wiring connections for the TMR Analog Combo FTM. Wire each channel per the following examples for each type of signal.

Note: The Analog Combo Module will exhibit deviations on speed inputs during significant ground "bounce" events like surge from lightning strikes or switching for of high current inductive loads when cables are longer than 30 m. If these transients are present at an installation sight and are affecting the analog combo module signal readings either filter the I/O response times in GAP to ignore the deviations or provide the cabling for the MicroNet TMR with intervening isolators.

8.4.3.2. Speed Sensor Inputs

The MPU and proximity probe inputs are read and the speed is provided to the application program. A derivative output is provided via the application software if desired. The speed sensor inputs are filtered by the Analog Combo module and the filter time constant is selectable through the application software program at 8 milliseconds or 16 milliseconds. Eight milliseconds should be acceptable for most applications. 16 milliseconds may be necessary for very slow speed applications. The speed range determines the maximum speed that the module will detect. The control output of the software will detect a minimum speed of one fiftieth of the speed range. This allows detection of failed speed sensors to help prevent overspeed due to slow update times at very low speeds. The monitor output of the GAP block will read down to 0.5 Hz, irrespective of the speed range. An application may use any combination of accepted MPU and proximity probes, and any combination of speed ranges.

Any of the module's four speed channels accepts passive magnetic pickup units (MPUs) or proximity probes. Each speed input channel can only accept one MPU or one proximity probe.

A proximity probe may be used to sense very low speeds. With a proximity probe, speed can be sensed down to 0.5 Hz. When interfacing to open collector type proximity probes, a pull-up resistor is required between the supplied proximity probe voltage and the proximity probe input to the FTM. Individually fused 12 Vdc and 24 Vdc sources are provided with each speed input to power system proximity probes (100 mA fuses, located on the FTMs, are used). External pull-up resistors are required when interfacing with an open collector type proximity probe. See Figure 8-7 for MPU/proximity probe wiring example. Channel 1 shows an MPU connection, channel 2 shows a 24 V proximity connection, and channel 3 is an example of a 12 V proximity connection. Always jumper the unused MPU connection to eliminate possible noise interference when connecting a proximity probe.

IMPORTANT

It is not recommended that gears mounted on an auxiliary shaft coupled to the rotor be used to sense speed. Auxiliary shafts tend to turn more slowly than the rotor (reducing speed sensing resolution) and have coupling gear backlash, resulting in less than optimum speed control. For safety purposes, it is also not recommended that the speed sensing device sense speed from a gear coupled to a mechanical drive side of a system's rotor coupling.

IMPORTANT

When a speed sensor input channel has been wired as *either* MPU or proximity probe input, the unused MPU/Prox must be jumpered at the FTM. When an input channel is not used, both the MPU and Prox inputs must be jumpered. See example in Figure 8-7.

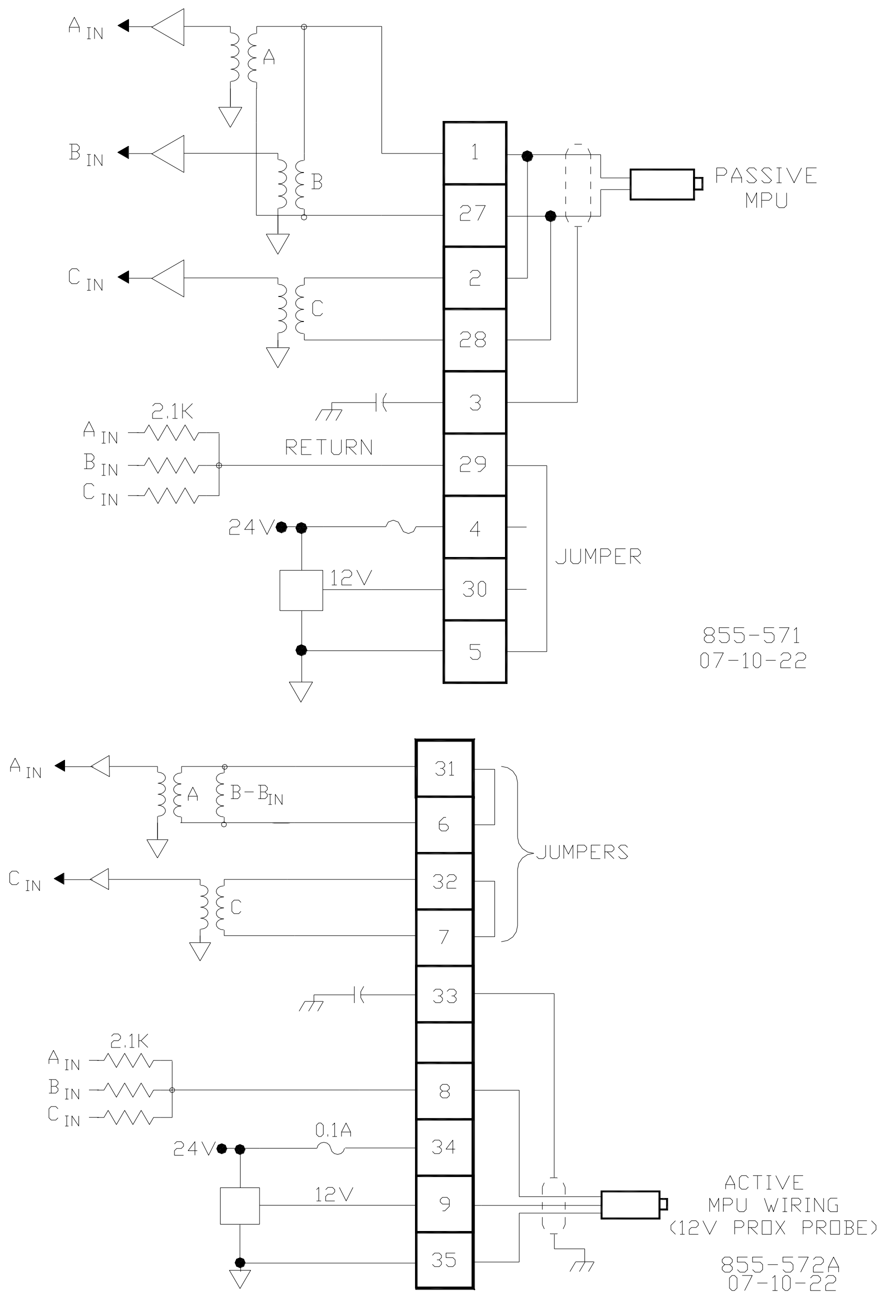


Figure 8-3. MPU/Proximity Interface Wiring to the TMR Analog Combo FTM

Analog Inputs

The TMR analog inputs must be current type due to the TMR FTM. See Appendix A for specific part numbers. All modules use the same cable and FTMs.

All current inputs may be used with two-wire ungrounded (loop powered) transducers or isolated (self-powered) transducers. All analog inputs have 200 Vdc of common mode rejection. If interfacing to a non-isolated device, which may have the potential of reaching over 200 Vdc with respect to the control's common, the use of a loop isolator is recommended to break any return current paths that may produce erroneous readings. All current inputs use 200 ohm resistors across their inputs.

Each current input channel may power its own 4–20 mA transducer. This power is protected with a 100 mA fuse on each channel to prevent an inadvertent short from damaging the module. The 24 Vdc outputs are capable of providing 24 Vdc with ±10% regulation. Power connections can be made through terminals located on the FTMs. Refer to Figure 8-8 for 4–20 mA Current Input wiring.

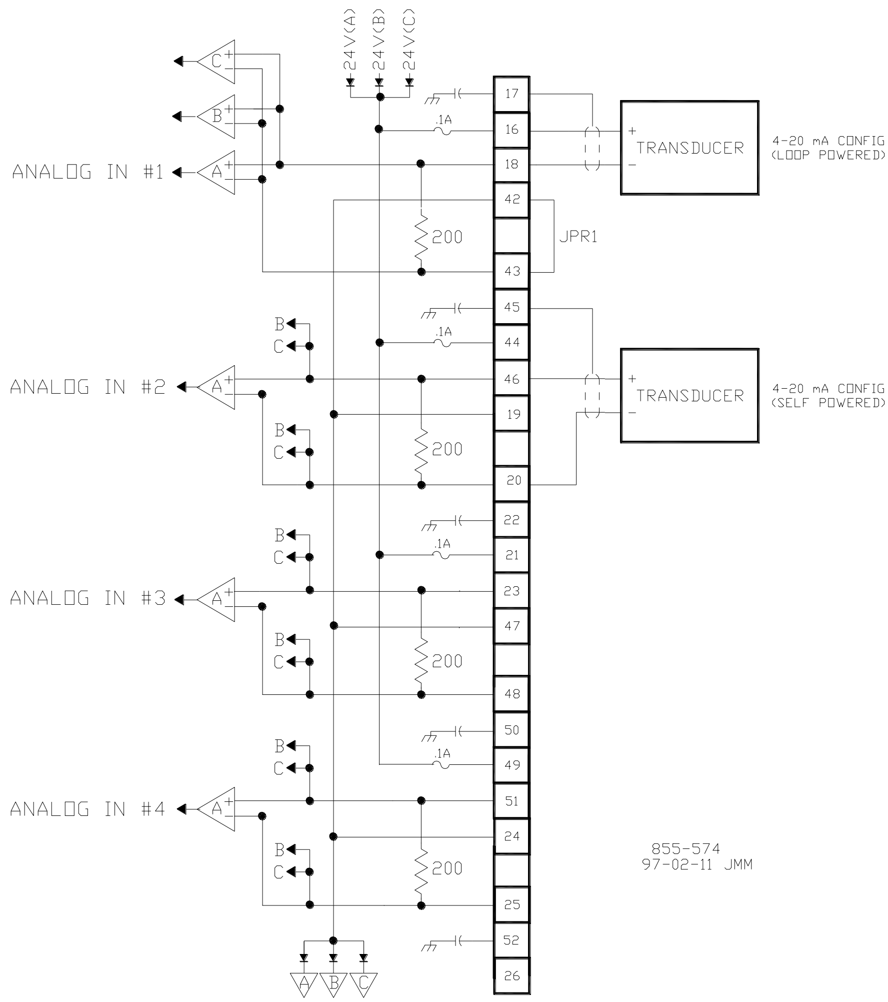


Figure 8-4. Current Input Wiring for an Analog Combo Module FTM

Only self-powered voltage transducers should be used on voltage input channels. The full-scale range must not exceed 5 volts. Refer to Figure 8-9 for 0–5 Vdc voltage transducer input wiring.

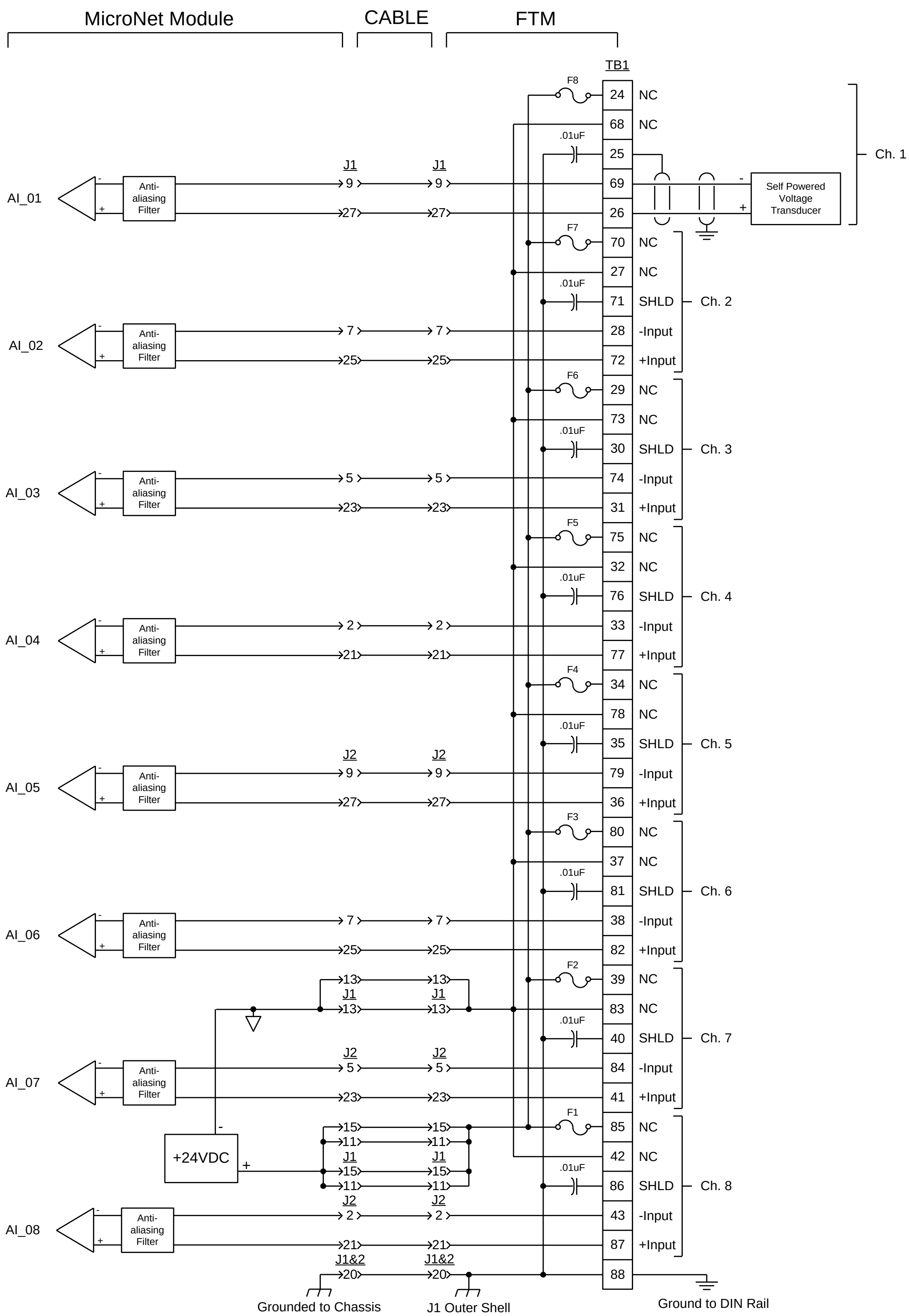


Figure 8-5. Voltage Input Wiring for an Analog Combo Module FTM (Simplex)

Analog Outputs

The analog outputs are 4–20 mA with a full-scale range of 0–25 mA. Each output monitors the output source current for fault detection. All of the analog outputs may be individually disabled. When a channel fault or a module fault is detected, the application program may annunciate the fault, disable the channel or module, and stop using the data in system calculations or control.

The Analog Combo module has four 4–20 mA current output drivers. All analog outputs can drive a maximum load of 600 ohms (load + wire resistance). Care should be taken to prevent ground loops and other faults when interfacing to non-isolated devices. See Figure 8-10 for an example of 4–20 mA output wiring.

Actuator Outputs

The actuator outputs may be configured for 4–20 mA or 20–160 mA. Configuration is done through the application software; no hardware modifications in the forms of jumpers or switches are necessary. For fault detection, each output monitors the output source current and the output return current. All of the actuator outputs may be individually disabled. When a channel fault or a module fault is detected, the application program may annunciate the fault, disable the channel or module, and stop using the data in system calculations or control.

Dither may be provided in the application software for each output. Dither is a low frequency (25 Hz) signal consisting of a 5 millisecond pulse modulated onto the DC actuator-drive current to reduce sticking due to friction in linear type actuators. Woodward TM-type actuators typically require dither. Dither amplitude is variable through the application software. See Figure 8-10 for an example of actuator wiring.

IMPORTANT

For a dual coil actuator, two actuator driver outputs must be used.

Configuration Notes

- Maximum impedance for a 4 to 20 mA actuator output driver is 360 ohms (actuator impedance + wire resistance).
- Maximum impedance for a 20 to 160 mA actuator output is 45 ohms (actuator impedance + wire resistance).
- Each actuator driver senses its source and return current to allow overcurrent and undercurrent alarms and shutdowns.

Released

8.4.4. FTM Reference

See Chapter 12 for complete Analog Combo FTM field wiring information. See Appendix A for proper Module, FTM, and cable part numbers.

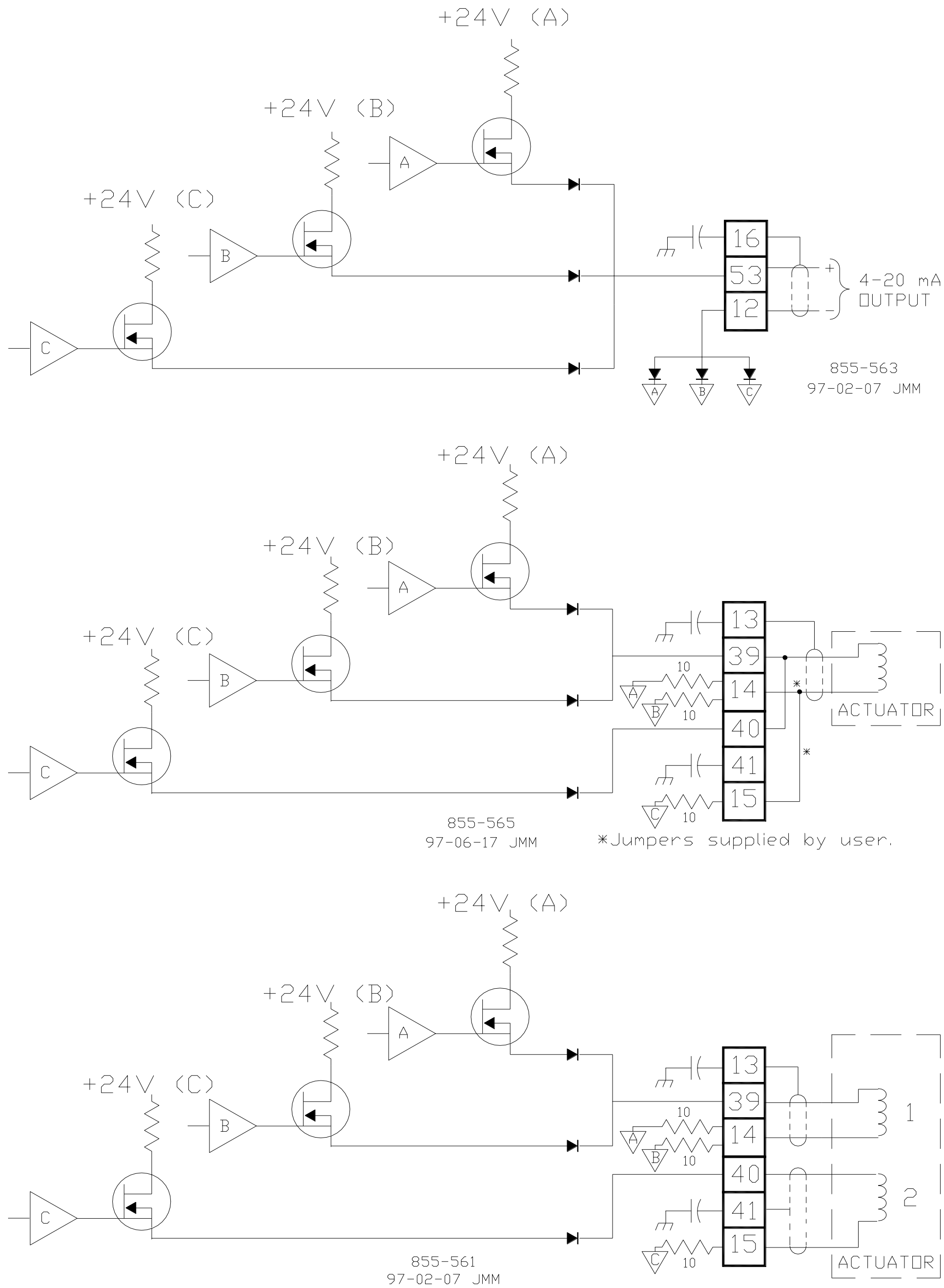


Figure 8-6. Analog Output and Actuator Wiring for an Analog Combo FTM

8.4.5 Troubleshooting

8.4.5.1 Fault Detection (Module Hardware)

Each Analog Combo module has a red Fault LED that is turned on when the system is reset. During initialization of a module, which occurs after every CPU reset, the CPU turns the Fault LED on. The CPU then tests the module using diagnostic routines built into the software. If the diagnostic test is not passed, the LED remains on or blinks. If the test is successful, the LED goes off. If the Fault LED on a module is illuminated after the diagnostics and initialization have been completed, the Analog Combo module may be faulty or may be located in the wrong slot.

Table 8-1. LED Indications of Failure

Number of LED Flashes	Failure
1	Hardware watchdog, CPU clock failure, reset fail
2	Micro-controller internal RAM test failure
3	External RAM test failure
4	Unexpected exception error
5	Dual Port RAM test failure
6	EEPROM failure
7	Communications watchdog time out

8.4.5.2 Fault Detection (I/O)

In addition to detecting module hardware faults, the application program may detect I/O faults.

Analog Input Faults. The application software may set a high and low latch setpoint to detect input faults.

Speed Sensor Input Faults. The application software may set a high and low latch setpoint to detect input faults. The low latch setpoint must be greater than one fiftieth of the frequency range.

Analog Output Driver Faults: The module monitors the source currents and annunciates faults. The application determines the course of action in the event of a fault.

Actuator Driver or Load Faults: The module monitors the source and return currents and annunciates faults. The application determines the course of action in the event of a fault.

Micro-controller Faults: The system monitors a software watchdog, a hardware watchdog, and a software watchdog on the VME bus communications. All outputs are shutdown in the event of a microcontroller fault.

Troubleshooting Guide

If during normal control operation, all of a chassis' TMR Analog Combo I/O modules have Fault LEDs on, check the kernel's CPU module for a failure. If during normal control operation, only the MPU and Analog I/O module's Fault LED is on or flashing, insure that it is installed in the correct slot. If it is, then replace that MPU and Analog I/O module. See instructions for replacing the module in Chapter 14 Installation and Replacement Procedures. When a module fault is detected, its outputs should be disabled or de-energized.

Speed Sensor Inputs

MPUs: If a speed sensor input is not functioning properly, verify the following:

- Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 14 Installation and Replacement Procedures.
- Measure the input voltage on the terminal block. It should be in the range of 1–25 VRMS.
- Verify that the signal waveform is clean and void of double zero crossings.
- Verify that no ground connection exists and that the resulting 60 Hz signal is absent.
- Measure the frequency. It should be in the range of 100 Hz - 25 kHz.

Look at the individual inputs into each kernel. A and B should read an input, and C should also read this input if the terminal block jumpers are installed. The application software should contain three separate numbers, one from each module. The numbers should be within 0.1% of each other, except kernel C if the jumpers are not installed.
Verify that any unused MPU/Prox inputs are jumpered per Figure 8-7.

⚠CAUTION	**The following actions may shut down the prime mover. If all of the MPU and Analog I/O modules are reading approximately the same number, but it is not the right reading, go to step 1. If two of the MPU and Analog I/O modules are reading correctly, but one is reading incorrectly, go to step 2.**

1. Check the wiring. If the inputs are reading 0, look for a loose connection on the terminal blocks or disconnected or misconnected cables. Check the application software configuration to ensure that the input is configured properly. If the connections and application software are verified and the correct voltage is present on the terminal block, but all of the MPU and Analog I/O modules are reading 0 V (with a meter), exchange FTM #1 with FTM #2. See instructions for replacing the FTM in Chapter 14, Installation and Replacement Procedures. If the problem follows the FTM, replace the FTM. The FTM contains only traces and a few discrete components, so failure is extremely unlikely.

2. If one or two of the MPU and Analog I/O modules are reading the correct number, but the other module(s) is (are) incorrect, check the application software configuration of the modules with the non-working channels. Also, check to ensure that the cables are connected properly. If C kernel is not working, but A and B are, check to insure that the terminal block jumpers are installed and if the MPU can drive three inputs. If the reading is still incorrect, but the other readings from the MPU and Analog I/O module are correct, remove the MPU and Analog I/O module and exchange the J1 and J2 cables. See instructions for replacing the module in Chapter 14 Installation and Replacement Procedures. If the problem moves to a different channel, replace the cable. If not, replace the MPU and Analog I/O module. If the readings are incorrect on several channels of the same MPU and Analog I/O module, corresponding to both cables, replace the MPU and Analog I/O module.

Proximity Probes

If a speed sensor input is not functioning properly, verify the following:

- Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 14 Installation and Replacement Procedures.
- Measure the input voltage on the terminal block. It should be in the range of 3.5 - 32 Vpeak.
- Verify that the signal waveform is clean and void of double zero crossings.
- Verify that no ground connection exists and that the resulting 60 Hz signal is absent.
- Measure the frequency. It should be in the range of 0.5 Hz, to 25 kHz.
- Check the wiring. Look for a loose connection at the terminal blocks, disconnected or misconnected cables, a missing jumper on the terminal block, or a blown fuse on the 24 Vdc on the FTM. See Figure 8-11 or 8-12 for FTM fuse locations.
- Check the software configuration to ensure that the input is configured properly.
- Check the fuse on the FTM. See the instructions and fuse locations below.
- If the other channels on the MPU and Analog I/O module are also not working, check the fuse on the MPU and Analog I/O module. This fuse is visible and can be changed through the bottom of the module. If the fuse is blown, fix the wiring problem and replace the fuse with another fuse of the same type and rating.
- Look at the individual inputs into each kernel. Each module reads the same input from the FTM, so the software should contain three separate numbers, one from each MPU and Analog I/O module. The numbers should be within 0.1% of each other unless a high common mode voltage is present.
- Verify that any unused MPU/Prox inputs are jumpered per Figure 8-7.

CAUTION **The following actions may shut down the prime mover. If all of the MPU and Analog I/O modules are reading approximately the same number, but it is not the right reading, go to step 1. If two of the modules are reading correctly, but one is reading incorrectly, go to step 2.**

- Check the wiring. If the inputs are reading 0, look for a loose connection on the terminal blocks, disconnected or misconnected cables, a missing jumper on the terminal block, or a blown fuse on the 24 Vdc on the FTM. See instructions for replacing the fuse, below. Check the MPU and Analog I/O module fuse. See instructions for replacing the module in Chapter 14 Installation and Replacement Procedures. This fuse is visible and can be changed through the bottom of the module. If the fuse is blown, fix the wiring problem, then replace the fuse with another fuse of the same type and rating. Check the application software configuration to ensure that the input is configured properly. If the connections and application software are verified and the correct voltage is present on the terminal block, but all of the MPU and Analog I/O modules are reading 0 V (with a meter), exchange FTM #1 with FTM #2. See instructions for replacing the FTM in Chapter 14 Installation and Replacement Procedures. If the problem follows the FTM, replace the FTM. The FTM contains only a wire wound 3 W resistor and traces, so failure is extremely unlikely.
- If one or two of the MPU and Analog I/O modules are reading the correct number, but the other module(s) is (are) incorrect, check the application software configuration of the modules with the non-working channels, and check to ensure that the cables are connected properly. If the other channels on the same MPU and Analog I/O module are also not working, check the fuse on the MPU and Analog I/O module. See the instructions for replacing the module in Chapter 14 Installation and Replacement Procedures. This fuse is visible and can be changed through the bottom of the module. If this fuse is blown, fix the wiring problem and replace the fuse with a fuse of the same type and rating. If the reading is still incorrect, but the other readings from the MPU and Analog I/O module are correct, remove the MPU and Analog I/O module and exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the MPU and Analog I/O module. If the readings are incorrect on several channels of the MPU and Analog I/O module, corresponding to both cables, replace the MPU and Analog I/O module.

Analog Inputs

If an analog input is not functioning properly, verify the following:

- Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 14 Installation and Replacement Procedures.

Measure the input voltage on the terminal block. It should be in the range of
0–5 V.

- Look at the individual inputs into each kernel. Each module reads the same input from the FTM, so the application software should contain three separate numbers, one from each MPU and Analog I/O module. The numbers should be within 0.1% of each other unless a high common mode voltage is present.
- Check the wiring. If the inputs are reading 0 or the engineering units that correspond to 0 mA, look for a loose connection on the terminal blocks, disconnected or misconnected cables, and a missing jumper on the terminal block if the input is a current input, or a blown fuse on the 24 Vdc on the FTM. See Figure 8-11 or 8-12 for FTM fuse locations.
- If all of the inputs are reading high, check that the 24 Vdc is not connected across the input directly.
- Check the software configuration to ensure that the input is configured properly.
- Check the fuse on the FTM. See the instructions and fuse locations below.

CAUTION **The following actions may shut down the prime mover. If all of the MPU and Analog I/O modules are reading approximately the same number, but the reading is incorrect, go to step 1. If two of the MPU and Analog I/O modules are reading correctly, but one is reading incorrectly, go to step 2.**

- Check the wiring. If the inputs are reading zero or the engineering units that correspond to 0 mA, look for a loose connection on the terminal blocks, disconnected or misconnected cables, a missing jumper on the terminal block if the input is a loop powered current input, or a blown fuse on the 24 Vdc on the FTM. See instructions for replacing the fuses on the FTM, below. If all of the inputs are reading high, check to ensure that the 24 Vdc is not connected across the input directly. Check the MPU and Analog I/O module fuse. See instructions for replacing the module in Chapter 14, Installation and Replacement Procedures. This fuse is visible and can be changed through the bottom of the module. If the fuse is blown, fix the wiring problem, then replace the fuse with another fuse of the same type and rating. Check the application software configuration to ensure that the input is configured properly. If the connections and application software are verified and the correct voltage is present on the terminal block, but all of the MPU and Analog I/O modules are reading 0 V, exchange FTM #1 with FTM #2. See instructions for replacing the FTM in Chapter 14 Installation and Replacement Procedures. If the problem follows the FTM, replace the FTM. The FTM contains only a wire wound
  3 W resistor and traces, so failure is extremely unlikely.
- If one or two of the MPU and Analog I/O modules are reading the correct number, but the other module(s) is (are) incorrect, check the application software configuration of the modules with the non-working channels, and check to ensure that the cables are connected properly. If the other channels on the same MPU and Analog I/O module are not working either, check the fuse on the MPU and Analog I/O module. See instructions for replacing the module in Chapter 14 Installation and Replacement Procedures. This fuse is visible and can be changed through the bottom of the module. If this fuse is blown, fix the wiring problem and replace the fuse with a fuse of the same type and rating. If the reading is still incorrect, but the other readings from the MPU and Analog I/O module are correct, remove the MPU and Analog I/O module and exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the MPU and Analog I/O module. If the readings are incorrect on several channels of the MPU and Analog I/O module, corresponding to both cables, replace the MPU and Analog I/O module.

Analog Outputs

If an analog output is not functioning properly, verify the following:

- Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 14 Installation and Replacement Procedures.
- Check the load resistance to ensure that it is below 600 ohms.
- Check to ensure that the load wiring is isolated.
- Check the wiring for a loose connection on the terminal blocks and disconnected or misconnected cables.
- Disconnect the field wiring and connect a resistor across the output. If the output is correct across the resistor, there is a problem with the field wiring.
- If the other output channels on the MPU and Analog I/O module are also not working, check the fuse on the MPU and Analog I/O module. See instructions for module replacement in Chapter 14 Installation and Replacement Procedures. This fuse is visible and can be changed through the bottom of the module. If the fuse is blown, fix the wiring problem and replace the fuse with a fuse of the same type and rating.
- Check the software configuration to ensure that the output is configured properly.

⚠ CAUTION	**The following actions may shut down the prime mover. Disconnect the field wiring and connect a resistor across the output. If the output current is 0 mA, go to step 1. If the output current is correct, but some of the outputs have a fault, go to step 2.**

- Check the wiring for a loose connection on the terminal blocks or disconnected or misconnected cables. If none of the outputs on a given MPU and Analog I/O module is functioning, check the MPU and Analog I/O module fuse. See instructions for replacing the module in Chapter 14 Installation and Replacement Procedures. This fuse is visible and can be changed through the bottom of the module. If the fuse is blown, fix the wiring problem, then replace the fuse with another fuse of the same type and rating. Check the application software configuration to ensure that the output is configured properly. If the connections and application software are verified, exchange FTM #1 with FTM #2. See instructions for replacing the FTM in Chapter 14 Installation and Replacement Procedures. If the problem follows the FTM, replace the FTM. The FTM contains only traces and a few discrete components, so failure is extremely unlikely.
- If one or two of the MPU and Analog I/O modules have an output fault, but the other module(s) does (do) not, check the application software, and check to ensure that the cables are connected properly. If the other output channels on the same MPU and Analog I/O module are also not working, check the fuse on the MPU and Analog I/O module. See instructions for replacing the module in Chapter 14 Installation and Replacement Procedures. This fuse is visible and can be changed through the bottom of the module. If the fuse is blown, fix the wiring problem and replace the fuse with a fuse of the same type and rating. If the output still has a fault, but the other output channels on the MPU and Analog I/O module are functioning properly, remove the MPU and Analog I/O module and exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the MPU and Analog I/O module. If the readings are incorrect on several channels of the MPU and Analog I/O module, corresponding to both cables, replace the same MPU and Analog I/O module.

Actuator Outputs

If an actuator output is not functioning properly, verify the following:

- Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 14 Installation and Replacement Procedures.
- Check the load resistance to ensure that it is below the specified limit.
- Check to ensure that the load wiring is isolated.
- Check the wiring for a loose connection on the terminal blocks or disconnected or misconnected cables.
- Disconnect the field wiring and connect a resistor across the output.
- If the other output channels on the MPU and Analog I/O module are also not working, check the fuse on the MPU and Analog I/O module. See instructions for module replacement in Chapter 14 Installation and Replacement Procedures. This fuse is visible and can be changed through the bottom of the module. If the fuse is blown, fix the wiring problem, and replace the fuse with a fuse of the same type and rating.
- Check the software configuration to ensure that the output is configured properly

⚠CAUTION	**The following actions may shut down the prime mover. Disconnect the field wiring and connect a resistor across the output; if the output current is 0 mA, go to step 1. If the output current is correct, but some of the outputs have a fault, go to step 2.**

- Check the wiring for a loose connection on the terminal blocks, or disconnected or misconnected cables. If none of the outputs on a given MPU and Analog I/O module are functioning, check the MPU and Analog I/O module fuse. See instructions for replacing the module in Chapter 14 Installation and Replacement Procedures. This fuse is visible and can be changed through the bottom of the module. If the fuse is blown, fix the wiring problem, then replace the fuse with another fuse of the same type and rating. Check the application software configuration to ensure that the output is configured properly. If the connections and application software are verified, exchange FTM #1 with FTM #2. See instructions for replacing the FTM in Chapter 14, Installation and Replacement Procedures. If the problem follows the FTM, replace the FTM. The FTM contains only traces and a few discrete components, so failure is extremely unlikely.

- If one or two of the MPU and Analog I/O modules have an output fault, but the other module(s) does (do) not, check the application software configuration, and check to ensure that the cables are connected properly. Check the wiring for dual coil and single coil actuators, and ensure that the wiring configuration matches the application software configuration. If the other output channels on the same MPU and Analog I/O module are also not working, check the fuse on the MPU and Analog I/O module. See instructions for replacing the module in Chapter 14 Installation and Replacement Procedures. This fuse is visible and can be changed through the bottom of the module. If this fuse is blown, fix the wiring problem and replace the fuse with a fuse of the same type and rating. If the output still has a fault, but the other output channels on the MPU and Analog I/O module are functioning properly, remove the MPU and Analog I/O module and exchange the J1 and J2 cables. If the problem moves to the other channel, replace the cable. If not, replace the MPU and Analog I/O module. If the readings are incorrect on several channels of the same MPU and Analog I/O module, corresponding to both cables, replace the MPU and Analog I/O module.

Replacing a Fuse on the Field Terminal Module (FTM)

1. Verify that the condition that caused the fuse to blow has been corrected.

⚠ CAUTION	**If power has not been removed from the control system, power will be active at the module and at the FTM. Shorting of protected circuitry could cause a control system shutdown.**

2. Remove FTM cover carefully, to prevent contact with any FTM circuitry under the cover. To remove the FTM cover, pinch the retaining barb and lift the cover.
3. Locate and replace the fuse with another fuse of the same size and rating. See Figure 8-11 or Figure 8-12 for channel fuse locations.
4. Replace the FTM cover.

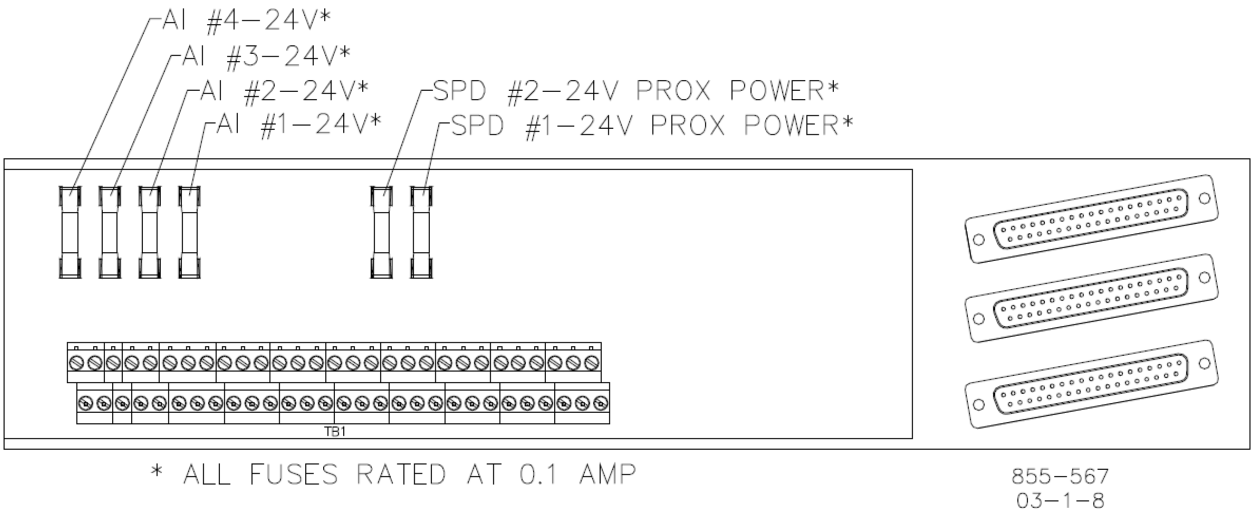


Figure 8-7. TMR MPU and Analog I/O Module FTM Fuse Locations

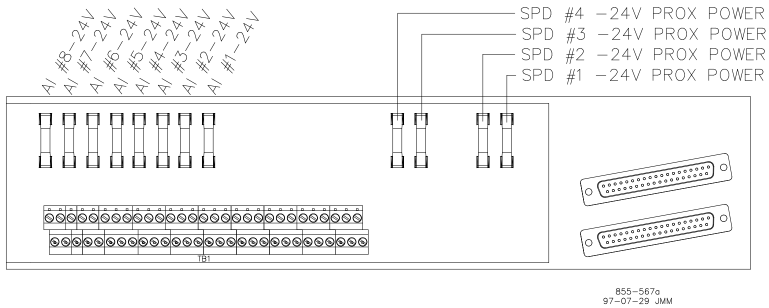


Figure 8-8. MPU and Analog I/O Module FTM Fuse Locations

8.5. TMR Analog Combo Module – 3 MPU, 1 Prox

Information on this module is found in Volume 3, Chapter 5.

8.6. 24/8 Analog Module

Information on this module is found in Volume 3, Chapter 5.

8.7. Dataforth 24/8 Analog Module

Information on this module is found in Volume 3, Chapter 5.

8.8. Analog Combo Module

8.8.1—Module Description

Each High Density Analog Combo module contains circuitry for four speed sensor inputs, eight analog inputs, four analog outputs, and two proportional actuator driver outputs. Each speed sensor input may be from a magnetic pick-up or from a proximity probe, each analog input may be 4–20 mA or 0–5 V, and each actuator driver may be configured as 4–20 mA or 20–160 mA.

There are two configurations of the Analog Combo Modules. One has the analog inputs configured for 4–20 mA and the other is configured for 0–5 V. See Appendix A for specific part numbers. In a simplex system, either Analog Combo module is connected through two analog cables to one Analog Combo FTM. All of the I/O are accessible on the FTM, and the channels are labeled to correspond to their software locations, e.g. analog input 1 on the FTM will be analog input 1 in the application software.

This module includes no potentiometers and requires no calibration. An Analog Combo module may be replaced with another module of the same part number without any adjustment.

Figure 8-9. Analog Combo Module

8.8.2 Module Specifications

8.8.2.1 Digital Speed Sensor Inputs

Number of channels:	4
Update time:	5 ms

8.8.2.2 MPU Input Ratings

Input frequency:	100 - 25000 Hz
Input amplitude:	1-25 Vrms
Input impedance:	2000 Ohms
Isolation voltage:	500 Vrms
Resolution:	12 bits minimum over chosen frequency range
Accuracy:	0.03% full scale, minimum

8.8.2.3 Proximity Probe Input Ratings

Input frequency:	0.5 - 25000 Hz
Input amplitude:	3.5 - 32 Vdc input to the module
Available power:	12 Vdc or 24 Vdc, 50 mA maximum
Isolation voltage:	0 Vrms
Resolution:	12 bits minimum over chosen frequency range
Accuracy:	Software calibrated to 0.03% full scale
Fuse:	24 Vdc 100 mA fuse/channel, 12 Vdc short circuit protected
Time Stamping:	5 millisecond resolution on low event and low latch

8.8.2.4 Analog Input Ratings

Number of channels:	8
Update time:	5 millisecond
Input range:	0–25 mA, or 0–5 V; Dependent on module part number.

IMPORTANT **The maximum input voltage range may vary between 4.975 and 5.025 Volts from module to module.**

Isolation:	0 VRMS, -60 dB CMRR, 200 Vdc common mode rejection voltage; no galvanic isolation
Input impedance:	200 ohms
Anti-aliasing filter:	2 poles at 10 ms
Resolution:	16 bits
Accuracy:	Software calibrated to 0.1%, over 25 mA full scale
Temp drift:	275 ppm/C, maximum
Fuse:	100 mA fuse per channel
Time stamping:	5 ms resolution on low event and latch, and high event and latch

8.8.2.5 4–20 mA Analog Output Ratings

Number of channels:	4
Update time:	5 ms
Driver:	Pulse Width Modulated (PWM)
PWM frequency:	6.14 kHz
Filter:	3 poles at 500 ms
Current output:	4–20 mA current output range: 0 - 25 mA
Isolation:	0 Vrms
Max load resistance:	600 ohms (load + wire resistance)
Current readback:	11 bits
Readback isolation:	-60 dB CMRR, 200 Vdc common mode
Resolution:	11 bits
Accuracy:	Software calibrated to 0.2%, over 25 mA full scale
Temperature drift:	125 ppm/C, maximum
Readback accuracy:	0.2%, over 25 mA full scale
Readback temp drift:	400 ppm/C, maximum

8.8.2.6 Actuator Driver Output Ratings

Number of channels:	2
Update time:	5 millisecond
Driver:	PWM (proportional only), single or dual coil
PWM frequency:	6.14 kHz
Filter:	3 poles at 500 microseconds
Current output:	4–20 mA or 20–160 mA, software selectable
Current output range:	0-24 mA or 0–196 mA, depending on the selected range
Isolation:	0 Vrms
Max. act resistance	45 ohms on the 20–160 mA output, 360 ohms on the 4–20 mA output
Readback	Actuator source and return currents
Readback isolation	-60 dB CMRR, 200 Vdc common mode
Dither current	25 Hz, fixed duty cycle, software variable amplitude
Resolution	11 bits over 25 or 200 mA range
Accuracy	Software calibrated to 0.2% of 25 or 200 mA range
Temperature drift	125 ppm/C, maximum
Readback accuracy	0.1% of 25 or 200 mA range
Readback temp drift	150 ppm/C, maximum

8.8.3. Installation

The modules slide into card guides in the control's chassis and plug into the motherboard. The modules are held in place by two screws, one at the top and one at the bottom of the front panel. Also at the top and bottom of the module are two handles which, when toggled (pushed outward), move the modules out just far enough for the boards to disengage the motherboard connectors.

There are two configurations of the Analog Combo Modules. One has the analog inputs configured for 4–20 mA and the other is configured for 0–5 V. See Appendix A for specific part numbers. In a simplex system, each Analog Combo module is connected through two Low Density analog cables to one Analog Combo FTM. All of the I/O are accessible on the FTM, and the channels are labeled to correspond to their software locations. See Figure 8-36 for configuration.

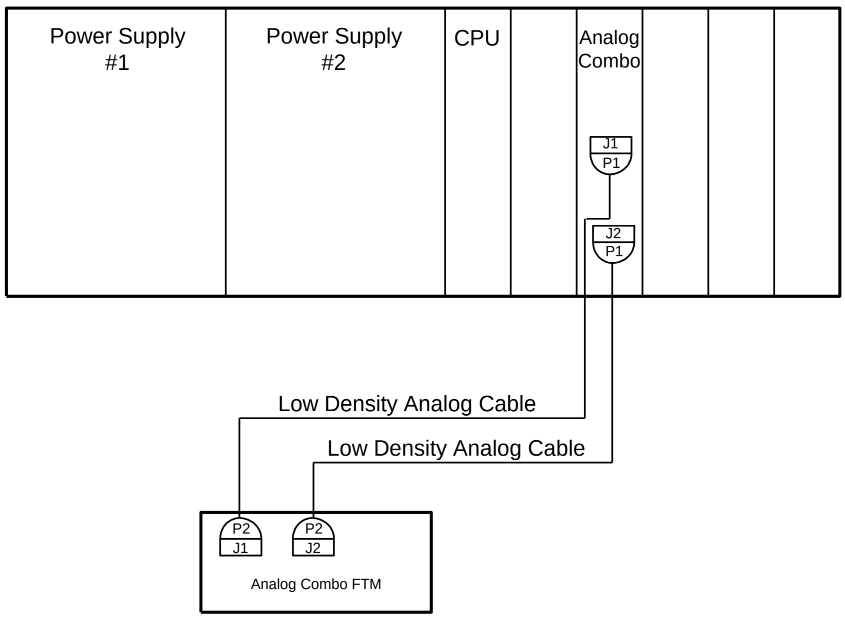


Figure 8-10. Simplex System Configuration Example

8.8.3.1 Field Wiring

See Chapter 12 for complete wiring connections for the Analog Combo FTM. Wire each channel per the following examples for each type of signal.

NOTICE

CE COMPLIANCE—MPU / proximity probe field wiring cables should be limited to less than 30 m (100 ft) for best EMC surge performance.

Degraded surge performance may occur under the following conditions:

- **cable lengths greater than 30 m**
- **ground fault conditions created by poor cable shield termination**
- **DGND coupled/connected to protective earth**

8.8.3.2 Speed Sensor Inputs

The MPU and proximity probe inputs are read and the speed is provided to the application program. A derivative output is provided via the application software if desired. The speed sensor inputs are filtered by the Analog Combo module and the filter time constant is selectable through the application software program at 8 milliseconds or 16 milliseconds. Eight milliseconds should be acceptable for most applications. 16 milliseconds may be necessary for very slow speed applications. The speed range determines the maximum speed that the module will detect. The control output of the software will detect a minimum speed of one fiftieth of the speed range. This allows detection of failed speed sensors to help prevent overspeed due to slow update times at very low speeds. The monitor output of the GAP block will read down to 0.5 Hz, irrespective of the speed range. An application may use any combination of accepted MPU and proximity probes, and any combination of speed ranges.

Any of the module's four speed channels accepts passive magnetic pickup units (MPUs) or proximity probes. Each speed input channel can only accept one MPU or one proximity probe.

IMPORTANT	**When a speed sensor input channel has been wired as *either* MPU or proximity probe input, the unused MPU/Prox must be jumpered at the FTM. When an input channel is not used, both the MPU and Prox inputs must be jumpered. See example in Figure 8-37.**

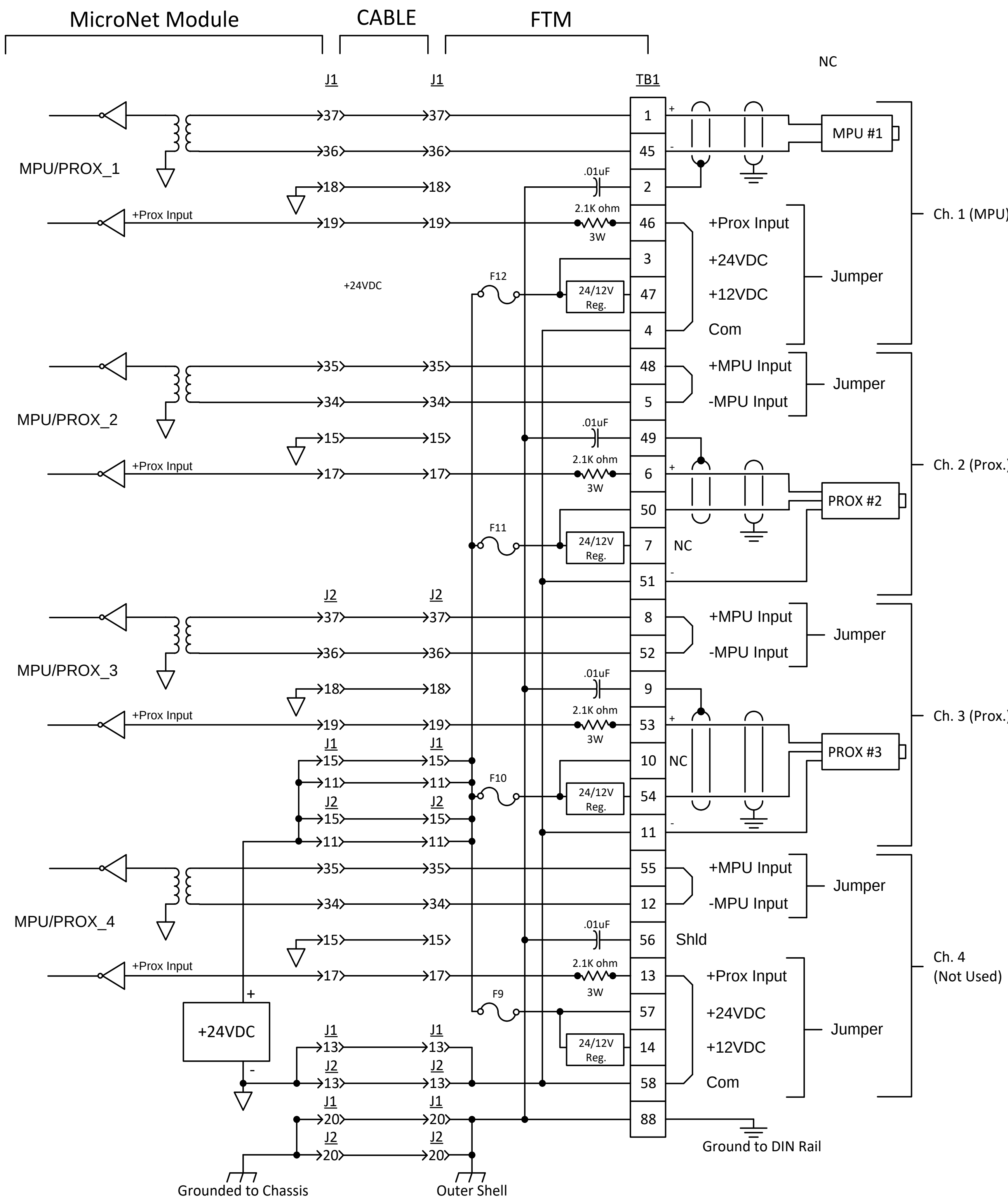


Figure 8-11. MPU/Proximity Interface Wiring to the Analog Combo FTM

A proximity probe may be used to sense very low speeds. With a proximity probe, speed can be sensed down to 0.5 Hz. When interfacing to open collector type proximity probes, a pull-up resistor is required between the supplied proximity probe voltage and the proximity probe input to the FTM. Individually fused 12 Vdc and 24 Vdc sources are provided with each speed input to power system proximity probes (100 mA fuses, located on the FTMs, are used). External pull-up resistors are required when interfacing with an open collector type proximity probe. See Figure 8-37 for MPU/proximity probe wiring example. Channel 1 shows an MPU connection, channel 2 shows a 24 V proximity connection, and channel 3 is an example of a 12 V proximity connection. Always jumper the unused MPU connection to eliminate possible noise interference when connecting a proximity probe.

IMPORTANT	**It is not recommended that gears mounted on an auxiliary shaft coupled to the rotor be used to sense speed. Auxiliary shafts tend to turn more slowly than the rotor (reducing speed sensing resolution) and have coupling gear backlash, resulting in less than optimum speed control. For safety purposes, it is also not recommended that the speed sensing device sense speed from a gear coupled to a mechanical drive side of a system's rotor coupling.**

Analog Inputs

The analog inputs may be current or voltage type dependent on the part number. See Appendix A for specific part numbers. Both modules use the same cable and FTM.

All current inputs may be used with two-wire ungrounded (loop powered) transducers or isolated (self-powered) transducers. All analog inputs have 200 Vdc of common mode rejection. If interfacing to a non-isolated device, which may have the potential of reaching over 200 Vdc with respect to the control's common, the use of a loop isolator is recommended to break any return current paths that may produce erroneous readings. All current inputs use 200 ohm resistors across their inputs.

Each current input channel may power its own 4–20 mA transducer. This power is protected with a 100 mA fuse on each channel to prevent an inadvertent short from damaging the module. The 24 Vdc outputs are capable of providing 24 Vdc with ±10% regulation. Power connections can be made through terminals located on the FTMs. Refer to Figure 8-38 for 4–20 mA Current Input wiring.

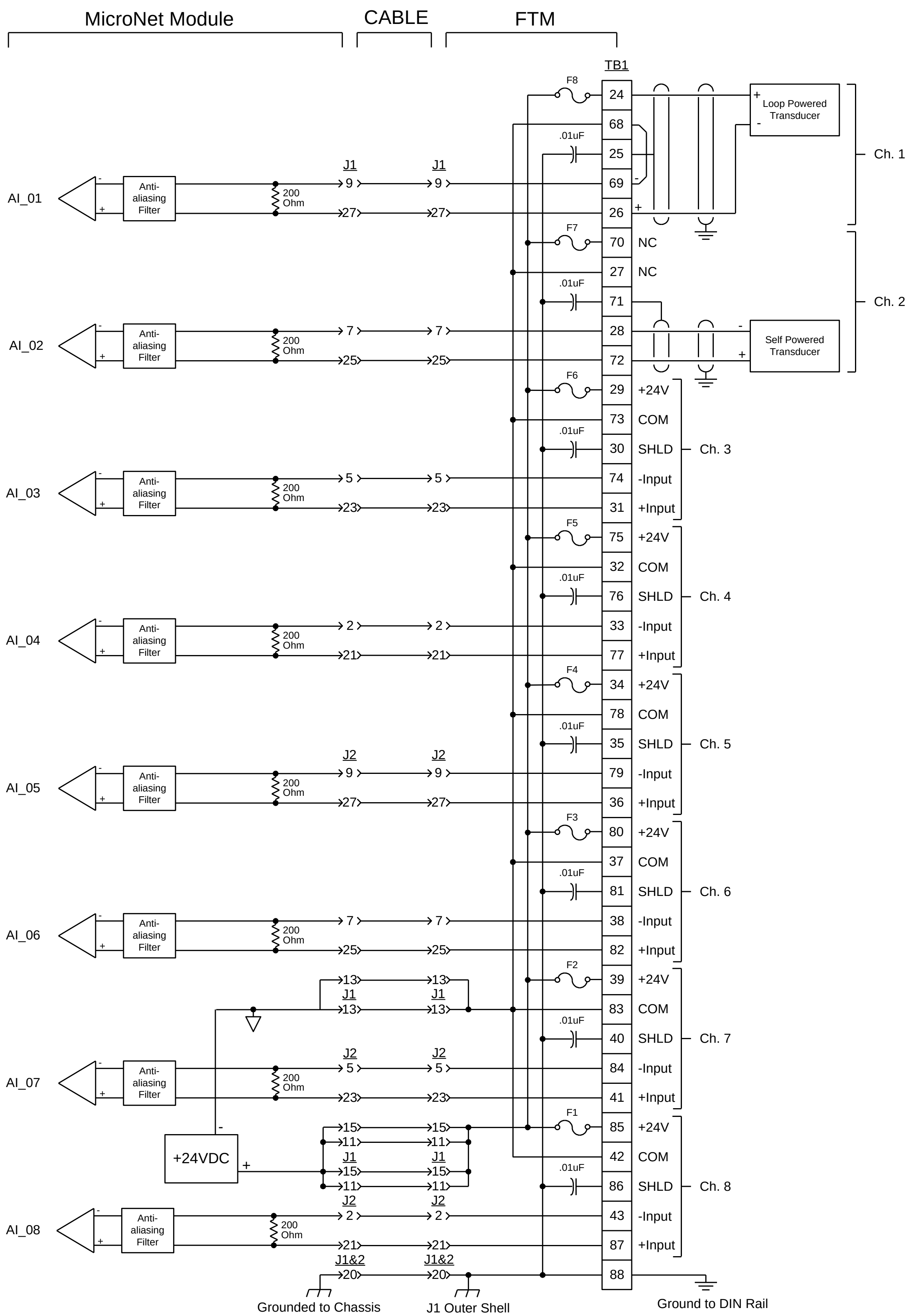


Figure 8-12. Current Input Wiring for an Analog Combo Module FTM

Only self-powered voltage transducers should be used on voltage input channels. The full-scale range must not exceed 5 volts. Refer to Figure 8-39 for 0–5 Vdc voltage transducer input wiring.

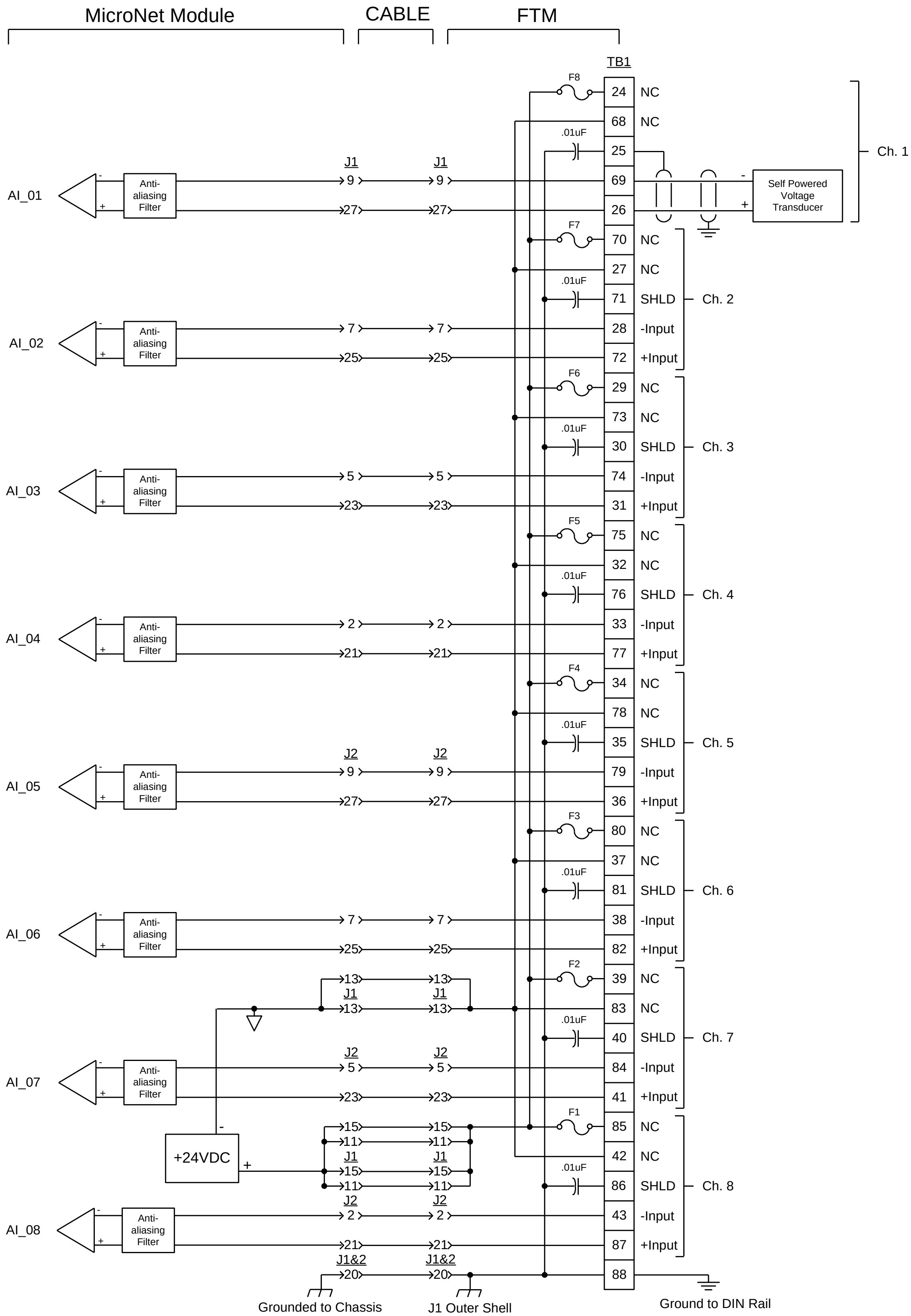


Figure 8-13. Voltage Input Wiring for an Analog Combo Module FTM

Analog Outputs

The analog outputs are 4–20 mA with a full-scale range of 0–25 mA. Each output monitors the output source current for fault detection. All of the analog outputs may be individually disabled. When a channel fault or a module fault is detected, the application program may annunciate the fault, disable the channel or module, and stop using the data in system calculations or control.

The Analog Combo module has four 4–20 mA current output drivers. All analog outputs can drive a maximum load of 600 ohms (load + wire resistance). Care should be taken to prevent ground loops and other faults when interfacing to non-isolated devices. See Figure 8-40 for an example of 4–20 mA output wiring.

Actuator Outputs

The actuator outputs may be configured for 4–20 mA or 20–160 mA. Configuration is done through the application software; no hardware modifications in the forms of jumpers or switches are necessary. For fault detection, each output monitors the output source current and the output return current. All of the actuator outputs may be individually disabled. When a channel fault or a module fault is detected, the application program may annunciate the fault, disable the channel or module, and stop using the data in system calculations or control.

Dither may be provided in the application software for each output. Dither is a low frequency (25 Hz) signal consisting of a 5-millisecond pulse modulated onto the DC actuator-drive current to reduce sticking due to friction in linear type actuators. Woodward TM-type actuators typically require dither. Dither amplitude is variable through the application software. See Figure 8-40 for an example of actuator wiring.

IMPORTANT

For a dual coil actuator in a simplex system, use two actuator driver outputs.

Configuration Notes

- Maximum impedance for a 4 to 20 mA actuator output driver is 360 ohms (actuator impedance + wire resistance).
- Maximum impedance for a 20 to 160 mA actuator output is 45 ohms (actuator impedance + wire resistance).
- Each actuator driver senses its source and return current to allow overcurrent and undercurrent alarms and shutdowns.

8.8.4 FTM Reference

See Chapter 12 for complete Analog Combo FTM field wiring information. See Appendix A for proper Module, FTM, and cable part numbers.

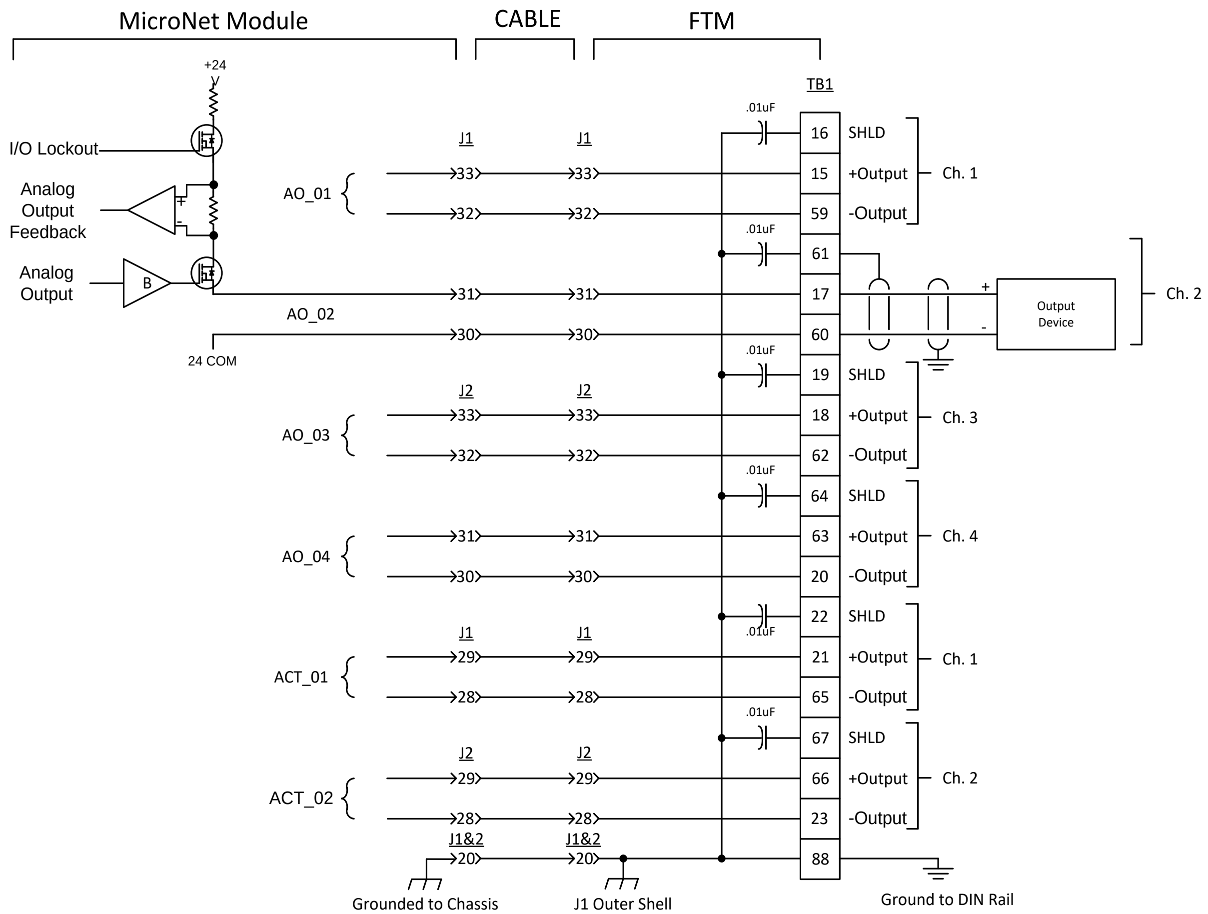


Figure 8-14. Analog Output and Actuator Wiring for an Analog Combo FTM

8.8.5 Troubleshooting

8.8.5.1 Fault Detection (Module Hardware)

Each Analog Combo module has a red Fault LED that is turned on when the system is reset. During initialization of a module, which occurs after every CPU reset, the CPU turns the Fault LED on. The CPU then tests the module using diagnostic routines built into the software. If the diagnostic test is not passed, the LED remains on or blinks. If the test is successful, the LED goes off. If the Fault LED on a module is illuminated after the diagnostics and initialization have been completed, the Analog Combo module may be faulty or may be located in the wrong slot.

Table 8-2. LED Indications of Failure

Number of LED Flashes	Failure
1	Hardware watchdog, CPU clock failure, reset fail
2	Micro-controller internal RAM test failure
3	External RAM test failure
4	Unexpected exception error
5	Dual Port RAM test failure
6	EEPROM failure
7	Communications watchdog time out

8.8.5.2 Fault Detection (I/O)

In addition to detecting module hardware faults, the application program may detect I/O faults.

Analog Input Faults. The application software may set a high and low latch setpoint to detect input faults.

Speed Sensor Input Faults. The application software may set a high and low latch setpoint to detect input faults. The low latch setpoint must be greater than one fiftieth of the frequency range.

Analog Output Driver Faults. The module monitors the source currents and annunciates faults. The application determines the course of action in the event of a fault.

Actuator Driver or Load Faults. The module monitors the source and return currents and annunciates faults. The application determines the course of action in the event of a fault.

Micro-controller Faults. The system monitors a software watchdog, a hardware watchdog, and a software watchdog on the VME bus communications. All outputs are shutdown in the event of a microcontroller fault.

Troubleshooting Guide

If during normal control operation all of a chassis' Analog Combo modules have Fault LEDs on, check the chassis' CPU module for a failure. If during normal control operation, only the Analog Combo module's Fault LED is on or flashing, insures that it is installed in the correct slot. If it is, then replace that Analog Combo module. See instructions for replacement in Chapter 15. When a module fault is detected, its outputs should be disabled or de-energized.

Speed Sensor Inputs

MPUs. If a magnetic pickup input is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 14.
2. Measure the input voltage on the terminal block. It should be in the range of 1–25 VRMS.
3. Verify that the signal waveform is clean and void of double zero crossings.
4. Verify that no ground connection exists and that the resulting 60 Hz signal is absent.
5. Measure the frequency. It should be in the range of 100 Hz - 25 kHz.
6. Verify that any unused MPU/Prox inputs are jumpered per Figure 8-27.
7. Check the wiring. Look for a loose connection at the terminal blocks and disconnected or misconnected cables.
8. Check the software configuration to ensure that the input is configured properly.
9. After verifying all of the above, exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the Analog Combo module.
10. If the readings are incorrect on several channels of the module, corresponding to both cables, replace the Analog Combo module.
11. If replacing the module does not fix the problem, replace the FTM. See instructions for replacing the FTM in Chapter 15. The FTM does not contain any active components on the MPU inputs, so replacing it should be the last option.

Proximity Probes

If a proximity probe input is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 14.
2. Measure the input voltage on the terminal block. It should be in the range of 3.5 – 32 Vpeak.
3. Verify that the signal waveform is clean and void of double zero crossings.
4. Verify that no ground connection exists and that the resulting 60 Hz signal is absent.
5. Measure the frequency. It should be in the range of 0.5 Hz to 25 kHz.
6. Verify that any unused MPU/Prox inputs are jumpered per Figure 8-27.
7. Check the wiring. Look for a loose connection at the terminal blocks, disconnected or misconnected cables, a missing jumper on the terminal block, or a blown fuse on the 24 Vdc on the FTM.
8. Check the software configuration to ensure that the input is configured properly.
9. After verifying all of the above, exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the Analog Combo module.

10. If the readings are incorrect on several channels of the Analog Combo module, corresponding to both cables, replace the Analog Combo module.
11. If replacing the module does not fix the problem, replace the FTM. See instructions for replacing the FTM in Chapter 15. The FTM contains only a wire-wound 3 W resistor and traces, so failure is extremely unlikely and replacing it should be the last option.

Analog Inputs

If an analog input is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 14.
2. Measure the input voltage on the terminal block. It should be in the range of 0–5 V.
3. Verify that there are no or minimal AC components to the Analog Input signal. AC components can be caused by improper shielding.
4. Check the wiring. If the inputs are reading 0 or the engineering units that correspond to 0 mA or volts, look for a loose connection on the terminal blocks, disconnected or misconnected cables, a missing jumper on the terminal block if the input is a current input, or a blown fuse on the 24 Vdc on the FTM.
5. If all of the inputs are reading high, check that the 24 Vdc is not connected across the input directly.
6. Check the software configuration to ensure that the input is configured properly.
7. Check the fuse on the FTM. See the instructions and fuse locations below.
8. If the other channels on the Analog Combo module are not working either, check the fuse on the Analog Combo module. See instructions for module replacement in Chapter 15. This fuse is visible and can be changed through the bottom of the module. If the fuse is blown, fix the wiring problem, then replace the fuse with another fuse of the same type and rating.
9. After verifying all of the above, exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the Analog Combo module.
10. If the readings are incorrect on several channels of the module, corresponding to both cables, replace the Analog Combo module.
11. If replacing the module does not fix the problem, replace the FTM. See instructions for replacing the FTM in Chapter 15. The FTM does not contain any active components on the MPU inputs, so replacing it should be the last option.

Analog Outputs

If an analog output is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 14.
2. Check the load resistance to ensure that it is not greater than 600 ohms.
3. Check to ensure that the load wiring is isolated.
4. Check the wiring for a loose connection on the terminal blocks and disconnected or misconnected cables.
5. Disconnect the field wiring and connect a resistor across the output. If the output is correct across the resistor, there is a problem with the field wiring.
6. If the other output channels on the Analog Combo module are also not working, check the fuse on the Analog Combo module. See instructions for module replacement in Chapter 15. This fuse is visible and can be changed through the bottom of the module. If the fuse is blown, fix the wiring problem and replace the fuse with a fuse of the same type and rating.
7. Check the software configuration to ensure that the output is configured properly.
8. After verifying all of the above, exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the Analog Combo module.
9. If the readings are incorrect on several channels of the module, corresponding to both cables, replace the Analog Combo module.
10. If replacing the module does not fix the problem, replace the FTM. See instructions for replacing the FTM in Chapter 15. The FTM does not contain any active components on the MPU inputs, so replacing it should be the last option.

Actuator Outputs

If an actuator output is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 14.
2. Check the load resistance to ensure that it is below the specified limit.
3. Check to ensure that the load wiring is isolated.
4. Check the wiring for a loose connection on the terminal blocks or disconnected or misconnected cables.
5. Disconnect the field wiring and connect a resistor across the output.
6. If the other output channels on the Analog Combo module are also not working, check the fuse on the Analog Combo module. See instructions for module replacement in Chapter 15. This fuse is visible and can be changed through the bottom of the module. If the fuse is blown, fix the wiring problem, and replace the fuse with a fuse of the same type and rating.
7. Check the software configuration to ensure that the output is configured properly.
8. After verifying all of the above, exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the Analog Combo module.
9. If the readings are incorrect on several channels of the module, corresponding to both cables, replace the Analog Combo module.
10. If replacing the module does not fix the problem, replace the FTM. See instructions for replacing the FTM in Chapter 15. The FTM does not contain any active components on the MPU inputs, so replacing it should be the last option.

8.8.5.4 Replacing a Fuse on the Field Terminal Module (FTM)

1. Verify that the condition that caused the fuse to blow has been corrected.

⚠CAUTION	**If power has not been removed from the control system, power will be active at the module and at the FTM. Shorting of protected circuitry could cause a control system shutdown.**

2. Remove FTM cover carefully, to prevent contact with any FTM circuitry under the cover. To remove the FTM cover, pinch the retaining barb and lift the cover.
3. Locate and replace the fuse with another fuse of the same size and rating.
4. Replace the FTM cover.

8.9. 34 Ch. High Density Versatile Input Module (HDVIM)

Information on this module is in Volume 3, Chapter 5

8.10. Current Input Modules

Information on these modules is in Volume 3, Chapter 5.

8.11. 8 Ch. Current Input (4–20 mA) Module

Information on this module is in Volume 3, Chapter 5.

8.12. Non-Standard 8 Ch. Current Input (4–20 mA) Module

Information on this module is in Volume 3, Chapter 5.

8.13. Voltage Input Modules

Information on these modules is in Volume 3, Chapter 5.

8.14. 8 Channel Voltage Input (0–10 Vdc) Module

Information on this module is in Volume 3, Chapter 5.

8.15. Current Output Modules

Information on these modules is in Volume 3, Chapter 5.

8.16. 8 Ch. Current Output (4–20 mA) Module

Information on this module is in Volume 3, Chapter 5.

8.17. 8 Ch. Current Output (0–1 mA) Module

Information on this module is in Volume 3, Chapter 5.

8.18. Voltage Output Modules

Information on these modules is in Volume 3, Chapter 5.

8.19. 8 Ch. Voltage Output (0–5 Vdc) Module

Information on this module is in Volume 3, Chapter 5.

8.20. 8 Ch. Voltage Output (0–10 Vdc) Module

Information on this module is in Volume 3, Chapter 5.

8.21. Thermocouple Input Modules

Information on these modules is in Volume 3, Chapter 5.

8.22. 8 Ch. TC (Fail Low) Module

Information on this module is in Volume 3, Chapter 5.

8.23. 8 Ch. TC (Fail High) Module

Information on this module is in Volume 3, Chapter 5.

8.24. RTD Input Modules

Information on these modules is in Volume 3, Chapter 5.

8.25. 8 Ch. RTD Input (10 ohm)

Information on this module is in Volume 3, Chapter 5.

8.26. 8 Ch. RTD Input (100 ohm)

Information on this module is in Volume 3, Chapter 5.

8.27. 8 Ch. RTD Input (200 ohm)

Information on this module is in Volume 3, Chapter 5.

8.28. 8 Ch. RTD Input (500 ohm)

Information on this module is in Volume 3, Chapter 5.

8.29. 4 Ch. MPU/Proximity Module

Information on this module is in Volume 3, Chapter 5.

8.30. MicroNet Speed Sensor Smart-Plus Module

The Speed Sensor Smart-Plus module is a MicroNet Plus module that will allow the customer to access information about the module during operation via AppManager.

Firmware upgrade can be performed using Service Pack installation via AppManager.

8.30.1 Module Description

This module has four speed inputs that are factory configured as either MPU or Eddy inputs. The configuration of MPU and Eddy inputs is dependent on the module item number.

These modules have no potentiometers and require no calibration. A module may be replaced with another module of the same part number without any adjustment.

8.30.2 Specification

Number Channels:	4
Input Type:	MPU/Eddy Detector (factory configured by module item number)
Input Frequency Range:	MPU: 50 Hz to 25 KHz Eddy: 1 Hz to 25 KHz
Input Amplitude:	MPU: 1 Vrms min, 25 Vrms max, Freq > 20 Hz Eddy: 10 mA
Input Impedance:	MPU: 2000 Ω Eddy: 2000 Ω
Isolation Voltage:	500Vrms to earth ground and control common, no galvanic isolation between channels
Resolution:	16 bits 0.0015% of range per LSB
Speed Accuracy (max):	0.01% over temperature range
Temperature drift:	1 ppm/°C
Derivative Accuracy (max):	0.10% of range (p-p)
Speed Filter:	5-10,000 ms (2 real poles)
Derivative Filter:	5-10,000 ms (1 pole + speed filter)
Acceleration Limit:	1-10,000 percent/second
Operating Temperature:	–15 to +65 °C
Speed probe supply current: (total for all 4 channels)	320mA

Note: This module must be used with Coder Version 4.06 or later.
Item 5466-5000 is backward compatible with Item 5464-658
Item 5466-5001 is backward compatible with Item 5464-834

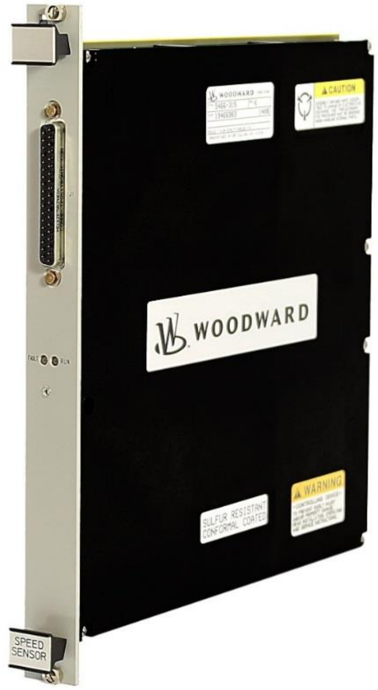


Figure 8-15. Speed Sensor Smart-Plus Module

8.30.3—Installation

The modules slide into card guides in the control's chassis and plug into the motherboard. The modules are held in place by two screws, one at the top and one at the bottom of the front panel. Also at the top and bottom of the module are two handles which, when toggled (pushed outward), move the modules out just far enough for the boards to disengage the motherboard connectors.

In a simplex system, each 4Ch Speed Module is connected through one low Density analog cable to one Analog Input FTM. All of the I/O are accessible on the FTM.

Each of the module's four speed channels accept either a passive magnetic pickup unit (MPU) or Eddy probe. The number of MPU and Eddy inputs per module is determined by software configuration set at the factory.
The item number of the module determines if the speed input is configured to MPU or Eddy input. Each speed input channel can only accept one MPU or one Eddy probe. See Appendix A for module item numbers.

An Eddy probe may be used to sense very low speeds. With an Eddy probe, speed can be sensed down to 1 Hz. See Figure 8-66 for MPU and Eddy probe wiring examples.

IMPORTANT	**It is not recommended that gears mounted on an auxiliary shaft coupled to the rotor be used to sense speed. Auxiliary shafts tend to turn more slowly than the rotor (reducing speed sensing resolution) and have coupling gear backlash, resulting in less than optimum speed control. For safety purposes, it is also not recommended that the speed sensing device sense speed from a gear coupled to a mechanical drive side of a system's rotor coupling.**

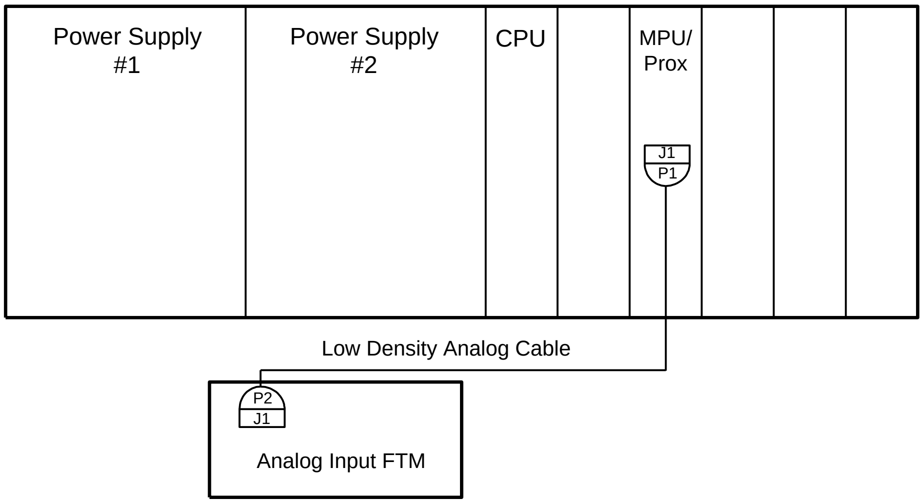


Figure 8-16. 4Ch MPU/Eddy Module

8.30.4 FTM Reference

See Figure 8-66 below for complete field wiring information for the 4Ch MPU/Proximity FTM. Note the ground connection on pin 37 of the FTM.

See Appendix A for part number Cross Reference for modules, FTMs, and cables.

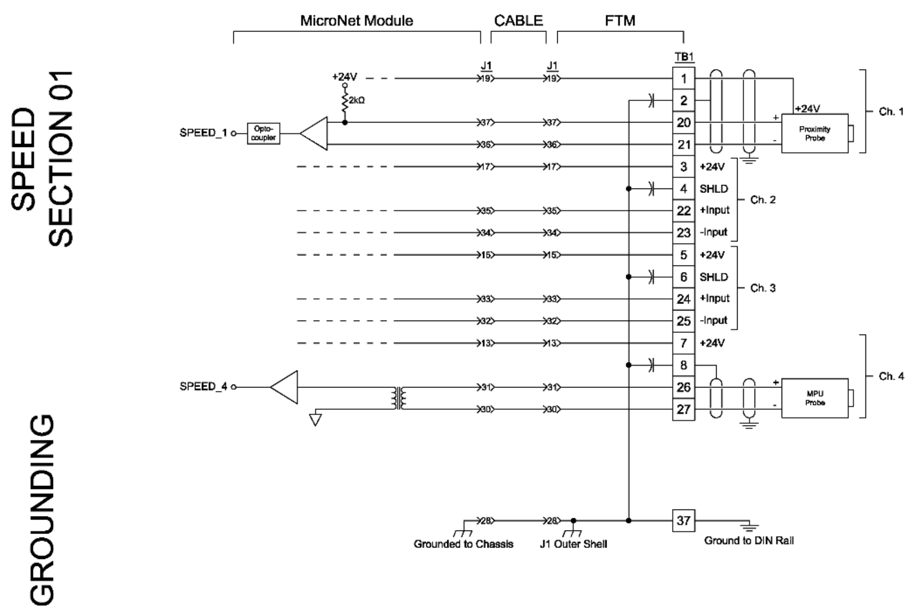


Figure 8-17. MPU and Eddy Probe Interface Wiring

8.30.5 Troubleshooting

Speed ranges are selected from the GAP and the signal is pre-scaled accordingly. The pre-scaled signal then goes to a counter where the period of the signal is measured. The Digital Signal Processor samples the counter's values every 100 microseconds and performs a divide to generate a digital speed signal.

Every 100 microseconds a digital-filter algorithm is executed to average the speed values in order to improve speed-sensor resolution at input frequencies greater than 200 Hz. This digital filter also provides a derivative output.

Once every rate time (5-200 ms typically), the latest speed and derivative information is moved to the Dual-Port RAM for access by the CPU module.

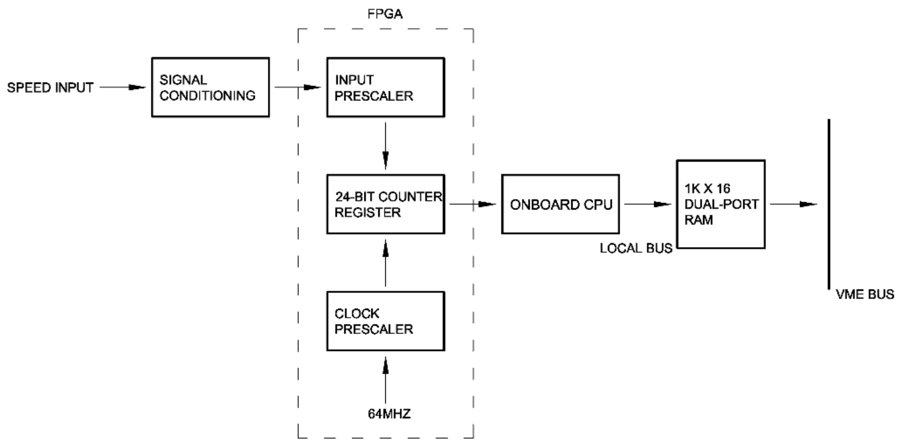


Figure 8-18. Digital Speed Sensor Module Block Diagram

During initialization, which occurs after every reset, the CPU turns the FAULT LEDs on. The CPU then tests each I/O module using diagnostic routines built into software. If the diagnostic test is not passed, the LED remains on. If the test and initialization are successful, the LED goes off and green RUN LED is turned on.

Table 8-3. LED Indications of Failure

Number of LED Flashes	Failure
1	Watchdog/MFT Lost Failure
2	No Application
3	Flash Memory Failure
4	Exception Failure
5	FPGA Failure
6	Non-Volatile Memory Error
7	Kernel Watchdog Error
8	MFT Timing Failure
9	Software Slip
10	RAM Memory Failure
11	Software Failure
12	Power Supply Failure
13	Configuration or Parameter Error
19	Speed Error

Detailed fault description for active flash code can be obtained in AppManager.

The CPU also tells this module in which rate group each channel is to run, as well as special information. At run time, the CPU then periodically broadcasts a "key" to all I/O cards, telling them which rate groups are to be updated at that time. Through this initialization/key broadcast system, each I/O module handles its own rate-group scheduling with minimal CPU intervention.

Troubleshooting Guide

MPUs: If a magnetic pickup input is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 15, Installation.
2. Measure the input voltage on the terminal block. It should be in the range of 1-25 VRMS.
3. Verify that the signal waveform is clean and void of double zero crossings.
4. Verify that no ground connection exists and that the resulting 60 Hz signal is absent.
5. Measure the frequency. It should be in the range of 50 Hz - 25 kHz.
6. Check the wiring. Look for a loose connection at the terminal blocks and disconnected or misconnected cables.

7. Check the software configuration to ensure that the input is configured properly.
8. If the readings are incorrect on several channels of the module, replace the Speed module.
9. If replacing the module does not fix the problem, replace the FTM. See instructions for replacing the FTM in Chapter 15, Installation. The FTM does not contain any active components on the MPU inputs, so replacing it should be the last option.

Eddy Probes

If an Eddy probe input is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 15, Installation.
2. Measure the input voltage on the terminal block. It should be in the range of 7 - 24 V-peak.
3. Verify that the signal waveform is clean and void of double zero crossings.
4. Verify that no ground connection exists and that the resulting 60 Hz signal is absent.
5. Measure the frequency. It should be in the range of 1 Hz to 25 kHz.
6. Check the wiring. Look for a loose connection at the terminal blocks, disconnected or misconnected cables.
7. Check the software configuration to ensure that the input is configured properly.
8. If the readings are incorrect on several channels of the Speed module, replace the Speed module.
9. If replacing the module does not fix the problem, replace the FTM. See instructions for replacing the FTM in Chapter 15, Installation.

IMPORTANT	**Recommendation:** **Return the module to Woodward every 6 years for health check and technical updates. This health check shall increase in frequency when the module is more than 20 years old**.

8.31. MicroNet 24/8 Analog Smart Plus Module

8.31.1 Module Description

The 24/8 Analog Smart Plus module is a MicroNet Plus module that will allow the customer to access information about the module during operation via AppManager.

Firmware upgrade can be performed using Service Pack installation via AppManager.

A 24/8 Analog Smart Plus module contains circuitry for twenty-four analog inputs and eight 4-20 mA outputs. These modules have no potentiometers and require no calibration. A module may be replaced with another module of the same part number without any adjustment.

The 24/8 Analog Smart Plus Modules come in three different configurations.

1. 24 channels of 4-20 mA or 0-5V inputs (GAP selectable) with eight channels of 4-20 mA outputs (2-pole 10 ms filter on all input channels, except channels 23 and 24, which have 2-pole 5 ms filter).
   Note: When changing a GAP selectable input type the application must be saved and an application restart is required. This allows both the hardware and software to initialize to the new input "type" setting.
2. 24 channels of 4-20 mA inputs with eight channels of 4-20 mA outputs (2-pole 10 ms filter on all input channels, except channels 23 and 24, which have 2-pole 5 ms filter).
3. 24 channels of 0-5Vdc inputs, with eight channels of 4-20 mA outputs (2-pole 10 ms filter on all input channels, except channels 23 and 24, which have 2-pole 5 ms filter).

All 4-20 mA analog inputs may be used with two-wire ungrounded (loop powered) transducers or isolated (self-powered) transducers. All analog inputs have 200 Vdc of common mode rejection. If interfacing to a non-isolated device, which may have the potential of reaching over 200 Vdc with respect to the control's common, the use of a loop isolator is recommended to break any return current paths producing erroneous readings.

Each board has an on-board processor for automatic calibration of the I/O channels. Each analog input incorporates a time-stamping feature with 5 ms resolution for two low set points and two high set points.

Figure 8-19. 24/8 Analog Smart Plus Module

8.31.2 Module Specification

Analog Input Ratings

Number of Channels:	24
Update Time:	5 ms
Input Range	0-25 mA or 0-5 V; software and hardware selectable
Isolation:	500 Vrms galvanic isolation to earth ground and control common, no galvanic isolation between channels 60 dB CMRR 200 Vdc common mode rejection voltage
Input imp. (4-20 mA):	200 ohms
Anti-aliasing filter:	2 poles at 10 ms (CH01-22) 2 poles at 5ms (CH23-24)
Resolution:	16 bits
Accuracy:	Software calibrated to 0.1%, over 0-25 mA full scale
Temperature Drift:	275 ppm/C, maximum
Fuse:	100 mA fuse per channel located at FTM
Time Stamping:	5 ms resolution on low event and latch, and high event and latch

4–20 mA Output Ratings

Number of channels:	8
Update time:	5 ms
Output Driver:	linear
Filter:	1 pole at 1ms plus 1pole at 0.25ms
Current output:	4–20 mA
Current output range:	0-25 mA

Isolation:	500 Vrms galvanic isolation to earth ground and control common, no galvanic isolation between channels
Max load resistance:	600 ohms (load + wire resistance)
Resolution:	14 bits
Accuracy:	Software calibrated to 0.2% of 0-25 mA full scale
Temperature drift:	125 ppm/C, maximum
Source read back isolation:	60 dB CMRR, 200 Vdc common mode rejection voltage
Read back resolution source:	12 bits
Read back resolution return:	8 bits
Read back accuracy:	0.5% of 0-25 mA full scale
Read back temp drift:	400 ppm/C, maximum

Note: Item 5466-5025 must be used with Coder Version TMR 1.00-1 or later.

Coder 4.06 compatible versions:

Item 5466-5026 is backward compatible with P/N 5466-332
Item 5466-5027 is backward compatible with P/N 5466-425

Note: Item 5466-5026 may be used in place of the 5466-315 if it is acceptable to have 5mS Anti-aliasing filter on A/I channels 23/24. (vs 10mS anti-aliasing filter). Please consult application engineering.

8.31.3 Installation

The modules slide into card guides in the control's chassis and plug into the motherboard. The modules are held in place by two screws, one at the top and one at the bottom of the front panel. Also at the top and bottom of the module are two handles which, when toggled (pushed outward), move the modules out just far enough for the boards to disengage the motherboard connectors.

Each 24/8 Analog Module is connected through two High Density Analog/Discrete cables to two 24/8 Analog FTMs. All I/Os on the module are accessible on the FTM, and the channels are labeled to correspond to their software locations (e.g., analog input 1 on the FTM will be analog input 1 in the application software). See Figure 9-69 for an example.

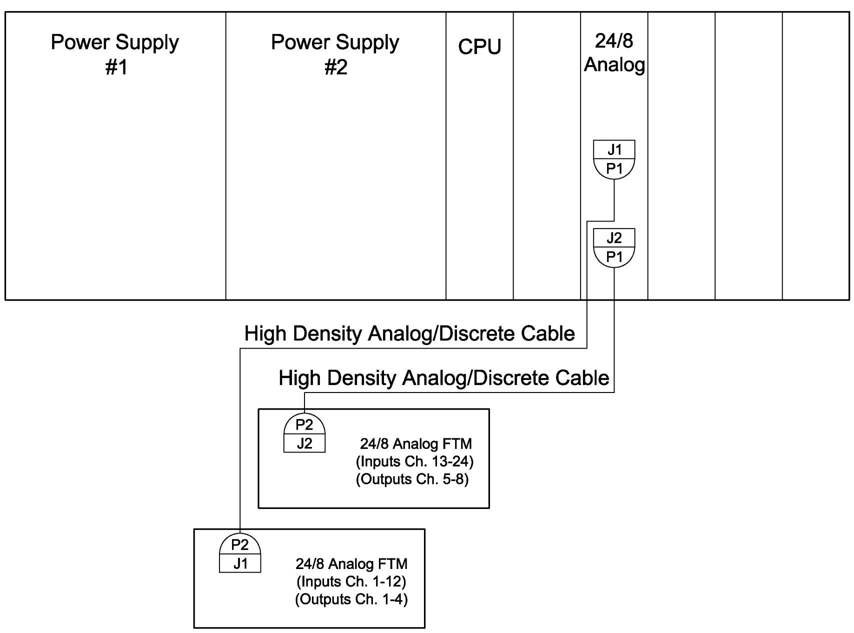


Figure 8-20. Simplex System Configuration Example

Analog Inputs

For a 4–20 mA input signal, the 24/8 Analog Module uses a 200 ohm resistor across the input located on the 24/8 Analog Module. Each analog input channel may power its own 4–20 mA transducer. See Figure 9-3 for analog input connection. This power is protected with a 100 mA fuse on each channel located at the FTM to prevent an inadvertent short from damaging the module. The 24 Vdc outputs are capable of providing 24 Vdc with ±10% regulation. Power connections can be made through terminals located on the 24/8 Analog FTMs. See Chapter 13 for complete field wiring information for the 24/8 Analog FTM.

IMPORTANT

Maximum loop power current is 0.32A per 12 inputs located on the same FTM.

IMPORTANT

When configuring the AI Combo block in GAP, set Conf. input field to 0 for all inputs working in 1-5V voltage mode. This will disconnect input 200ohms sense resistor and allow the block to use the module factory voltage calibration values.

IMPORTANT

When configuring the AI Combo block in GAP, set Conf. input field to 1 for all inputs working in 4-20mA current mode. This will allow the block to use the module factory calibration values for inputs that were calibrated with 200 ohm internal resistors on the 24/8 Analog Module.

IMPORTANT

When configuring the AI Combo block in GAP for 4-20mA input, set the Conf. input field to "2" for all inputs using the TMR Analog FTM. This will allow the block to use the module factory voltage calibration values with a gain factor for a 200 ohm external resistor on the TMR Analog FTM.

When configuring the AI Combo block in GAP, set Conf. input field to 2 for all 4–20 mA inputs when used with the Dataforth current input plug-in module. This will allow the block to use the module factory voltage calibration values with a gain factor for a 200 ohm external resistor on the Dataforth FTM.

IMPORTANT

Input type configuration is factory set for backward compatible part numbers.

IMPORTANT

For modules with GAP selectable inputs, when changing the Conf. input field to a new value an application save and application restart is required before the module can be used. This save and restart allows the hardware and software to be properly initialized together.

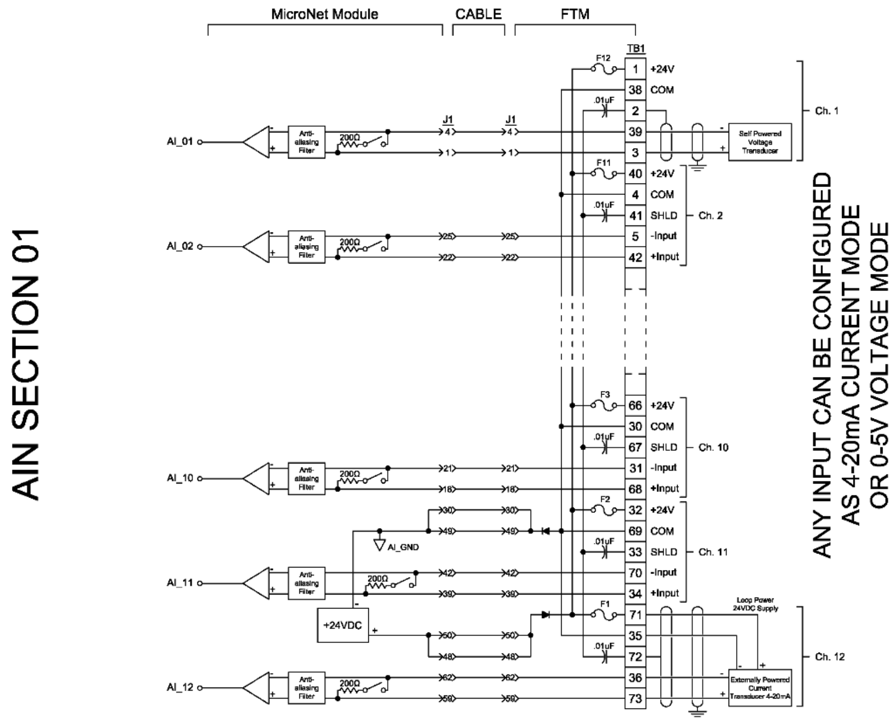


Figure 8-21. Analog Input Wiring for a 24/8 Analog FTM

Analog Outputs

There are eight analog output channels of 4–20 mA with a full-scale range of 0-25 mA. All Analog Outputs can drive a maximum load of 600 ohms (load + wire resistance). See Figure 9-4 for analog output connection. Each output monitors the output source and return current for fault detection. All of the analog outputs may be individually disabled. When a channel fault or a module fault is detected, the application program may annunciate the fault, disable the channel, and stop using data in system calculations or control. Care should be taken to prevent ground loops and other faults when interfacing to non-isolated devices. See Chapter 13 for complete field wiring information for the Analog High Density FTM.

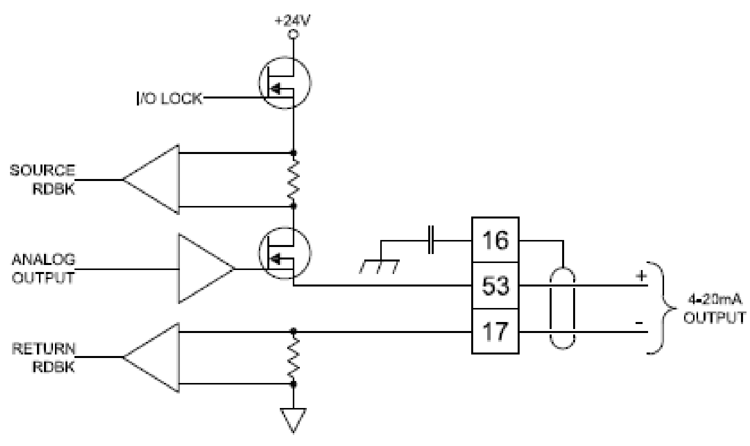


Figure 8-22. Analog Output Wiring for a 24/8 Analog FTM

8.31.4 FTM Reference

See Chapter 13 for complete field wiring information for the Analog High Density FTM. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

8.31.5 Troubleshooting

Each 24/8 Analog Smart Plus module has a red Fault LED that is turned on when the system is reset. During initialization of a module, which occurs after every CPU reset, the CPU turns the Fault LED on. The CPU then tests each module using diagnostic routines built into the software. If the diagnostic test is not passed, the LED remains on or blinks. If the test and initialization is successful, the red LED goes off and green RUN LED is turned on.

If the Fault LED on a module is illuminated after the diagnostics and initialization have been run, the module may be faulty or may be located in the wrong slot.

Table 8-4. LED Indications of Failure

Number of LED Flashes	Failure
1	Watchdog/MFT Lost Failure
2	No Application
3	Flash Memory Failure
4	Exception Failure
5	FPGA Failure
6	Non-Volatile Memory Error
7	Kernel Watchdog Error
8	MFT Timing Failure
9	Software Slip
10	RAM Memory Failure
11	Software Failure
12	Power Supply Failure
13	Configuration or Parameter Error
15	Parallel to Serial Bus Error
16	AI ADC Error
17	AO Read back ADC Error
20	AI ADC Timeout
21	AO Read back ADC Timeout
22	AO DAC Timeout

Detailed fault description for active flash code can be obtained in AppManager.

Fault Detection (I/O)

In addition to detecting the High Density Analog I/O module hardware faults, the application software may detect I/O faults.

Analog Input Faults: The application software may be set with a high and low latch set point to detect input faults.

Analog Output Driver Faults: The module monitors the source and return currents and annunciates faults. The application software determines the course of action in the event of a fault.

IMPORTANT

Backward compatible modules do not monitor return side current read back.

Microcontroller Faults: The system monitors a software watchdog, a hardware watchdog, and a software watchdog on the VME bus communications. All outputs are shut down in the event of a microcontroller fault.

Troubleshooting Guide

If during normal control operation, all of the 24/8 Analog Smart Plus modules have Fault LEDs on, check the chassis' CPU module for a failure. If during normal control operation only the 24/8 Analog module's Fault LED is on or flashing, insure that it is installed in the correct slot. If it is, then replace that module. See instructions for replacement in Chapter 15, Installation (System Level Installation). When a module fault is detected, its outputs will be disabled or de-energized.

Analog Inputs

If an analog input is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 15, Installation (System Level Installation).
2. Measure the input voltage on the FTM terminal block. It should be in the range of 0-5 V.
3. Verify that there are no or minimal AC components to the Analog Input signal. Improper shielding may introduce AC noise on the input terminals.
4. Check the wiring. If the inputs are reading 0 or the engineering units that correspond to 0 mA, look for a loose connection on the terminal blocks, disconnected or misconnected cables, a missing jumper on the terminal block if the input is a current input, or a blown fuse on the 24 Vdc on the FTM.
5. If all of the inputs are reading high, check that the 24 Vdc is not connected across the input directly.
6. Check the software configuration to ensure that the input is configured properly.
7. After verifying all of the above, exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the module.
8. If the readings are incorrect on several channels of the 24/8 Analog module, corresponding to both cables, replace the module.
9. If replacing the module does not fix the problem, replace the FTM. The FTM contains only traces and a few discrete components, so failure is extremely unlikely. See instructions for replacing the FTM in Chapter 15, Installation (System Level Installation).

Analog Outputs

If an analog output is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 15, Installation (System Level Installation).
2. Check the load resistance to ensure that it is not greater than 600 ohms.
3. Check to ensure that the load wiring is isolated.
4. Check the wiring for a loose connection on the FTM terminal blocks and disconnected or misconnected cables.
5. Disconnect the field wiring and connect a resistor across the output. If the output is correct across the resistor, there is a problem with the field wiring.
6. Check the software configuration to ensure that the output is configured properly.
7. After verifying all of the above, exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the module.
8. If the readings are incorrect on several channels of the module, corresponding to both cables, replace the module.
9. If replacing the module does not fix the problem, replace the FTM. The FTM contains only traces and a few discrete components, so failure is extremely unlikely. See instructions for replacing the FTM in Chapter 15, Installation (System Level Installation).

IMPORTANT

Recommendation:
The module should be returned to Woodward every 6 years for health check and technical updates. This health check shall increase in frequency when the module is more than 20 years old.

8.32. Speed/Analog IO Combo Smart-Plus Module

The Speed /Analog IO Combo Smart-Plus module is a MicroNet Plus module that will allow the customer to access information about the module during operation via AppManager.
Firmware upgrade can be performed using Service Pack installation via AppManager.

8.32.1 Module Description

This module has four speed inputs that are configurable in GAP application as either MPU, Prox or Eddy inputs.

The module contains circuitry for twelve analog inputs and four 4-20 mA outputs.

Analog inputs are configurable in GAP application as either 0-5Vdc voltage mode or 4-20mA current mode. All inputs have 2-pole 10ms filter, except channels 11 and 12, which have 2-pole 5ms filter.

> **Note:** When changing a GAP selectable input type the application must be saved and an application restart is required. This allows both the hardware and software to initialize to the new input "type" setting.

All 4-20 mA analog inputs may be used with two-wire ungrounded (loop powered) transducers or isolated (self-powered) transducers. All analog inputs have 200 Vdc of common mode rejection. If interfacing to a non-isolated device, which may have the potential of reaching over 200 Vdc with respect to the control's common, the use of a loop isolator is recommended to break any return current paths producing erroneous readings.

Each board has an on-board processor for automatic calibration of the I/O channels. Each analog input incorporates a time-stamping feature with 5 ms resolution for two low set points and two high set points.

These modules have no potentiometers and require no calibration. A module may be replaced with another module of the same part number without any adjustment.

8.32.2 Specifications

Number Channels:	4
Input Type:	MPU/Prox/Eddy Detector (configured in GAP application)
MPU ratings	
Input Frequency Range:	50 Hz to 25 KHz
Input Amplitude:	1 Vrms min, 25 Vrms max,
Input Impedance:	2000 Ω or 6000 Ω over 80 to 2000Hz
Prox ratings	
Input Frequency Range:	0.04 Hz to 25 KHz
Input Amplitude:	0-24Vpk
Input Impedance:	2000 Ω
12mA short circuit current	12mA short circuit current
Eddy ratings	
Input Frequency Range:	1 Hz to 25 KHz
Input Amplitude:	0-24Vpk
Input Impedance:	2000 Ω 12mA short circuit current
Common characteristics	
Isolation Voltage:	500Vrms to earth ground and control common, no galvanic isolation between channels
Resolution:	16 bits 0.0015% of range per LSB
Speed Accuracy (max):	
P/N5466-1115	0.03% over temperature range
Temperature drift:	1 ppm/°C
Derivative Accuracy (max):	0.10% of range (p-p)

Speed Filter:	5-10,000 ms (2 real poles)
Derivative Filter:	5-10,000 ms (1 pole + speed filter)
Acceleration Limit:	1-10,000 percent/second
Operating Temperature:	–15 to +65 °C
Speed probe supply current:	320mA (total for all 4 channels)

Analog Input Ratings

Number of channels:	12
Update time:	5 ms
Input range:	0-25 mA or 0-5 V; set in GAP application
Isolation:	500 Vrms galvanic isolation to earth ground and control common, no galvanic isolation between channels 60 dB CMRR 200 Vdc common mode rejection voltage
Input imp. (4-20 mA):	200 ohms
Anti-aliasing filter:	2 poles at 10 ms (CH01-10) 2 poles at 5ms (CH11-12)
Resolution:	16 bits
Accuracy:	Software calibrated to 0.1%, over 0-25 mA or 0-5Vdc full scale
Temp drift:	275 ppm/C, maximum
Fuse:	100 mA fuse per channel located at FTM
Time stamping:	5 ms resolution on low event and latch, and high event and latch

4–20 mA Output Ratings

Number of channels:	4
Update time:	5 ms
Output Driver:	linear
Filter:	1 pole at 1ms plus 1pole at 0.25ms
Current output:	4–20 mA
Current output range:	0-25 mA
Isolation:	500 Vrms galvanic isolation to earth ground and control common, no galvanic isolation between channels
Max load resistance:	600 ohms (load + wire resistance)
Resolution:	14 bits
Accuracy:	Software calibrated to 0.2% of 0-25 mA full scale
Temperature drift:	125 ppm/C, maximum
Source read back isolation:	60 dB CMRR, 200 Vdc common mode rejection voltage
Read back resolution source:	12 bits
Read back resolution return:	8 bits
Read back accuracy:	0.5% of 0-25 mA full scale
Read back temp drift:	400 ppm/C, maximum

Two version of the Speed/AIO Combo are available:

Standard Accuracy (5466-1115), primarily intended for Steam Turbine markets. This unit can be used to replace the 5466-253 and -316 in systems where actuation is controlled separately.
High Accuracy (5466-1105), primarily intended for Gas Turbine markets.

These modules utilize new GAP blocks and require Coder 5.08 or later (Steam) or Coder MicroNet 1.00 or later (Gas Turbine).

Figure 8-23. Speed/Analog IO Combo Smart-Plus Module

8.32.3 Installation

The modules slide into card guides in the control's chassis and plug into the motherboard. The modules are held in place by two screws, one at the top and one at the bottom of the front panel. Also at the top and bottom of the module are two handles which, when toggled (pushed outward), move the modules out just far enough for the boards to disengage the motherboard connectors.

In a simplex system, each Speed/Analog IO Combo Smart-Plus Module is connected through one Low Density Analog Cable to one Analog Input FTM and one High Density Analog Cable to one 24/8 Analog FTM.

All of the I/O are accessible on the FTM and the channels are labeled to correspond to their software locations (e.g., analog input 1 on the FTM will be analog input 1 in the application software). See Figure 9-73 for an example.

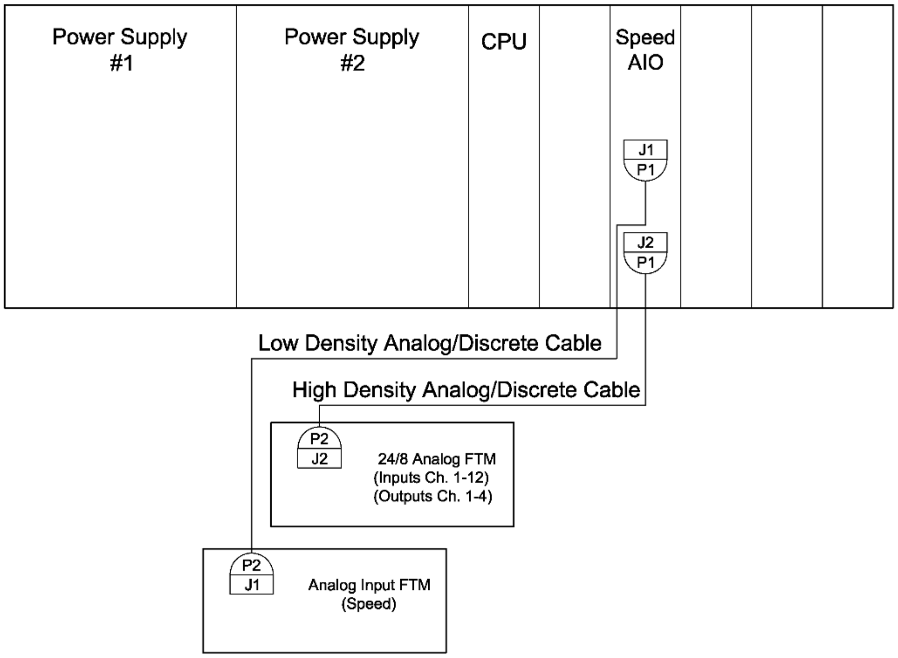


Figure 8-24. Simplex System Configuration Example.

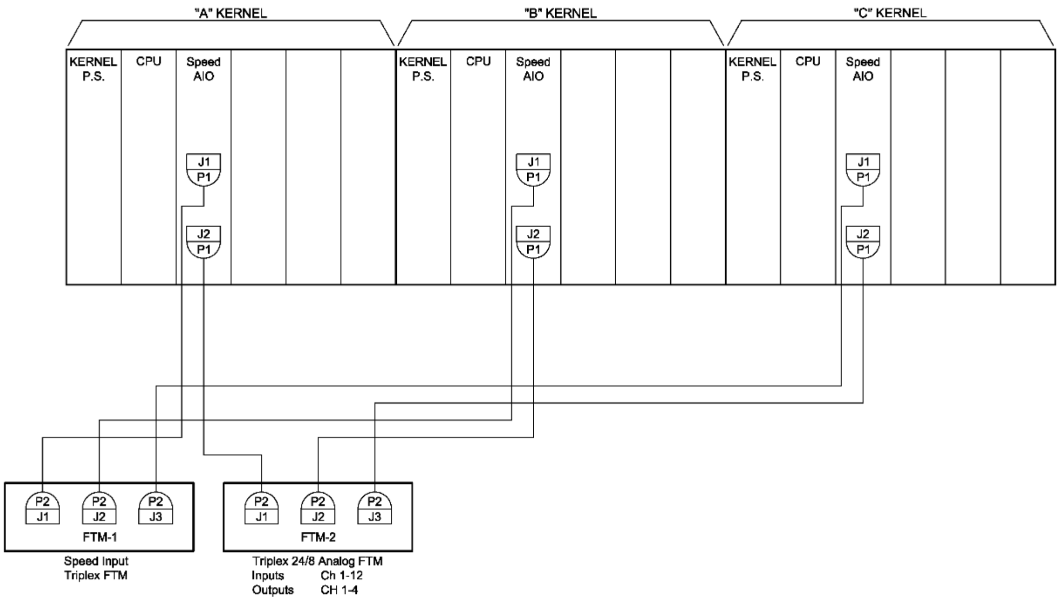


Figure 8-25. TMR System Configuration Example.

Speed Inputs

Each of the module's four speed channels accept either a passive magnetic pickup unit (MPU), Prox or Eddy probe. The number of MPU, Prox, and Eddy inputs per module is determined by GAP software.

Prox or Eddy probes may be used to sense very low speeds. With a Prox probe, speed can be sensed down to 0.04 Hz. See Figure 9-74 for MPU and Prox probe wiring examples. Unused inputs should be set to MPU2K mode and jumpered at the FTM.

IMPORTANT

Not recommended that gears mounted on an auxiliary shaft coupled to the rotor be used to sense speed. Auxiliary shafts tend to turn more slowly than the rotor (reducing speed-sensing resolution) and have coupling gear backlash, resulting in less than optimum speed control. For safety purposes, not recommended that the speed sensing device sense speed from a gear coupled to a mechanical drive side of a system's rotor coupling.

IMPORTANT

When configuring the AI_SS block in GAP, set PROBE_TYPE input field to:
0 - for all inputs working in MPU2K mode
1 - for all inputs working in MPU10K mode
2 - for all inputs working in PROX mode
3 - for all inputs working in Eddy mode
This will allow the input to correctly sense the output signal from specified probe type.

8.32.4 FTM Reference

See Figure 9-95 below for complete field wiring information for the 4Ch MPU/Prox/Eddy FTM. Note the ground connection on pin 37 of the FTM.

See Figures 9-96 and 9-97 for wiring information for 4Ch MPU/Prox/Eddy in TMR system.

See Appendix A for part number Cross Reference for modules, FTMs, and cables.

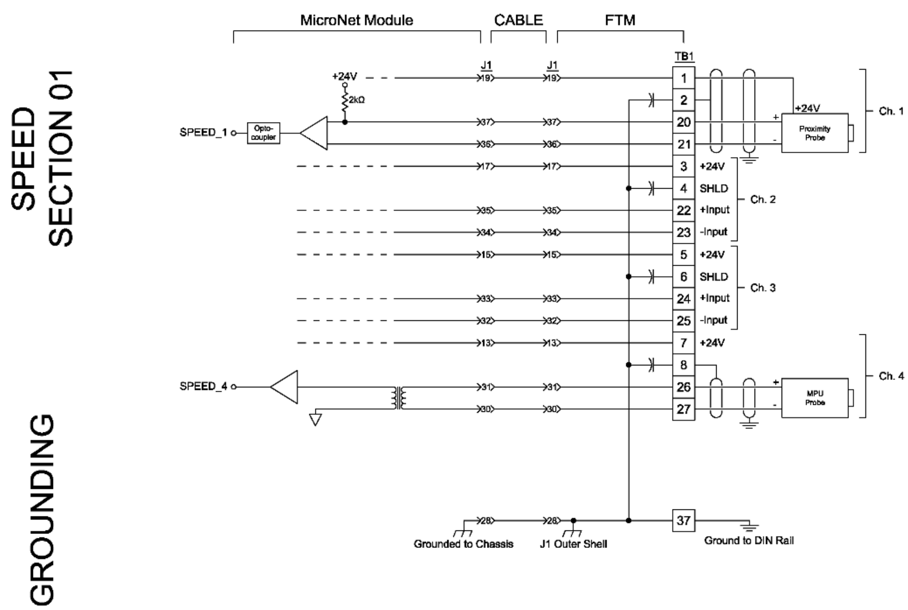


Figure 8-26. MPU and Prox Probe Interface Wiring

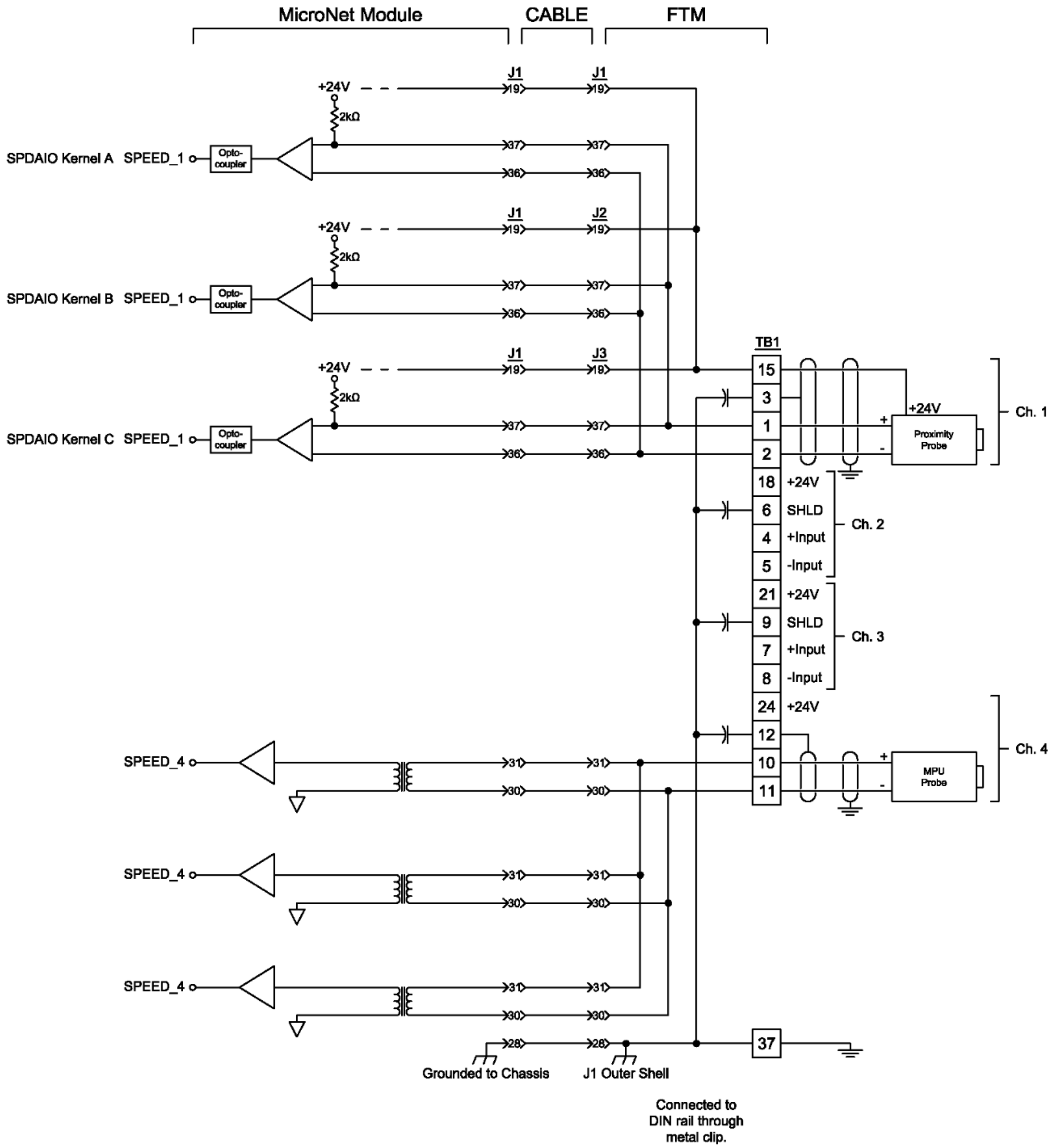


Figure 8-27. MPU Probe Interface Wiring in TMR system

Analog Inputs

For a 4–20 mA input signal, the Speed/Analog IO Combo Smart-Plus Module uses a 200 ohm resistor across the input located onboard the module. Each analog input channel may power its own 4–20 mA transducer.

See Figure 9-75 for analog input connection. This power is protected with a 100 mA fuse on each channel located at the FTM to prevent an inadvertent short from damaging the module. The 24 Vdc outputs are capable of providing 24 Vdc with ±10% regulation. Power connections can be made through terminals located on the 24/8 Analog FTMs. See Chapter 13 for complete field wiring information for the 24/8 Analog FTM.

IMPORTANT — **Maximum loop power current is 0.32A per 12 inputs located on the same FTM.**

IMPORTANT — **When configuring the AI Combo block in GAP, set Conf. input field to 0 for all inputs working in 1-5V voltage mode. This will disconnect input 200ohms sense resistor and allow the block to use the module factory voltage calibration values.**

IMPORTANT — **When configuring the AI Combo block in GAP, set Conf. input field to 1 for all inputs working in 4-20mA current mode. This will allow the block to use the module factory calibration values for inputs that were calibrated with 200 ohm internal resistors on the 24/8 Analog Module.**

IMPORTANT — **When configuring the AI Combo block in GAP, set Conf. input field to 2 for all 4-20 mA inputs when used with the Dataforth current input plug-in module. This will allow the block to use the module factory voltage calibration values with a gain factor for a 200 ohm external resistor on the Dataforth FTM.**

IMPORTANT — **For modules with GAP selectable inputs, when changing the Conf. input field to a new value an application save and application restart is required before the module can be used. This save and restart allows the hardware and software to be properly initialized together.**

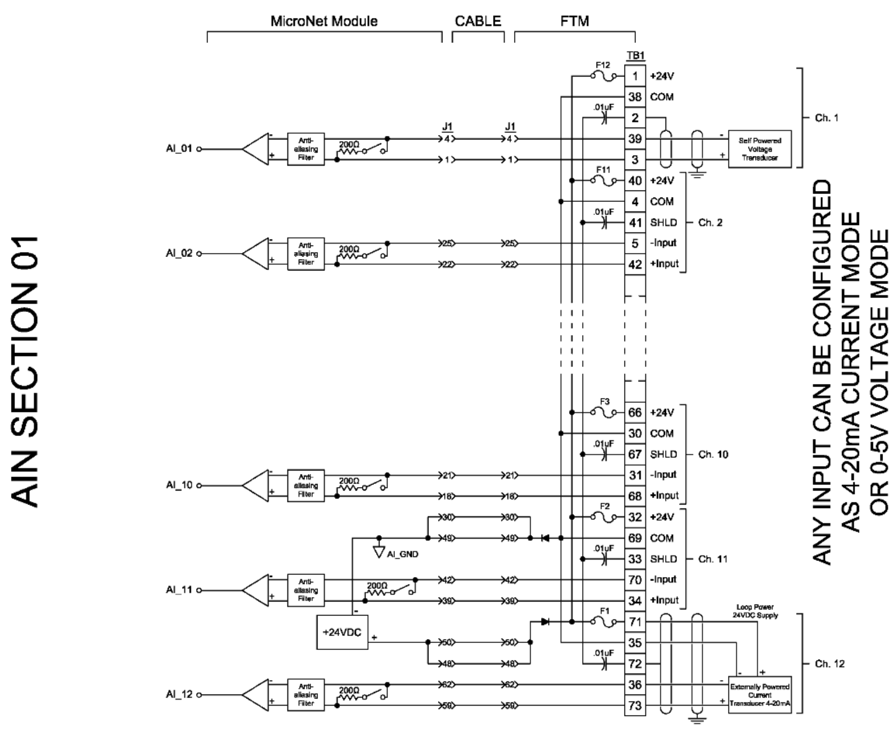


Figure 8-28. Analog Input Wiring for a 24/8 Analog FTM

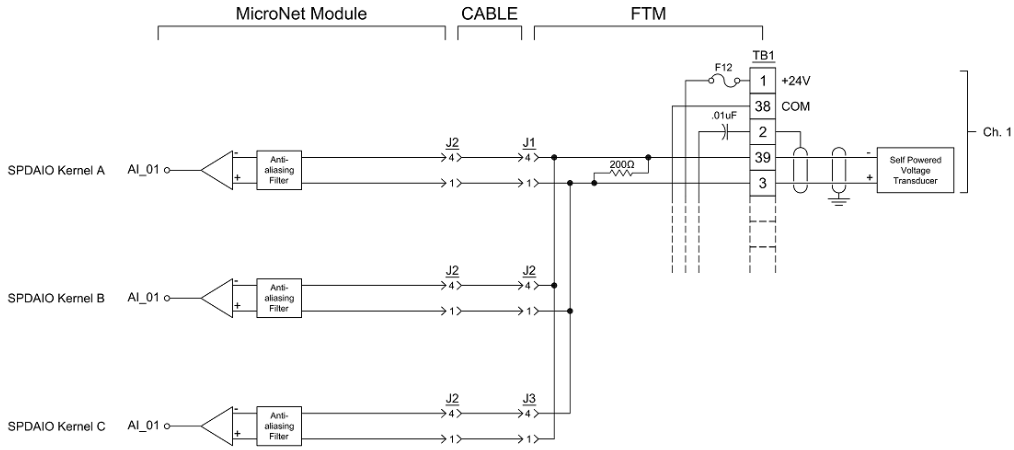


Figure 8-29. Analog Input Wiring for a TMR 24/8 Analog FTM.
Self-Powered Sensor Connection Example

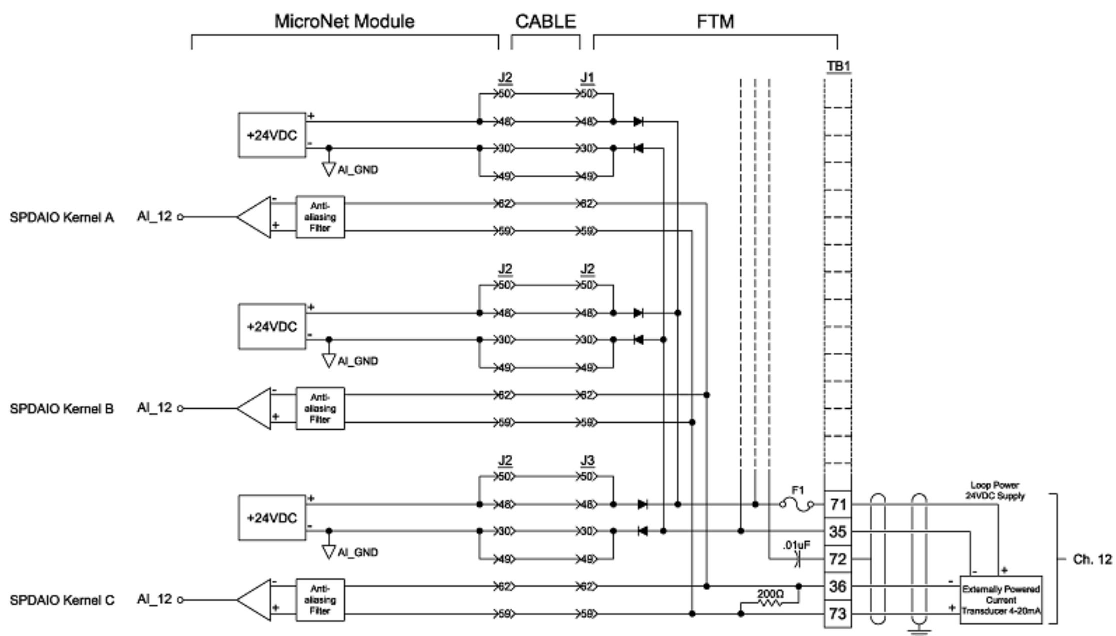


Figure 8-30. Analog Input Wiring for a TMR 24/8 Analog
FTM Externally Powered Sensor Connection Example

Analog Outputs

There are four analog output channels of 4–20 mA with a full-scale range of 0-25 mA. All Analog Outputs can drive a maximum load of 600 ohms (load + wire resistance). See Figure 9-76 for analog output connection. Each output monitors the output source and return current for fault detection. All of the analog outputs may be individually disabled. When a channel fault or a module fault is detected, the application program may annunciate the fault, disable the channel, and stop using data in system calculations or control. Care should be taken to prevent ground loops and other faults when interfacing to non-isolated devices. See Chapter 13 for complete field wiring information for the Analog High Density FTM.

Released

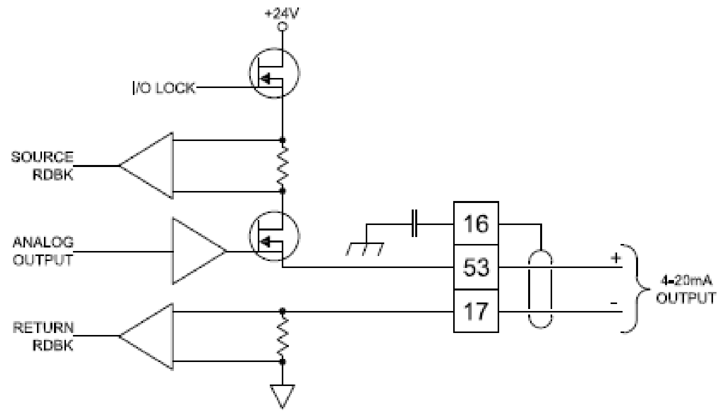


Figure 8-31. Analog Output Wiring for a 24/8 Analog FTM

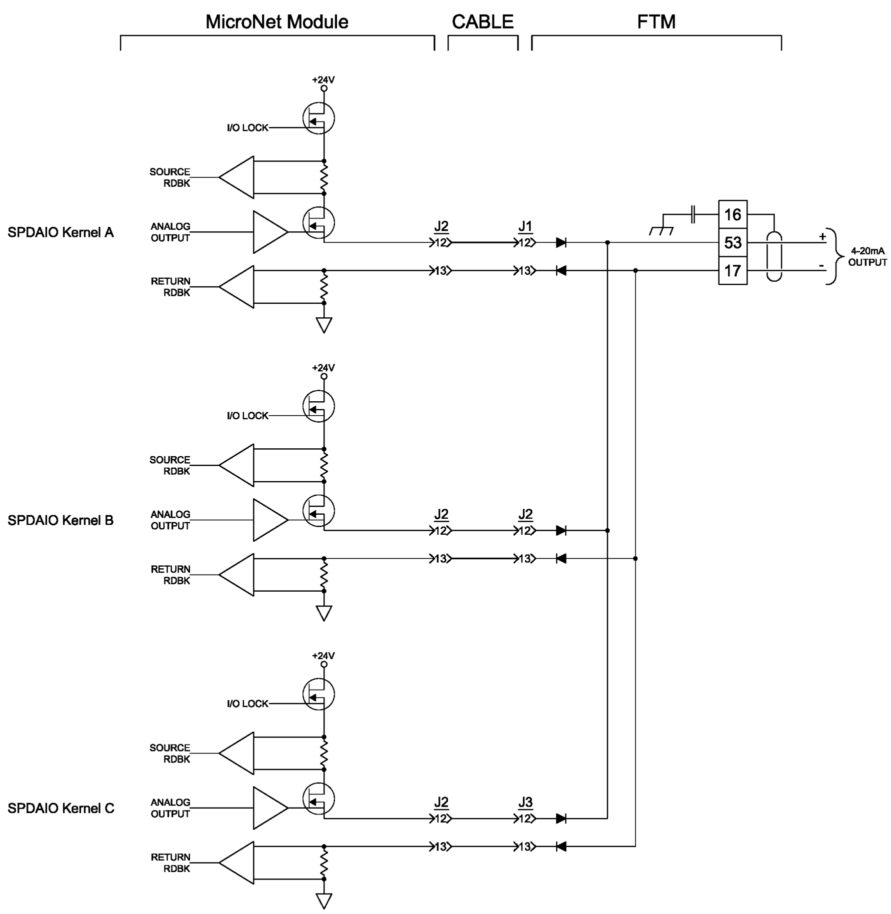


Figure 8-32. Analog Output Wiring for a TMR 24/8 Analog FTM

8.32.5 Troubleshooting

Speed ranges are selected from the GAP and the signal is pre-scaled accordingly. The pre-scaled signal then goes to a counter where the period of the signal is measured. The Digital Signal Processor samples the counter's values every 100 microseconds and performs a divide to generate a digital speed signal.

Every 100 microseconds a digital-filter algorithm is executed to average the speed values in order to improve speed-sensor resolution at input frequencies greater than 200 Hz. This digital filter also provides a derivative output.

Once every rate time (5-200 ms typically), the latest speed and derivative information is moved to the Dual-Port RAM for access by the CPU module.

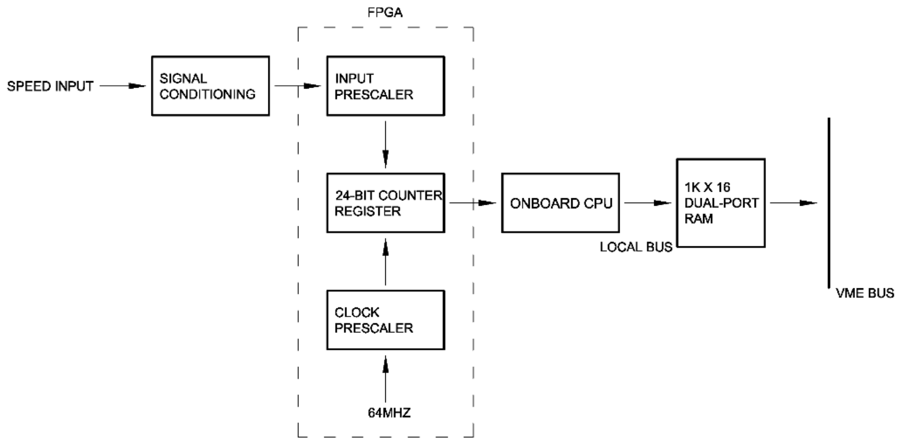


Figure 8-33. Digital Speed Sensor Module Block Diagram

During initialization, which occurs after every reset, the CPU turns the FAULT LEDs on. The CPU then tests each I/O module using diagnostic routines built into software. If the diagnostic test is not passed, the LED remains on. If the test and initialization are successful, the LED goes off and green RUN LED is turned on.

Table 8-5. LED Indications of Failure

Number of LED Flashes	Failure
1	Watchdog/MFT Lost Failure
2	No Application
3	Flash Memory Failure
4	Exception Failure
5	FPGA Failure
6	Non-Volatile Memory Error
7	Kernel Watchdog Error
8	MFT Timing Failure
9	Software Slip
10	RAM Memory Failure
11	Software Failure
12	Power Supply Failure
13	Configuration or Parameter Error
15	Parrallel to Serial Bus Error
16	AI ADC Error
17	AO Readback ADC Error
19	Speed Error
20	AI ADC Timeout
21	AO Readback ADC Timeout
22	AO DAC Timeout

AppManager contains detailed fault descriptions for active flash code.

Fault Detection (I/O)

In addition to detecting the Speed/Analog IO Combo Smart-Plus Module hardware faults, the application software may detect I/O faults.

Analog Input Faults: The application software may be set with a high and low latch set point to detect input faults.

Analog Output Driver Faults: The module monitors the source and return currents and annunciates faults. The application software determines the course of action in the event of a fault.

Microcontroller Faults: The system monitors a software watchdog, a hardware watchdog, and a software watchdog on the VME bus communications. All outputs are shut down in the event of a microcontroller fault.

The CPU also tells this module in which rate group each channel is to run, as well as special information. At run time, the CPU then periodically broadcasts a "key" to all I/O cards, telling them which rate groups are to be updated at that time. Through this initialization/key broadcast system, each I/O module handles its own rate-group scheduling with minimal CPU intervention.

Troubleshooting Guide

If during normal control operation, all of the modules have Fault LEDs on, check the chassis' CPU module for a failure.
If during normal control operation only the Speed/Analog IO Combo Smart-Plus module's Fault LED is on or flashing, insure that it is installed in the correct slot. If it is, then replace that module. See instructions for replacement in Chapter 15, Installation (System Level Installation). When a module fault is detected, its outputs will be disabled or de-energized.

MPUs

If a magnetic pickup input is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 15, Installation.
2. Measure the input voltage on the terminal block. It should be in the range of 1-25 VRMS.
3. Verify that the signal waveform is clean and void of double zero crossings.
4. Verify that no ground connection exists and that the resulting 60 Hz signal is absent.
5. Measure the frequency. It should be in the range of 50 Hz - 25 kHz.
6. Look at the individual inputs into each kernel. The application software should contain three separate numbers, one from each module. The numbers should be within 0.05% of each other.
7. Check the wiring. Look for a loose connection at the terminal blocks and disconnected or misconnected cables.
8. Check the software configuration to ensure that the input is configured properly.
9. If the readings are incorrect on several channels of the module, replace the module.
10. If replacing the module does not fix the problem, replace the FTM. See instructions for replacing the FTM in Chapter 15, Installation. The FTM does not contain any active components on the MPU inputs, so replacing it should be the last option.

Prox Probes

If a prox probe input is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 15, Installation.
2. Measure the input voltage on the terminal block. Low level of the input signal should be in the range of 0-10V, high level should be in the range of 15 - 24V to ensure correct signal conditioning operation.
3. Verify that the signal waveform is clean and void of double zero crossings.
4. Verify that no ground connection exists and that the resulting 60 Hz signal is absent.
5. Measure the frequency. It should be in the range of 0.04 Hz to 25 kHz.
6. Look at the individual inputs into each kernel. The application software should contain three separate numbers, one from each module. The numbers should be within 0.05% of each other.

7. Check the wiring. Look for a loose connection at the terminal blocks, disconnected or misconnected cables.
8. Check the software configuration to ensure that the input is configured properly.
9. If the readings are incorrect on several channels of the Speed module, replace the module.
10. If replacing the module does not fix the problem, replace the FTM. See instructions for replacing the FTM in Chapter 15, Installation.

Eddy Probes

If an eddy probe input is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 15, Installation.
2. Measure the input voltage on the terminal block. It should be in the range of 7 - 24 V-peak.
3. Verify that the signal waveform is clean and void of double zero crossings.
4. Verify that no ground connection exists and that the resulting 60 Hz signal is absent.
5. Measure the frequency. It should be in the range of 1Hz to 25 kHz.
6. Look at the individual inputs into each kernel. The application software should contain three separate numbers, one from each module. The numbers should be within 0.05% of each other.
7. Check the wiring. Look for a loose connection at the terminal blocks, disconnected or misconnected cables.
8. Check the software configuration to ensure that the input is configured properly.
9. If the readings are incorrect on several channels of the Speed module, replace the module.
10. If replacing the module does not fix the problem, replace the FTM. See instructions for replacing the FTM in Chapter 15, Installation.

Analog Inputs

If an analog input is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 15, Installation (System Level Installation).
2. Measure the input voltage on the FTM terminal block. It should be in the range of 0-5 V.
3. Verify that there are no or minimal AC components to the Analog Input signal. Improper shielding may introduce AC noise on the input terminals.
4. Check the wiring. If the inputs are reading 0 or the engineering units that correspond to 0 mA, look for a loose connection on the terminal blocks, disconnected or misconnected cables, a missing jumper on the terminal block if the input is a current input, or a blown fuse on the 24 Vdc on the FTM.
5. If all of the inputs are reading high, check that the 24 Vdc is not connected across the input directly.
6. Check the software configuration to ensure that the input is configured properly.
7. If the readings are incorrect on several channels of the Speed AI Combo Smart Plus module and the wiring is correct replace the module.
8. If replacing the module does not fix the problem, replace the FTM. The FTM contains only traces and a few discrete components, so failure is extremely unlikely. See instructions for replacing the FTM in Chapter 15, Installation (System Level Installation).

Analog Outputs

If an analog output is not functioning properly, verify the following:

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 15, Installation (System Level Installation).
2. Check the load resistance to ensure that it is not greater than 600 ohms.
3. Check to ensure that the load wiring is isolated.
4. Check the wiring for a loose connection on the FTM terminal blocks and disconnected or misconnected cables.
5. Disconnect the field wiring and connect a resistor across the output. If the output is correct across the resistor, there is a problem with the field wiring.
6. Check the software configuration to ensure that the output is configured properly.
7. If the readings are incorrect on several channels of the module, and the wiring is correct, replace the module.
8. If replacing the module does not fix the problem, replace the FTM. The FTM contains only traces and a few discrete components, so failure is extremely unlikely. See instructions for replacing the FTM in Chapter 15, Installation (System Level Installation).

IMPORTANT	**Recommendation:** **The module should be returned to Woodward every 6 years for health check and technical updates. This health check shall increase in frequency when the module is more than 20 years old.**

Revision History

Changes in Revision P—
- Updated notes under section 6.1.8 Ethernet Switch Hardware

Changes in Revision N—
- Added content to Section 5.1.9 CAN Communication Ports
- Added CAN Cable Specification Section
- Replaced Figure 5-8
- Added ID numbers 200 and 201 to Table 5-6
- Added clarifying content to paragraph 5.1.9 CAN Communication Ports

Changes in Revision M—
- Added New Warning box to the Regulatory Compliance Section
- Edited note in Section 8.31.2

Changes in Revision L—
- Added Selectable Input Save and Restart notes and Important Blocks to Chapter 8.
- Added RTN Switch Updates to Section 6.1.8
- Moved obsolete modules from Chapters 5, 6, 7, and 8 to Volume 3
- Updated EMC and Low Voltage Directives

Changes in Revision K—
- Replaced proximity input and proximity probe references with Eddy references in Chapter 8.
- 4-10mA Output Ratings updated in Chapter 8
- References to Speed Module removed from Chapter 8

Changes in Revision J—
- Minor correction in section 5.1.5
- Corrected Figure 7-7
- Added Table 8-13
- Added content to Troubleshooting section of Chapter 8

Changes in Revision H—
- Updated Compliance information.
- Updated front panel indicator tables and related information as marked with change bars.
- Minor corrections as marked.

Chapters 9–15 and the appendixes are contained in volume 2.

We appreciate your comments about the content of our publications.

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