

**MicroNet™ Simplex Digital Control  
MicroNet™ Plus Digital Control**

**This manual replaces manual 85584  
for the MicroNet Simplex.**

**Manual 26166 consists of 2 volumes (26166V1 & 26166V2).**

**Installation and Operation Manual**



### General Precautions

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

Practice all plant and safety instructions and precautions.

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



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- Volume 1 contains chapters 1–9 (manual 26166V1).
- Volume 2 contains chapters 10–16 and the appendixes (manual 26166V2).

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# Warnings and Notices

## Important Definitions



This is the safety alert symbol. It is 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**

**IOLOCK.** When a CPU or I/O module fails, watchdog logic drives it into an IOLOCK condition where all output circuits and signals are driven to a known de-energized state as described below. The System **MUST** be designed such that IOLOCK and power OFF states will result in a **SAFE** condition of the controlled device.

- CPU and I/O module failures will drive the module into an IOLOCK state.
- CPU failure will assert an IOLOCK signal to all modules and expansion racks to drive them 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.

The IOLOCK state is asserted under various conditions including:

- CPU and I/O module watchdog failures
- PowerUp and PowerDown conditions
- System reset and hardware/software initialization
- Entering configuration mode

**NOTE:** Additional watchdog details and any exceptions to these failure states are specified in the related CPU or I/O module section of the manual.

### **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.

**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. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
  - Do not touch any part of the PCB except the edges.
  - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
  - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

# Regulatory Compliance

**IMPORTANT**

For LINKnet regulatory information, please refer to the appropriate chapter in Volume 2 of this manual.

## European Compliance for CE Marking

These listings are limited only to those units bearing the CE Marking:

- EMC Directive:** Declared to 2004/108/EC COUNCIL DIRECTIVE of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility.
- Low Voltage Directive:** Declared to 2006/95/EC COUNCIL DIRECTIVE of 12 December 2006 on the harmonization of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits.
- ATEX – Potentially Explosive Atmospheres Directive:** Declared to 94/9/EC COUNCIL DIRECTIVE of 23 March 1994 on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres. Zone 2, Category 3, Group II G, Ex nA [nL] IIC T3 X

## Other European and International Compliance

Compliance with the following European Directives or standards does not qualify this product for application of the CE Marking:

- GOST R:** Certified for use in ordinary locations within the Russian Federation per GOST R certificate POCC US.MJ03.B01257.

## 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. For use in Canada and the United States. 5441-694 DIO FTM Relay Driver rated for temperatures up to 75 °C, Temperature Code T3A. CSA Listing per Certificate of Compliance 2314167.

## Marine

- American Bureau of Shipping:** ABS SVR Rules 2012 1-14/7.7, 1-1-A3, 4-2-1/7.3, 4-2-1/7.5.1, 4-9-3/17, 4-9-7/13, 4-9-2/11.7 & 4-9-4/23. The MicroNet Digital Control System is to be installed in an enclosed, environmentally conditioned space (0 to +55 °C)
- Det Norske Veritas:** Standard for Certification No. 2.4, 2006: Temperature Class A, Humidity Class B, Vibration Class B, and EMC Class A. Enclosure protection required according to the Rules to be provided upon installation on board.
- Lloyd's Register of Shipping:** LR Type Approval Test Specification No. 1, 2002 for Environmental Categories ENV1, ENV2

**SIL Compliance**

For MiroNet Simplex and MicroNet Plus Digital Controls, SIL information may be found in manual B26728 which is not included within Volume 1 or Volume 2 of this manual.

**Special Conditions for Safe Use**

**The 16-Channel Relay Interface Modules are suitable for ordinary or non-hazardous locations only.**

This equipment is suitable for use in European Zone 2, Group IIC environments when installed in an IP54 minimum rated enclosure per self-declaration to EN60079-15.

Wiring must be in accordance with North American Class I, Division 2, or European Zone 2, Category 3 wiring methods as applicable, 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.

For ATEX compliance, this equipment must be installed in an area providing adequate protection against the entry of dust or water. A minimum ingress protection rating of IP54 is required for the enclosure per EN60529. The interior of the enclosure shall not be accessible in normal operation without the use of a tool and must meet the construction requirements of IEC 60079-0.

For ATEX compliance, this equipment must be protected externally against transient disturbances. Provisions shall be made to prevent the power input from being exceeded by transient disturbances of more than 40% of the rated voltage.

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.

**IMPORTANT**

This equipment is considered indicator equipment and is not to be used as metrology equipment. All measurements need to be verified using calibrated equipment.

**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 à moins de se trouver dans un emplacement non dangereux.

# Chapter 1.

## General Information

### 1.1—Introduction

The MicroNet Plus and MicroNet Simplex controls are a 32-bit microprocessor-based digital controllers that are programmable for many types of applications in the control of:

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

The MicroNet Controls family provide 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 simplex and redundant based control configurations. Please refer to manual 26167 for TMR-based control configurations.

The MicroNet Operating System, together with Woodward's Graphical Application Program (GAP), 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 5 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.

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

Communications with the MicroNet platform are available to program and service the control as well as to interface with other systems (Plant DCS, HMI, etc.). Application code is generated by use of Woodward's GAP program or Woodward's Ladder Logic programming environment. 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 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 control is available in chassis sizes with 6, 8, 12, or 14 VME slots. Each has dedicated power supply and control sections located in a single chassis. The power supply architecture supports simplex or redundant power supplies.

### 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 Plus Systems

## 2.1—MicroNet Plus Redundant

The MicroNet controls family is developed around the VME chassis and a CPU module that goes into the first active slot of the VME chassis. All I/O modules plug into the remaining slots of the VME chassis.

The MicroNet Plus chassis offers both simplex (single CPU) and redundant (dual CPU) operation with up to 14 VME slots per chassis. The system may be expanded using copper or fiber cables to multiple chassis to accommodate additional system I/O requirements.

### 2.1.1—MicroNet Plus Configurations

Table 2-1-MicroNet Plus Configurations

System Config	Main and Expansion rack configurations		
	Main Rack	Optional Exp #1	Optional Exp #2
Full Redundancy	Redundant CPU's	Redundant RTNs	Redundant RTNs
Partial Redundancy	Redundant CPU's	Redundant RTNs	Single RTN
Partial Redundancy	Redundant CPU's	Single RTN	Redundant RTNs
Partial Redundancy	Redundant CPU's	Single RTN	Single RTN
Simplex	Single CPU	Single RTN	Single RTN

- MicroNet Plus**
- MicroNet 14 or 8 VME Slot Chassis
  - Dual CPU's for redundant operation
  - Single CPU for simplex operation
  - CPU5200/ CPU5200L and CPU\_1020
  - Simplex or Redundant I/O modules
  - Simplex or Redundant Power
  - Redundant smart fans



### MicroNet Plus Redundant System (Single, Dual, or Triple rack system)

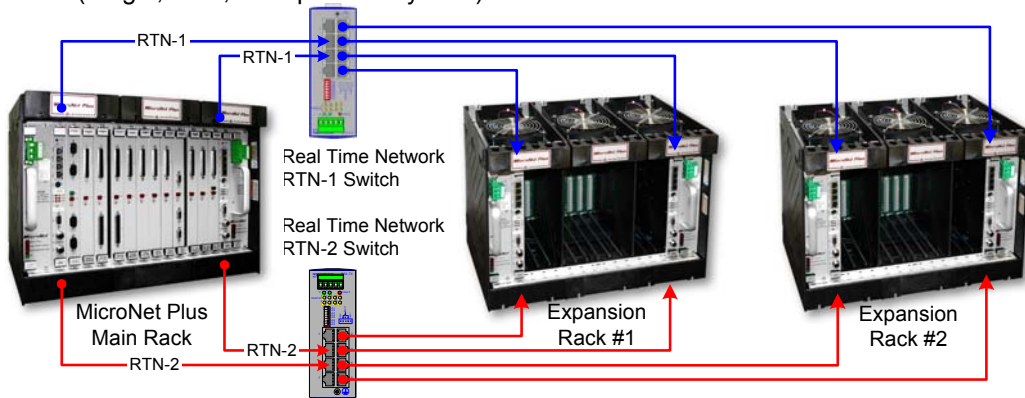


Figure 2-1-MicroNet Plus Redundant System

### 2.1.2—Redundant CPU Theory

The MicroNet Plus control system uses redundant CPU5200/CPU5200L modules that must be located in the first and last VME slots (A1 and A8 / A14). The chassis has a single motherboard and houses 2 power-supplies, 2 CPUs, and 12 I/O slots. The CPUs share a single data path to the VME modules and each other.

In a redundant system, there are two CPU modules, running the same application program, receiving power from the same pins on the VME backplane, and with access to the I/O modules over the same VME bus. The CPU modules communicate their health to each other over the VME bus, and arbitrate for control of the bus. The CPU which is in slot 1 and in good “health” first, gains control of the I/O modules, and is called the System Controller or SYSCON. The other CPU is then the backup or STANDBY CPU. The SYSCON sends all necessary state information to the backup CPU, allowing it to take control of the I/O modules if the SYSCON fails.

The following conditions will cause a failover from the SYSCON CPU to the backup STANDBY CPU:

- Failure of the on board CPU module power supplies
- Failure of the processor core, including the processor, RAM, flash, oscillator, etc.
- Failure of communications between the processor and the FPGA.
- A watchdog timeout between the CPU module and the FPGA. This would mean that one of the devices did not respond to the other device, within a prescribed amount of time.
- A reset of the SYSCON CPU, caused by the front panel or remote Resets
- An application requested failover
- An application stop

### 2.1.3—Redundant Power Supplies

Two load sharing power supplies provide redundant power to the motherboard, CPU and I/O modules. The MicroNet Plus power supplies are 2-slot wide each and are located at each end of the chassis in the designated PS1 and PS2 slots.

### 2.1.4—Simplex Inputs and Outputs

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.

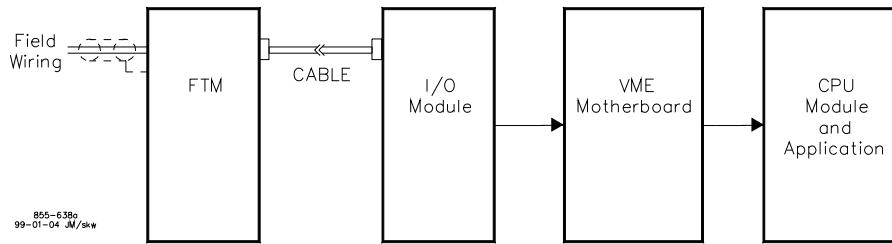


Figure 2-2—Input Flow

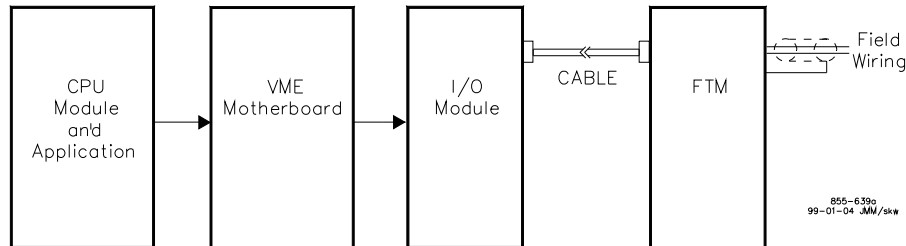


Figure 2-3—Output Flow

### 2.1.4—Redundant Inputs and Outputs

Two levels of redundancy are available. The first involves wiring two external input devices to two separate input channels. See Figure 2-3. 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

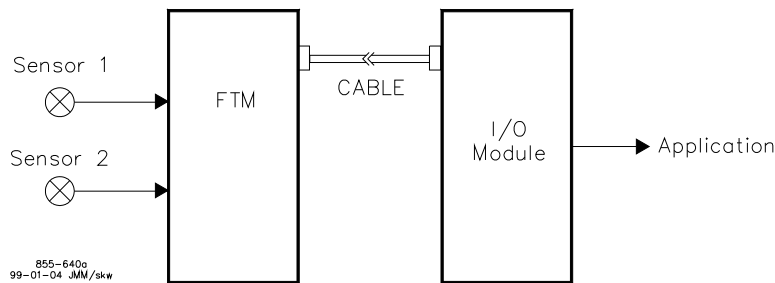


Figure 2-4—Redundant Sensors

The second level is wiring two external input devices to two separate I/O modules. See Figure 2-4. In the event of a failure in one of the sensors, connections, cables, FTMs, or I/O modules, a valid input is still available.



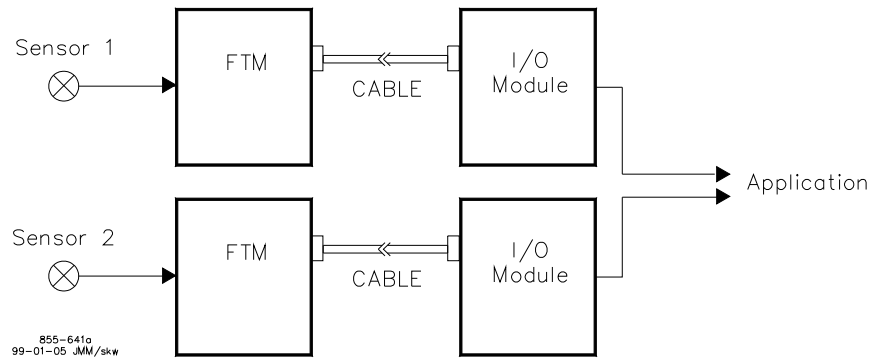


Figure 2-5—Redundant Inputs

This process can be expanded for triplicated inputs. With triplicated inputs, redundant inputs are available if an input fails. It is also possible to determine which input is not valid when using triplicated inputs.

### 2.1.5—Redundant Outputs

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 read back is provided. For discrete outputs, fault detection requires sensing the relay contact state.

## 2.2—MicroNet Plus Redundant Operation

To use the MicroNet Plus for redundant operation, a CPU must be in the first VME slot (slot A1) and a CPU must be in the last VME slot (slot A14). In the GAP application select the MICRONET14 or MICRONET8 chassis type and place a MicroNet Plus compatible CPU module in both A1 and A14 / A8 slots.

### Start-up

- Load and start the application on each CPU using AppManager.
- If the CPUs are started within 20 seconds of each other they will boot in the “Redundant” mode.
- If the CPUs are not started within 20 seconds of each other the first CPU started will become the master and the second CPU will have to re-sync to the running CPU.
- If the applications are not the same and both CPUs are started together, CPU1 (located in slot A1) will be the SYSCON and the backup CPU will be failed.

### Normal Operation (Redundant)

- Normally the CPUs will be powered up together and will start running the application within the 20 second window.
- The first CPU to start running the application will remove the WATCHDOG (as indicated by the red LED on the CPU) and become the SYSCON (as indicated by the green LED on the CPU).
- When the second CPU starts running the application the SYSCON control will go to CPU1 (located in slot A1).
- Both CPUs will establish communication and CPU2 will temporarily become SYSCON (as indicated by the green LED on the CPU) to do a diagnostic test to ensure it can drive the VME bus.
- This diagnostic test will switch the SYSCON between both CPU1 and CPU2 three times before proceeding.

After this diagnostics test is completed, the CPUs will determine if the GAP application on both CPUs is the same.

- If they have the EXACT same application CPU1 (located in slot A1) will be SYSCON and initialize the I/O.
- CPU2 will wait at a rendezvous point for the SYSCON CPU to be ready.
- When the SYSCON CPU is ready it will turn out IO\_LOCK (as indicated by the LED on the CPU) and start running the GAP application.
- After the SYSCON starts running the real-time code, the CPUs will start sharing data.
- If the SYSCON CPU fails, the Backup CPU will take over running the GAP application and the I/O.
- If the CPUs do not have the same application, CPU1 (located in slot A1) will become the SYSCON and start up in the SIMPLEX mode (see section Only One CPU) with the Backup failed flag set to TRUE. (see picture of CHAS\_STAT block)

### Single CPU operation (Simplex)

- If only one CPU is started (or the second CPU is started 20 seconds after the first CPU) this CPU will start up in the SIMPLEX mode.
- When this occurs the CPU (in A1 or A14) will remove the WATCHDOG then wait 20 seconds for the second CPU then continue with normal SYSCON start-up of initializing the I/O and running the real-time application.
- When the 2nd CPU is started, it will determine the other CPU is running and ask the SYSCON to allow it to sync-in.
- The SYSCON CPU will communicate with the BACKUP and if the BACKUP has the EXACT same application and is functioning properly, the SYSCON will allow the BACKUP CPU to sync.
- If the BACKUP syncs in correctly, the backup fault indication in the GAP will go FALSE (see Figure 2-9).

## 2.3—MicroNet Plus Simplex

The MicroNet Controls family is developed around the VME chassis and a CPU module that goes into the first active slot of the VME chassis. All I/O modules plug into the remaining slots of the VME chassis.

The MicroNet Plus chassis offers both simplex (single CPU) and redundant (dual CPU) operation with up to 14 VME slots per chassis. The system may be expanded to use multiple chassis to accommodate additional system I/O requirements.

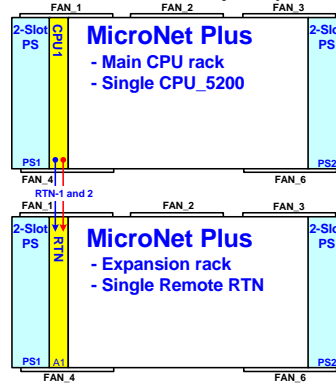
System Diagrams—MicroNet Plus Simplex

MicroNet Plus

- MicroNet 14 or 8 VME Slot Chassis
- Single CPU for simplex operation
- Motorola PowerPC CPU5200
- Simplex or Redundant I/O modules
- Simplex or Redundant Power
- Redundant smart fans



MicroNet Plus - Simplex (2-rack)



MicroNet Plus - Simplex (3-rack)

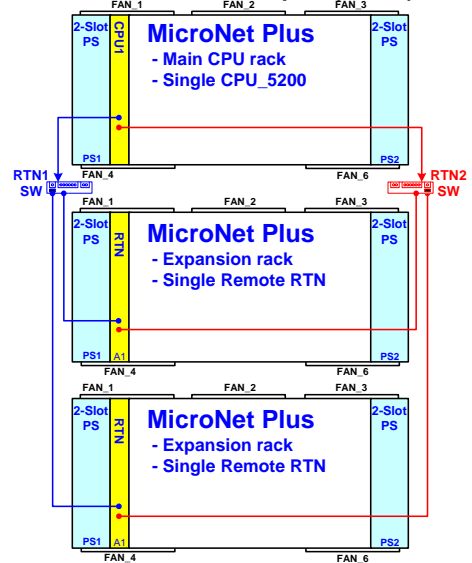


Figure 2-6 MicroNet Plus Simplex System Diagrams

2.3.1—Redundant Power Supplies

Two load sharing power supplies provide redundant power to the motherboard, CPU and I/O modules. The MicroNet Plus power supplies are 2-slot wide each and are located at each end of the chassis in the designated PS1 and PS2 slots.

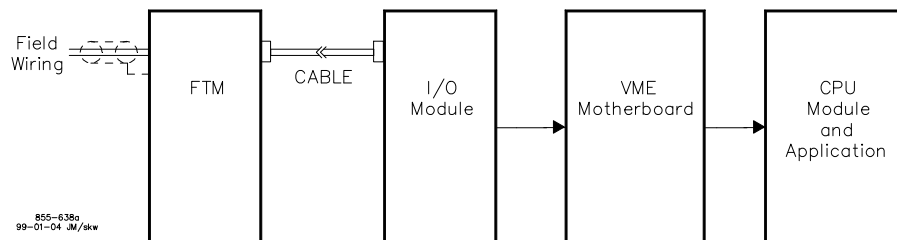
2.3.2—Single CPU Options

The MicroNet Plus control system may be used in simplex mode with a single CPU5200/CPU5200L module that must be located in slot A1 of the main chassis. No other options are available.

**Note:** The CPU5200 module offers high processing capability in a PowerPC MPC5200 processor with features like dual Ethernet, dual Real Time Network ports, dual CAN, and a configurable RS-232/RS-422/RS-485 serial port. Module operating temperature limits are -40 °C to +85 °C.

2.3.3—Simplex Inputs and Outputs

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.



855-638a  
99-01-04 JM/skw

Figure 2-7—Input Flow

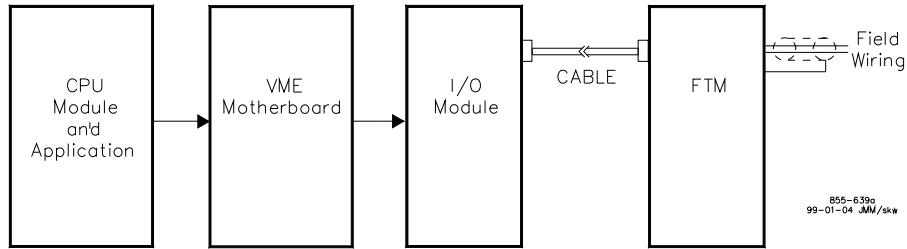


Figure 2-8—Output Flow

### 2.3.4—Redundant Inputs and Outputs

Two levels of redundancy are available. The first involves wiring two external input devices to two separate input channels. See Figure 2-7. 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

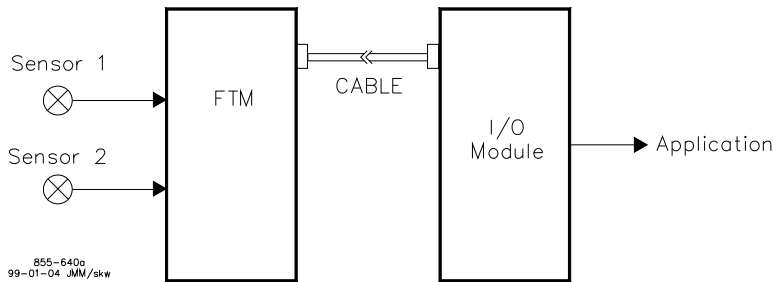


Figure 2-9—Redundant Sensors

The second level is wiring two external input devices to two separate I/O modules. See Figure 2-8. In the event of a failure in one of the sensors, connections, cables, FTMs, or I/O modules, a valid input is still available.

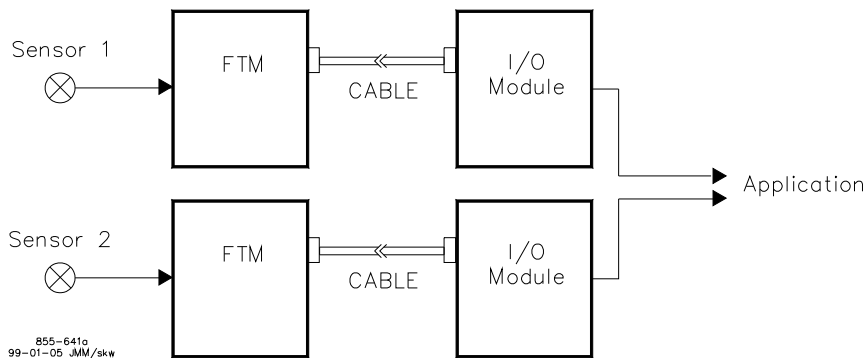


Figure 2-10—Redundant Inputs

This process can be expanded for triplicated inputs. With triplicated inputs, redundant inputs are available if an input fails. It is also possible to determine which input is not valid when using triplicated inputs.

### 2.3.5—Redundant Outputs

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 read back is provided. For discrete outputs, fault detection requires sensing the relay contact state.

## 2.4—MicroNet Plus Simplex Operation

To use the MicroNet Plus for simplex operation, the CPU must be in the first user slot (slot A1).

- In the GAP application, select the MICRONET14 or MICRONET8 chassis and use a CPU module in slot A1.
- The CPU can only be the CPU5200/CPU5200L or CPU\_1020.
- Assign communication and I/O modules according to your application needs.
- Compile and code your application using the Woodward GAP/Coder tools.
- Use the AppManager Service Tool to load and start the application over Ethernet.
- After starting the application, the CPU will initialize the I/O and run the real-time application.
- System initialization is complete when all the I/O module fault LED's are cleared.

### Expansion Chassis Notes

The GAP application may also define expansion chassis by using the Remote Real Time Network (Remote RTN) module in slot A1 of each expansion chassis.

**Note:** CPU5200 based systems require that the expansion chassis use the Remote RTN module in slot A1. The CPU5200 in the main chassis controls the expansion chassis through its redundant RTN port connections to the Remote RTN module.

## 2.5—Module Replacement

Chapter 15 contains Installation and 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.

Sections 5.2 and 5.4 contain additional details for power supply installation and replacement. Note that power must be removed from the power supply input before a module is removed or inserted.

### NOTICE



Live insertion and removal of the CPU5200 and Remote RTN modules is allowed in a MicroNet 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 failover to another healthy CPU or Remote RTN module if available.

## 2.6—Latent Fault Detection

Because a redundant system can tolerate some 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 redundant system so that it may be repaired before another fault occurs. Without a fully triplicated system it is not possible to detect all latent faults, however most faults can be detected. For single or redundant I/O points, fault detection is dependent on the application software to detect its I/O faults.

Example of MicroNet Plus fault information available from the CHASSIS14 status block.

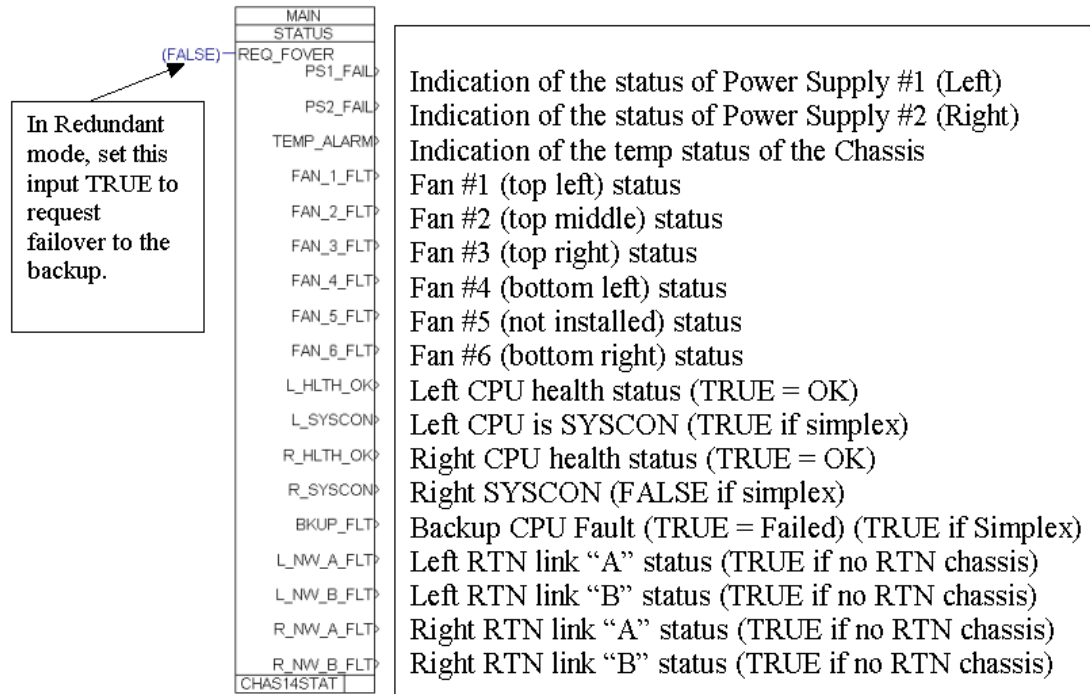


Figure 2-11—CHAS\_STAT Block



# Chapter 3. MicroNet Simplex Systems

## 3.1—MicroNet Simplex

The MicroNet Controls family is developed around the VME chassis and a CPU module that goes into the first active slot of the VME chassis. All I/O modules plug into the remaining slots of the VME chassis.

The MicroNet Simplex chassis offers single CPU operation with up to 12 VME slots per chassis. The system may be expanded to use multiple chassis to accommodate additional system I/O requirements. Different CPU options are available that provide a variety of system features.

Table 3-1-MicroNet Simplex Configurations

System Config	Main and Expansion rack configurations		
	Main Rack	Optional Exp #1	Optional Exp #2
Simplex (CPU5200)	Single CPU	Single RTN	Single RTN
Simplex (Pentium, Motorola x040)	Single CPU	---	---
Simplex (Pentium, Motorola x040)	Single CPU + Main XCVR	Remote XCVR	Remote XCVR

- MicroNet Simplex**
- MicroNet 12 or 6 I/O Slot Chassis
  - Single CPU for simplex operation
  - PowerPC CPU5200, Pentium, or Motorola x040 CPU options
  - Simplex or Redundant I/O modules
  - Simplex or Redundant Power

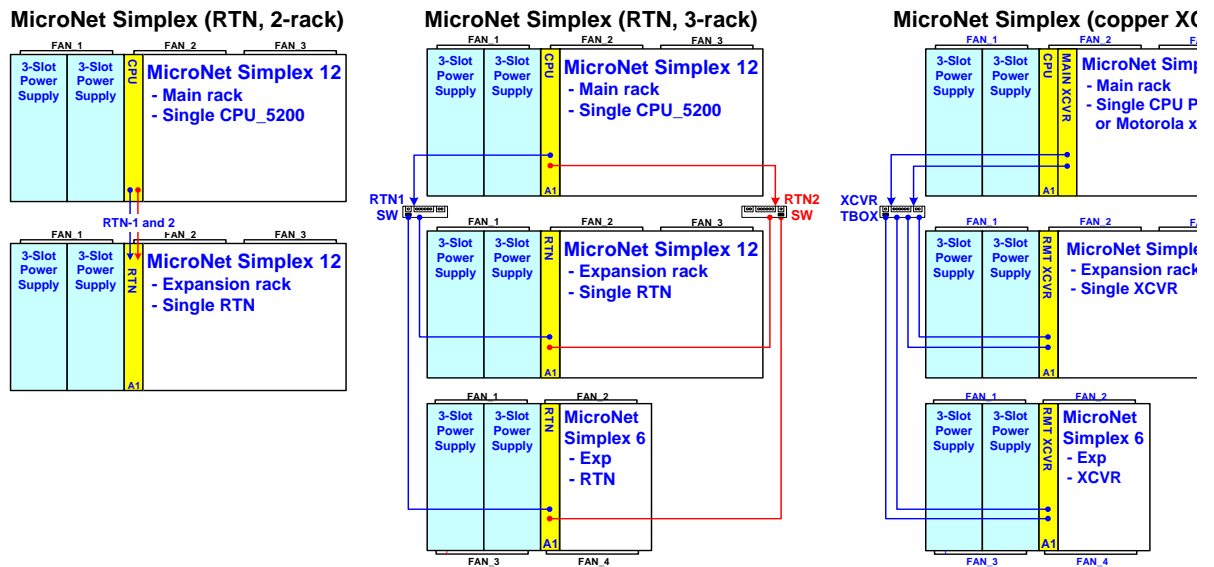


Figure 3-1-MicroNet Simplex System Diagrams

### 3.1.1—Single CPU Options

The MicroNet Simplex control system offers a single CPU module that must be located in slot A1 of the main chassis. Different CPU options may be selected to run the system.

- The CPU5200 module offers high processing capability in a PowerPC MPC5200 processor with features like dual Ethernet, dual Real Time Network ports, dual CAN, and a configurable RS-232/RS-422/RS-485 serial port. Module operating temperature limits are  $-40$  to  $+85$  °C.
- The Pentium CPU module offers high processing capability with single Ethernet and dual RS-232 serial ports. The Pentium CPU operating temperature limits are  $0$  to  $50$  °C.
- The Motorola 68040 CPU module offers basic capability and one RS-232 serial port.

### 3.1.2—Redundant Power Supplies

Two load sharing power supplies provide redundant power to the motherboard, CPU and I/O modules. The chassis consists of three sections where the 1<sup>st</sup> section is reserved for either (1) or (2) power supplies. The MicroNet Simplex power supplies are 3-slot wide each and are located together at the left side of the chassis.

### 3.1.3—Simplex Inputs and Outputs

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.

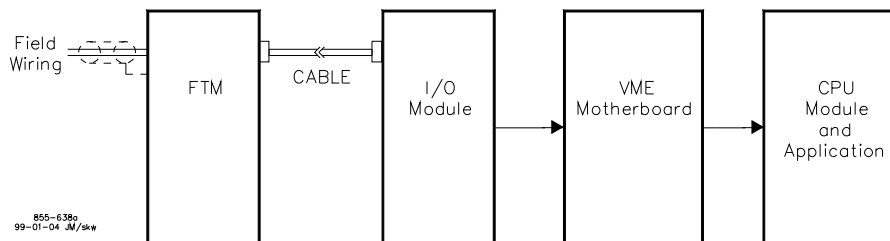


Figure 3-2—Input Flow

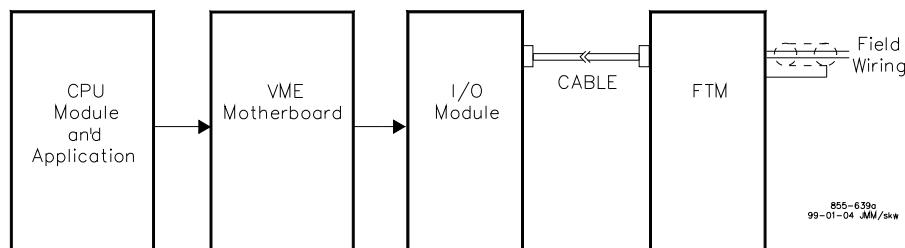


Figure 3-3—Output Flow

### 3.1.4—Redundant Inputs

Two levels of I/O signal redundancy are available. The first involves wiring two external input devices to two separate input channels. See Figure 3-3. 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

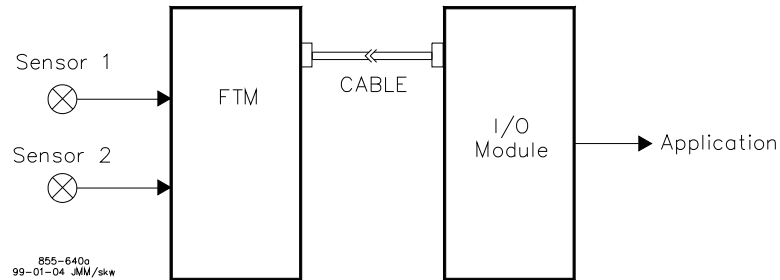


Figure 3-4—Redundant Sensors

The second level is wiring two external input devices to two separate I/O modules. See Figure 3-4. In the event of a failure in one of the sensors, connections, cables, FTMs, or I/O modules, a valid input is still available.

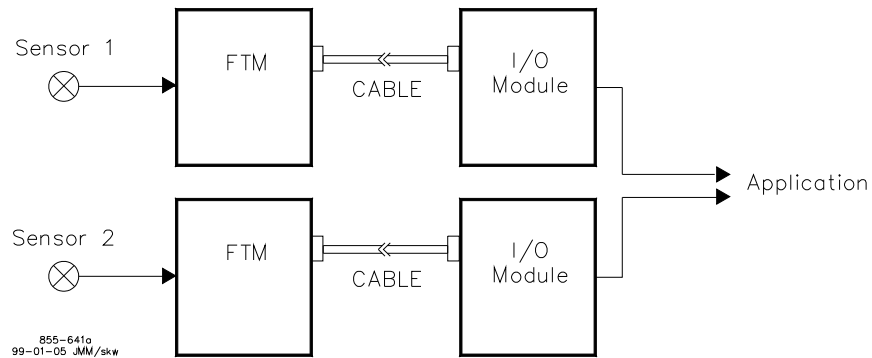


Figure 3-5—Redundant Inputs

This process can be expanded for triplicated inputs. With triplicated inputs, redundant inputs are available if an input fails. It is also possible to determine which input is not valid when using triplicated inputs.

### 3.1.5—Redundant Outputs

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 read back is provided. For discrete outputs, fault detection requires sensing the relay contact state.

## 3.2—MicroNet Simplex Operation

To operate the MicroNet Simplex, the CPU must be in the first user slot (slot A1).

- In the GAP application select the MICRONET12 or MICRONET6 chassis type and place an appropriate CPU in the A1 slot.
- The CPU selected can be either the CPU5200, Pentium, or Motorola x040.
- Assign communication and I/O modules according to your application needs.
- Compile and code your application using the Woodward GAP/Coder tools.
- For systems using the CPU5200 or Pentium CPU, use the AppManager Service Tool to load and start the application over Ethernet.
- For systems using the Motorola x040 CPU, the application can be loaded from a PCMCIA memory card or downloaded over Ethernet using a separate Ethernet module.
- After starting the application, the CPU will initialize the I/O and run the real-time application.
- System initialization is complete when all the I/O module fault LED's are cleared.

### Expansion Chassis Notes:

The GAP application may also define expansion racks by using either the Remote Real Time Network (Remote RTN) module or the Remote Transceiver (Remote XCVR) module. The expansion method used (Remote RTN or Remote XCVR) depends on the CPU being used in the main chassis.

- CPU5200 based systems require that the expansion chassis use the Remote RTN module in slot A1. The CPU5200 in the main chassis controls the expansion chassis through its redundant RTN port connections to the Remote RTN module.
- Pentium and Motorola x040 based systems require that the expansion chassis use the Remote XCVR module in slot A1 of the expansion rack. The system must also have a Main Transceiver (Main XCVR) module in the main chassis to control the expansion chassis.

### 3.3—Module Replacement

Chapter 15 contains Installation and 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.

Sections 5.2 and 5.4 contain additional details for power supply installation and replacement. Note that power must be removed from the power supply input before a module is removed or inserted.

#### **NOTICE**

**Live insertion and removal of a CPU or Remote RTN module in the MicroNet Simplex chassis is not recommended. Remove power to the chassis before insertion or removal. This process ensures that all I/O modules will be placed into a known I/O LOCK state upon power down.**

### 3.4—Latent Fault Detection

Because a redundant system can tolerate some 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 redundant system so that it may be repaired before another fault occurs. Without a fully triplicated system it is not possible to detect all latent faults, however most faults can be detected. For single or redundant I/O points, fault detection is dependent on the application software to detect its I/O faults.

## Chapter 4. Chassis Configurations

### 4.1—MicroNet Plus 14-Slot Chassis



Figure 4-1—MicroNet Plus 14-Slot I/O Chassis

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

#### Features:

- A total of (14) CPU 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 are built into the motherboard and trip at +65 °C
- Redundant, hot-swappable CPUs are supported

### 4.1.1—Specification

The MicroNet is designed around a modular 6-slot chassis (block). Each block consists of a pre-molded 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 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 4-1. 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 boards to terminal blocks 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.

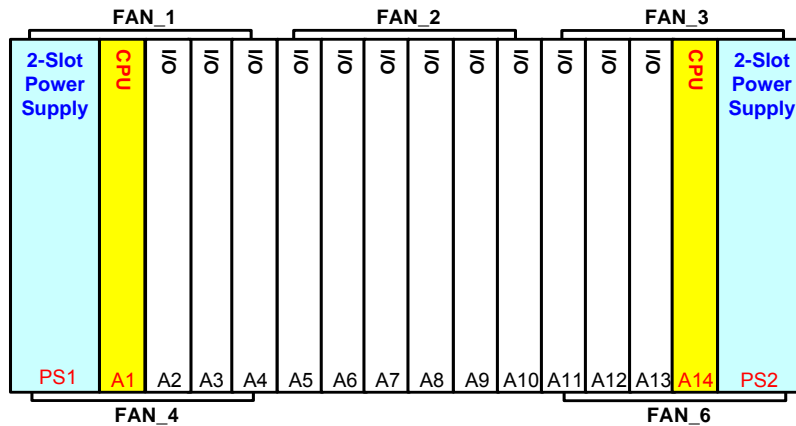


Figure 4-2—MicroNet Plus 14-Slot Chassis

#### CPU Slots (A1, A14)

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

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



## 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 CPU 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.

## Redundant Smart Fans

Each smart-fan provides a tachometer output to the CPU slots. The CPU 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.

## Motherboard Terminal Block (TB1)

The MicroNet Plus chassis includes a terminal block that provides CPU1 and CPU2 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.

## 24 Vdc Motherboard Power

- **Redundant systems**—Not recommended for use.
- **Simplex systems**—This power may be used for local Ethernet switch power upon successful EMC testing. 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.

## CPU Remote Reset Inputs (RST1, RST2)

Each CPU 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 CPU are designated RST1+, RST1– for slot A1 and RST2+, RST2– for slot A14. These inputs are optically isolated on each respective CPU module and require both a 24 V(+) and a common(-) to be wired. A momentary high will cause a CPU-reset.

## Chassis Overtemp Alarm

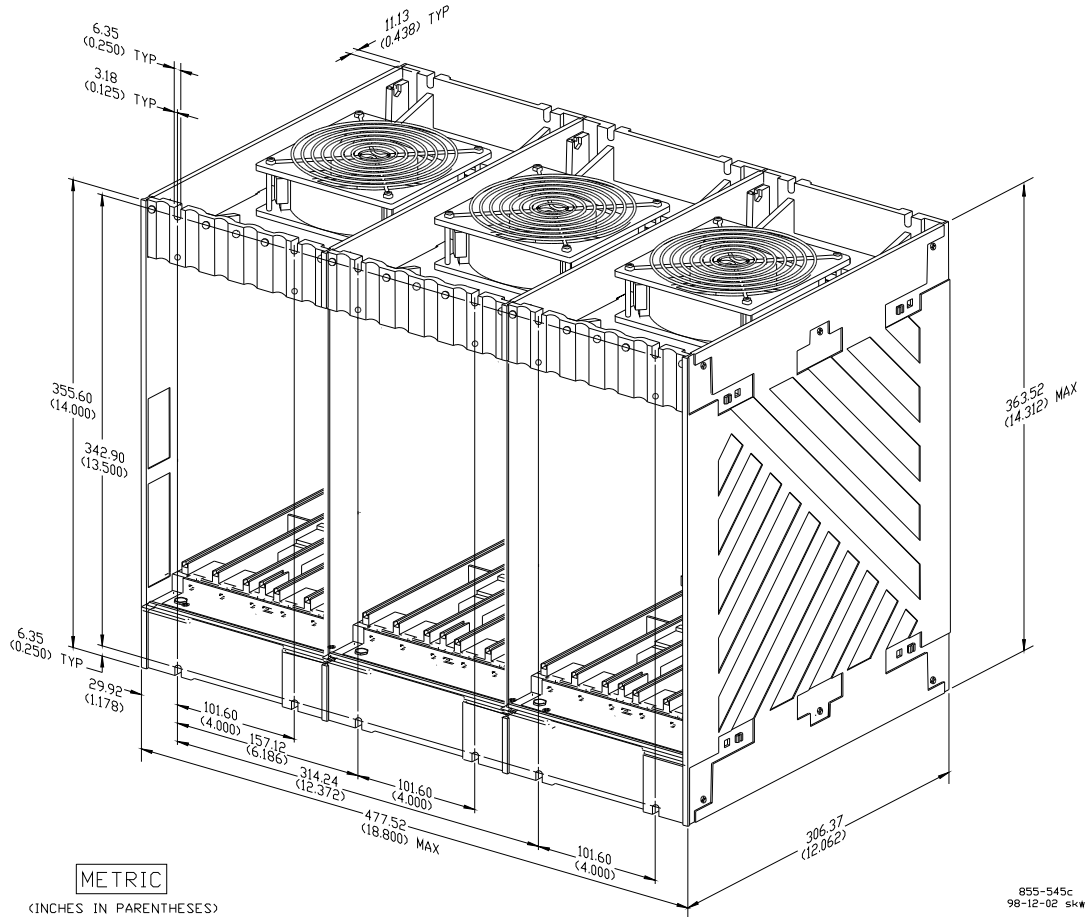
The MicroNet Plus chassis provides (3) over-temperature switches on the motherboard. The over-temperature switches will trip at  $65^{\circ}\text{C} \pm 3^{\circ}\text{C}$  and communicate this warning to the CPU and GAP application.

### Chassis Outline Drawing

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



CHASSIS OUTLINE DIMENSIONS  
MOUNTING SLOT DIMENSIONS SAME FRONT AND REAR

Figure 4-3—Outline Drawing of MicroNet Plus Chassis



## 4.2—MicroNet Plus 8-Slot Chassis



Figure 4-5—MicroNet Plus 8-Slot I/O Chassis

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

### Features:

- A total of 8 CPU 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 are built into the motherboard and trip at +65 °C
- Redundant, hot-swappable CPUs are supported

### 4.2.1—Specification

The MicroNet is designed around a modular 6-slot chassis (block). Each block consists of a pre-molded 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 4-6. 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 boards to terminal blocks 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.

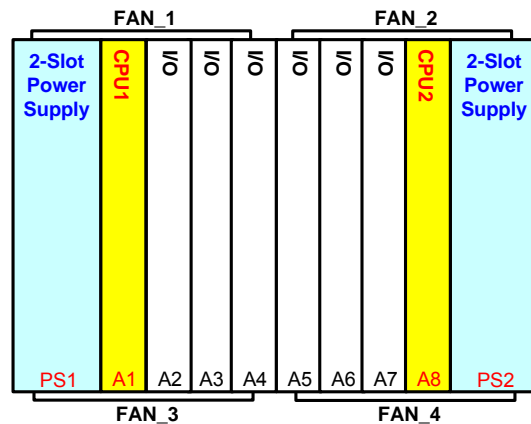


Figure 4-6—MicroNet Plus 8-Slot Chassis

### CPU Slots (A1, A8)

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

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

### 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 CPU 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.

### Redundant Smart Fans

Each smart-fan provides a tachometer output to the CPU slots. The CPU 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.

### Motherboard Terminal Block (TB1)

The MicroNet Plus chassis includes a terminal block that provides CPU1 and CPU2 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.

### 24 Vdc Motherboard Power

- **Redundant systems**—Not recommended for use.
- **Simplex systems**—This power may be used for local Ethernet switch power upon successful EMC testing. 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.

### CPU Remote Reset Inputs (RST1, RST2)

Each CPU 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 CPU are designated RST1+, RST1– for slot A1 and RST2+, RST2– for slot A8. These inputs are optically isolated on each respective CPU module and require both a 24 V(+) and a common(-) to be wired. A momentary high will cause a CPU-reset.

### Chassis Overtemp Alarm

The MicroNet Plus 8-slot chassis provides (2) over-temperature switches on the motherboard. The over-temperature switches will trip at  $65^{\circ}\text{C} \pm 3^{\circ}\text{C}$  and communicate this warning to the CPU and GAP application.

## Chassis Outline Drawing

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

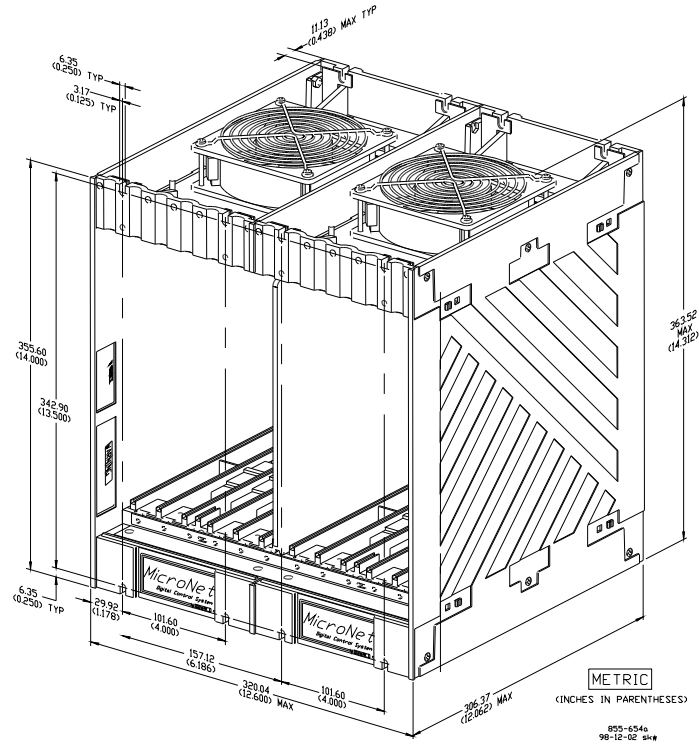


Figure 4-7—Outline Drawing of MicroNet Plus 8-Slot Chassis

## 4.2.2—Installation

Figure 4-8 shows the mounting template and fasteners to bulkhead mount the chassis. Rack mounting is not recommended.

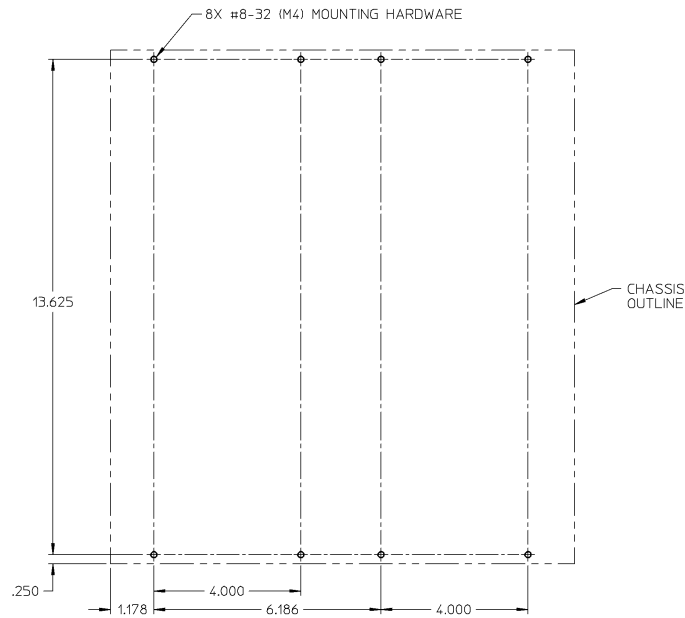


Figure 4-8—Mounting Template of MicroNet Plus 8-Slot I/O Chassis

## 4.3—Simplex 6-Slot I/O

This chassis contains six slots for CPU and I/O modules. Normally, this allows one CPU module and five I/O modules. In addition to the six CPU – 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.

### 4.3.1—Specification

The MicroNet is designed around a modular 6-slot chassis (block). Each block consists of a pre-molded 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 simplex six slot MicroNet control 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 4-10. 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 boards to terminal blocks in the cabinet.





Figure 4-9—Simplex MicroNet 6-Slot I/O

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.

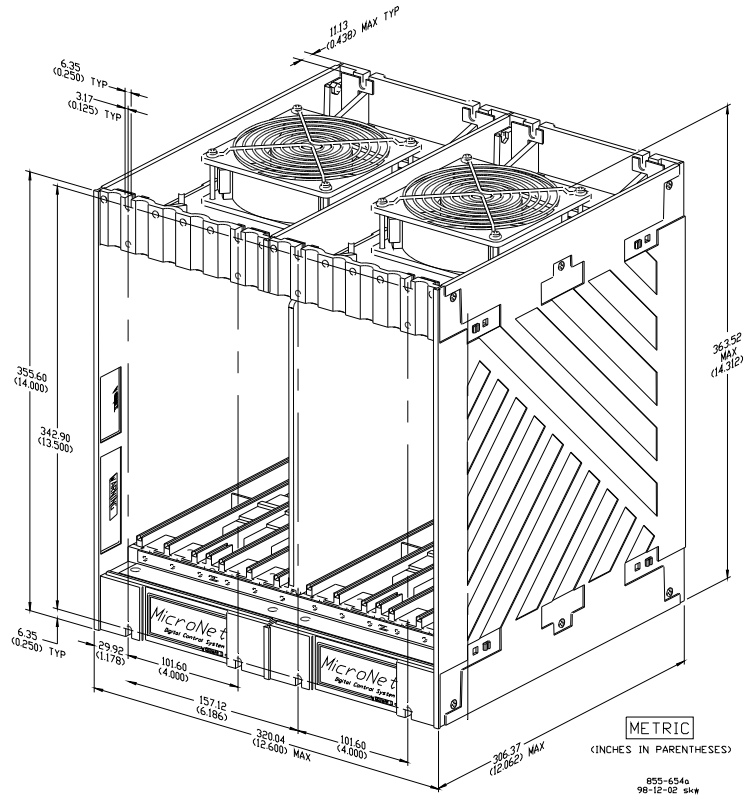


Figure 4-10—Outline Drawing of MicroNet 6-Slot I/O

### 4.3.2—Installation

Figure 4-11 shows the mounting template and fasteners to bulkhead mount the chassis. Rack mounting is not recommended.

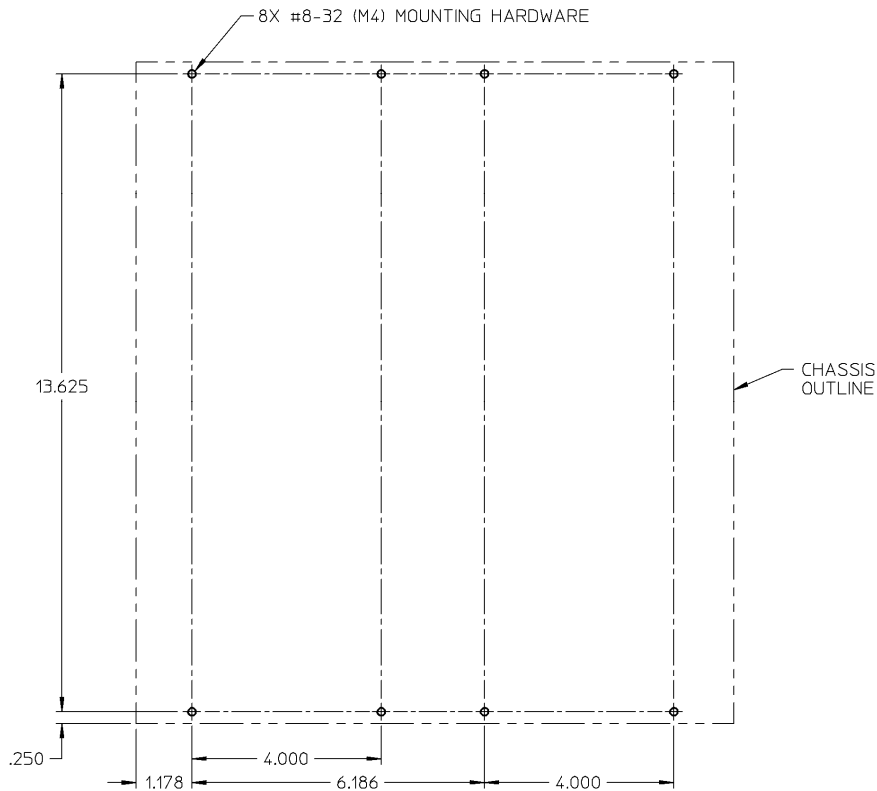


Figure 4-11—Mounting Template of MicroNet 6-Slot I/O Chassis

## 4.4—Simplex 12-Slot I/O (Input/Output)

### 4.4.1—Description

This chassis contains twelve slots for CPU and I/O (input/output) modules. Normally, this allows one CPU module and eleven I/O modules. In addition to the 12 CPU – 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.



Figure 4-12—Simplex MicroNet 12-Slot I/O

#### 4.4.2—Specification

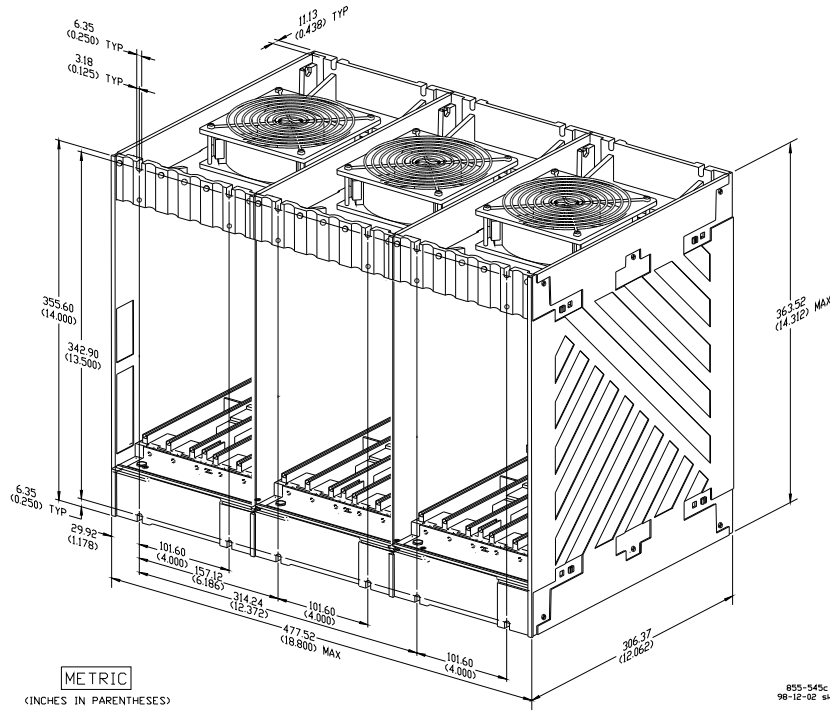
The MicroNet is designed around a modular 6-slot chassis (block). Each block consists of a pre-molded cage with a fan for cooling and a temperature switch for high temperature detection. The chassis are cooled by forced air, and either a module or a module blank must be installed in every slot to maintain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

The simplex twelve slot MicroNet control 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 4-13. 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 boards to terminal blocks 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.



CHASSIS OUTLINE DIMENSIONS  
MOUNTING SLOT DIMENSIONS SAME FRONT AND REAR

Figure 4-13—Outline Drawing of MicroNet 12-Slot I/O

### 4.4.3—Installation

Figure 4-14 shows the mounting template and fasteners to bulkhead mount the chassis. Rack mounting is not recommended.

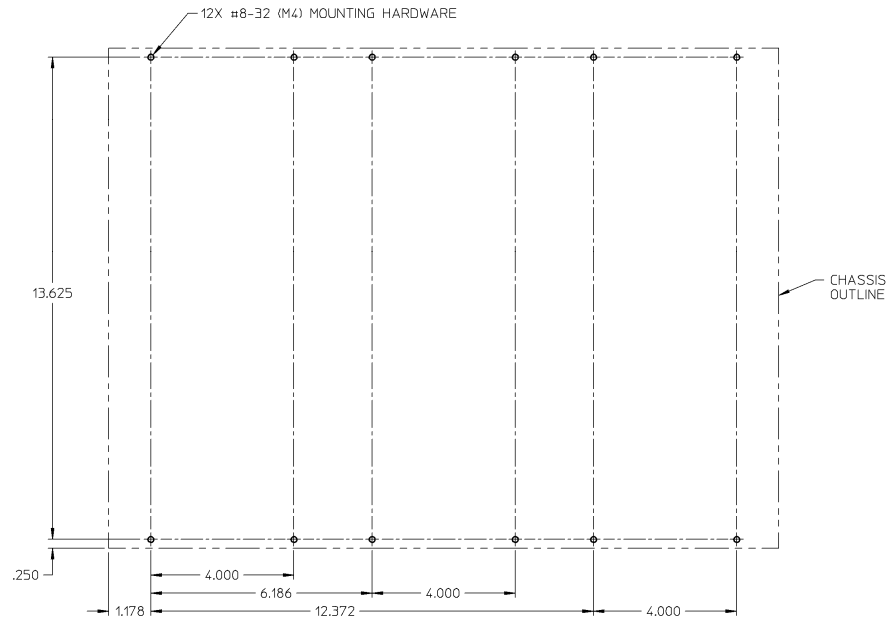


Figure 4-14—Mounting Template of MicroNet 12-Slot I/O Chassis

# Chapter 5.

## Power Supplies

### 5.1—MicroNet Plus Chassis Power Supplies

#### 5.1.1—Module Description

The MicroNet Plus Simplex or Redundant controls 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 Pre-charge @ 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 pre-charge bus. The 24 V and 5 V busses are load shared between the two power supply modules. The 5 V pre-charge bus is not load shared. Power output regulation at the motherboard, including line, load, and temperature effects, is less than  $\pm 10\%$  for the 24 V bus,  $\pm 5\%$  for the 5 V bus, and  $\pm 10\%$  for the 5 V Pre-charge bus. The 5 V and 5 V Pre-charge 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 one 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 Simplex installation instructions, see Chapter 15 (Installation).

#### **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 5-1—Power Supply Module

### 5.1.2—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.

#### 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



**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

**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 5-1 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 5-1 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 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 5-1 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 5-1, 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 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 5-1 provides each power supply's holdup time specification, which is the time the supply will continue to operate within specification after its input power is interrupted. This information may be useful in specifying uninterruptible power supply (UPS) systems.

Table 5-1—MicroNet Plus Power Supply Requirements

MAXIMUM INPUT VOLTAGE RANGE	MAXIMUM FUSE/ C.B. RATING (Time Delay)	WIRE SIZE ** (AWG/mm <sup>2</sup> )
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 mm<sup>2</sup> (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.

### 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. Toggle the CPU's RESET switch. The CPU's red Fault and Watchdog LEDs should turn off, and the green RUN LED should go on. At this time, the CPU is performing the self-diagnostic and boot-up processes. When the CPU has completed its diagnostic tests, all red LEDs on the CPU module or I/O modules should be off, and the control will begin running the application program.

### 5.1.3—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.

#### 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 heatsink 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 LED's 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.

## 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 CPU Low Vcc LED ON?

## 5.2—Simplex Expansion Power Supplies

### 5.2.1—Module Description

The MicroNet Simplex control 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 pre-charge outputs to the control. Power output regulation, including line, load, and temperature effects, is less than  $\pm 5\%$ .

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 Simplex Power Supply Troubleshooting (Section 5.5) 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 Simplex installation instructions, see Chapter 15 (Installation) and Section 5.3 of this chapter.

### **NOTICE**

**The MicroNet Simplex 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.**



Main PS Simplex (24 Vdc Input)

Main PS Simplex (120 Vac/dc Input)

Figure 5-2—Power Supply Modules

### 5.3—Simplex Power Supply Module Specifications

#### Main PS Simplex (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

**Main PS Simplex (120 Vac/dc Input)****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

**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

**Main PS Simplex (220 Vac Input)****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

**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

## 5.4—Installation

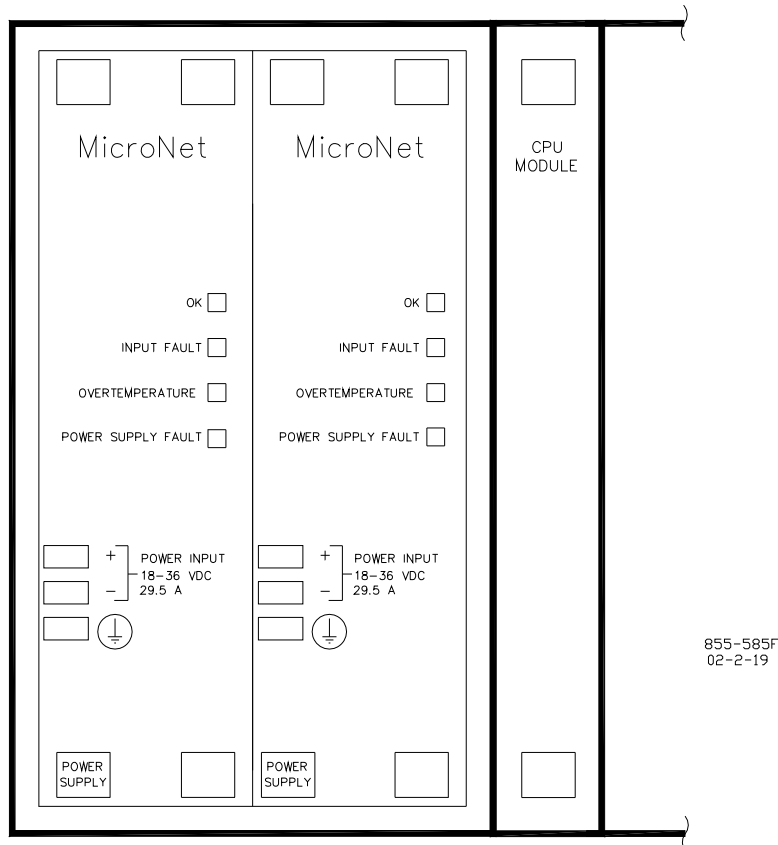


Figure 5-3—MicroNet Power Supply

### 5.4.1—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 5-2 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 5-2 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 5-2 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 5-2, 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 5-2 provides each power supply's holdup time specification, which is the time the supply will continue to operate within specification after its input power is interrupted. This information may be useful in specifying uninterruptible power supply (UPS) systems.

Table 5-2—MicroNet Simplex Power Supply Requirements

MAXIMUM INPUT VOLTAGE RANGE	MAXIMUM FUSE/ C.B. RATING (Time Delay)	WIRE SIZE ** (AWG/mm <sup>2</sup> )
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 mm<sup>2</sup> (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 mm<sup>2</sup> (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.



## 5.4.2—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.

If the system is configured with the 68040 or 68060 CPU, perform step #4. If the system is configured with the Windows NT CPU, skip step #4 and go to step #5.

4. Toggle the CPU's RESET switch up, then back to its normal down position. The CPU's red Fault and Watchdog LEDs should turn off, and the green RUN LED should go on. At this time, the CPU is performing the self-diagnostic and boot-up processes. When the CPU has completed its diagnostic tests, all red LEDs on the CPU module or I/O modules should be off, and the control will begin running the application program.
5. Plug in the mouse/keyboard/monitor. The CPU will automatically boot into Windows NT and run the application.

## 5.5—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.

### 5.5.1—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 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 heatsink 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.

### 5.5.2—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?

## Chapter 6. CPUs

### 6.1—PowerPC CPU5200 Module (Motorola)

#### 6.1.1—Module Description

The MicroNet PowerPC CPU Module contains a Motorola MPC5200 processor, 128 MB DDR RAM, 64 MB of flash memory, a Real Time clock, and various communication peripherals. These peripherals include (2) general use Ethernet ports, (2) Real Time Network ports, (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 CPU5200 Module can operate in both simplex and redundant modes. Every MicroNet Plus simplex control contains one CPU module located in the first I/O slot of the MicroNet chassis. A redundant configuration will also have a CPU located in the CPU2 location (slot 8 or slot 14 depending on which chassis is used).

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 and replacing the VME module in Chapter 15, Installation and Service, and Section 9.4.3—Installation.

#### **NOTICE**



**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 CPU module if available.**

The CPU module runs the GAP application program. Figure 6-2 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.

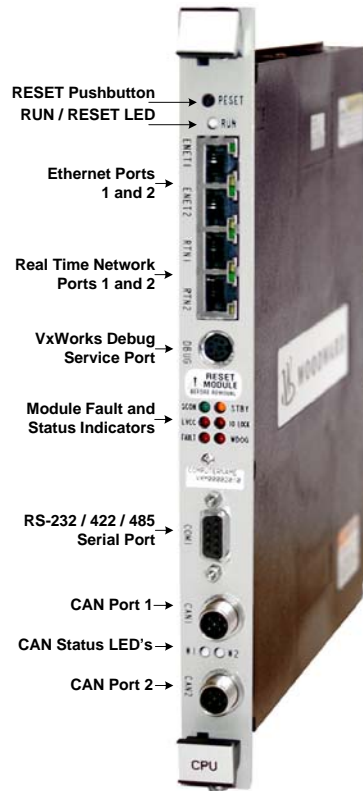


Figure 6-1— PowerPC CPU5200 Module (Motorola)

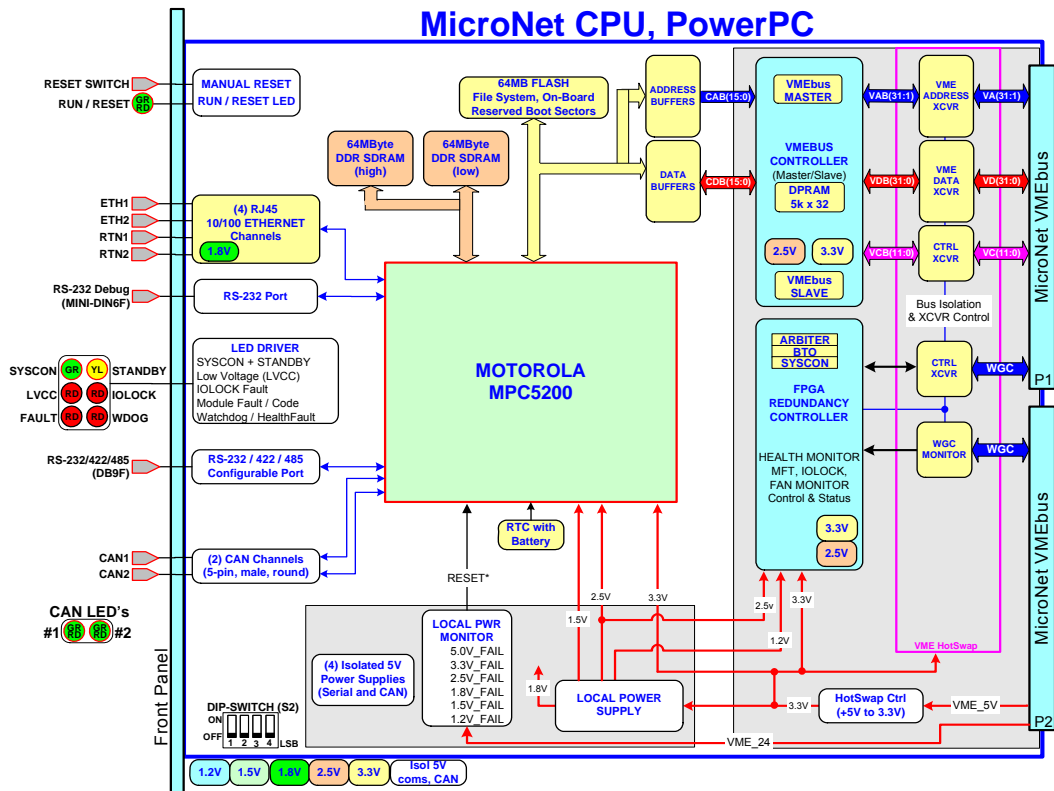


Figure 6-2—CPU Module Block Diagram

## 6.1.2—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.

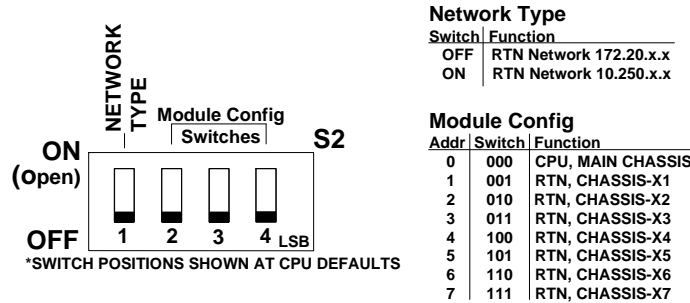


Figure 6-3— PowerPC CPU5200 Module Hardware Configuration

**Note:** If CAN for GS6 or RTCnet / LINKnet HT operation is required from an expansion rack, a CPU module must be used in place of the Remote RTN module and configured for an RTN using the Module Configuration Switch (S2) as shown above.

### 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.

### 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.

### 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

### 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/ic/software](http://www.woodward.com/ic/software). A PC connection must be made to Ethernet #1 (ENET1) using a RJ45 Ethernet cable.

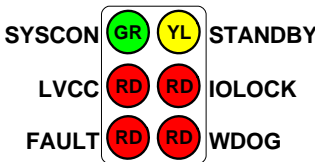
- Locate the ControlName on the module faceplate and highlight it in *AppManager*.
- To VIEW the IP address configuration, select menu option CONTROL - CONTROL INFORMATION. Look for the Ethernet adapter addresses under the Footprint Description.
- To CHANGE the IP address configuration, select menu option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



### 6.1.3—Front Panel Indicators (LEDs)

The MicroNet PowerPC CPU5200 module has the following front-panel LEDs.

Table 6-1— PowerPC CPU5200 Module Front Panel LEDs

LED	Name	Description
 RUN	RUN	<b>RUN / RESET (GREEN/RED)</b> —Active RED when the user pushes the reset switch. Active GREEN upon release and after the CPU Operating system is loaded and running.
	TX/RX	<b>TX/RX (GREEN)</b> —Active GREEN when data is transmitted or received.
	LINK	<b>LINK ACTIVE (YELLOW)</b> —A valid Ethernet connection to another device exists
	SYSCON	<b>System Controller (GREEN)</b> —Active when this CPU or Remote RTN module is the VMEbus System Controller.
	STANDBY	<b>Standby Ready (YELLOW)</b> —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	<b>Low VCC Power Fault (RED)</b> —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	<b>IOLOCK (RED)</b> —This LED indicates that an I/O LOCK condition exists either locally on the CPU itself and/or on the VMEbus.  <b>Note:</b> 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.
	FAULT	<b>CPU FAULT (RED)</b> —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.
<b>CAN LED's</b> #1  #2 	CAN #1, #2	CAN #1, #2 (GREEN/RED)—Active GREEN or RED when data is transmitted or received through CAN port #1 or #2.

### 6.1.4—Module Reset

#### 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.

#### CPU1 and CPU2 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+, and RST2– 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.

#### CPU1 and CPU2 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+, and RST2– 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.

#### Reset Notes:

- Resetting a CPU or Remote RTN module creates a HealthFault that immediately sets the WDOG light RED.
- Any System running with one healthy CPU. Reset detection will also drive IOLOCK and IORESET to place the Control System, its expansion racks, and all output signals into a known failsafe condition.
- Redundant Systems running with two healthy CPU's. Reset detection on the SYSCON (System Controller) causes an immediate "Failover" to the other STANDBY CPU who then becomes the new System Controller. 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.

<b>NOTICE</b>	<b>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.</b>
 <b>RESET MODULE BEFORE REMOVAL</b>	

### 6.1.5—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 shield box.

**IMPORTANT**

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

**6.1.6—RTN Ports**

Two Real Time Network ports (RJ45) are available to provide communications 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 these RTN ports (GAP block is RTN).

For redundant systems, up to (2) Remote RTN modules may be installed into each 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 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.

**IMPORTANT**

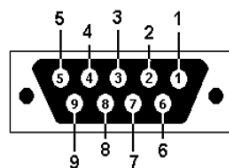
- Double shielded, Cat 5 Ethernet cables (SSTP) are required for customer installations.
- Cable length between the Main rack and RTN switch is 3 m (10 ft.) max.
- Cable length between the RTN switch and Expansion rack is 30 m (100 ft.) max.

**6.1.7—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 Bd to 57.6 kBd. 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.



DB9: View looking into female connector

- 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 6-4—CPU Communications Port (DB9F)

**6.1.8—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 kBd, 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. 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.

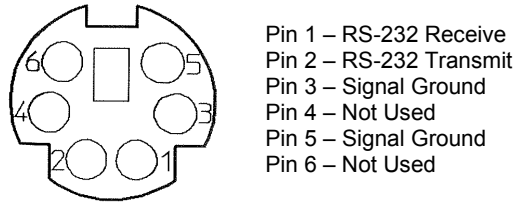


Figure 6-5—CPU Service Port (mini-DIN6F)

### 6.1.9—CAN Communication Ports

Two CAN ports (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. When using redundant CPU modules and a failover occurs, each CAN port automatically performs a failover from the SYSCON to the STANDBY CPU module.

**Note:** If CAN forGS6 or RTCnet / LINKnet HT operation is required from an expansion rack, a CPU module must be used in place of the Remote RTN module and configured for an RTN using the Module Configuration Switch (S2) as shown in section 6.1.2—Module Configuration above.

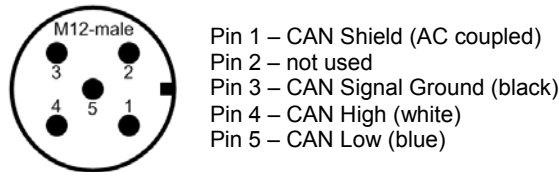


Figure 6-6—CAN Communication Ports (M12 male)

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 6-2- CAN Network Trunk Line Specifications

Network Speed	Max Trunk Length (Thick cable)	Max Trunk Length (Thin cable)	Max Drop Length	Max Cumulative Drop Length
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

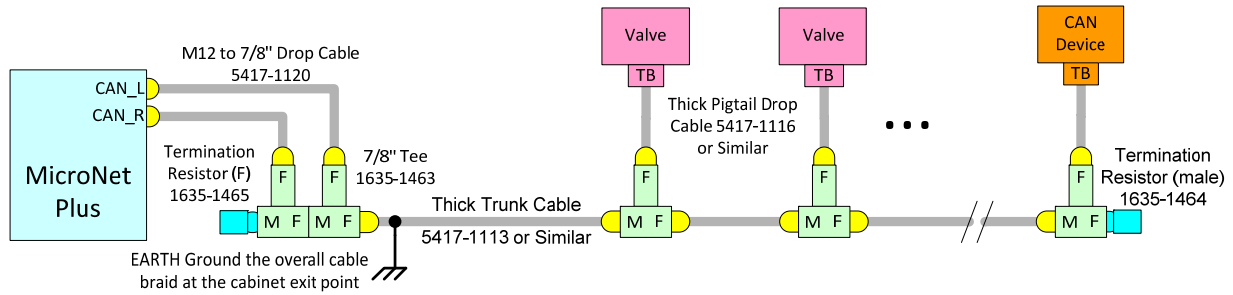


Figure 6-7—MicroNet to Valve CAN Interface

### 6.1.10—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 6-3—CAN Cable Specification

<b>Impedance:</b>	120 Ω ±10% at 1 MHz
<b>DC resistance:</b>	< 7 Ω per 1000 ft.
<b>Cable capacitance:</b>	12 pF/ft. at 1 kHz
<b>Propagation delay</b>	1.36 ns/ft. (maximum)
<b>Data Pair:</b>	19 strands, 1.0 mm <sup>2</sup> corresponds to 18 AWG, individually tinned, 3 twists/foot
<b>Power Pair:</b>	19 strands, 1.5 mm <sup>2</sup> corresponds to 15 AWG, individually tinned, 3 twists/foot
<b>Drain / Shield Wire:</b>	19 strands Tinned Copper shielding braid or shielding braid and foil
<b>Cable type:</b>	twisted pair cable. 2x2 lines
<b>Bend Radius:</b>	20x diameter during installation or 7x diameter fixed position
<b>Signal attenuation:</b>	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 6-4—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

## 6.1.11—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 6-5—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

## 6.2—PowerPC CPU5200L Module (Motorola)

### 6.2.1—Module Description

The MicroNet PowerPC CPU5200L Module contains a Motorola MPC5200 processor, 128 MB DDR RAM, 64 MB of flash memory, a Real Time clock, and various communication peripherals. These peripherals include (1) general use Ethernet port, (1) serial port, (1) one service port, and (1) CAN port. The Real Time Network (RTN) ports are not available, thus **this CPU does not support expansion chassis operation**. This module includes an FPGA to provide VMEbus master/slave capability as well as other functions necessary for redundant systems.

The CPU5200L Module can operate in both simplex and redundant modes. Every MicroNet Plus simplex control contains one CPU module located in the first I/O slot of the MicroNet chassis. A redundant configuration will also have a CPU located in the CPU2 location (slot 8 or slot 14 depending on which chassis is used).

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 and replacing the VME module in Chapter 15, Installation and Service, and Section 9.4.3—Installation.

**NOTICE**

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 CPU module if available.

The CPU module runs the GAP application program (corresponding GAP block is CPU\_ML5200). Figure 6-7 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 6-8—CPU5200L Module

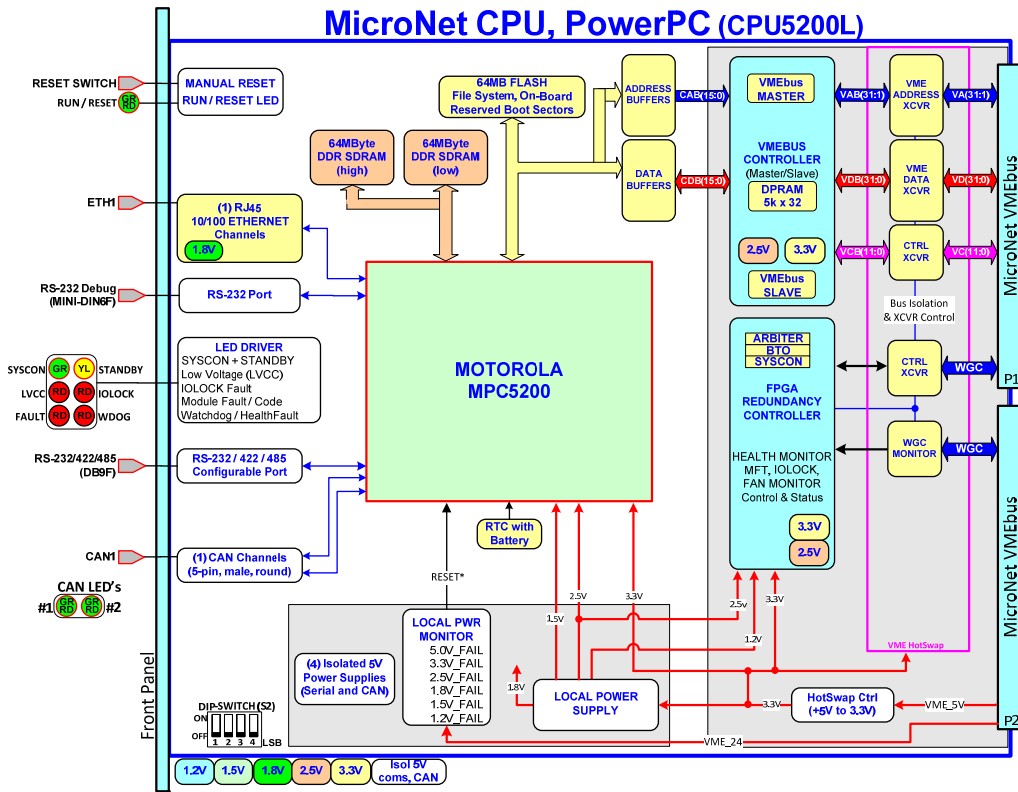


Figure 6-9—CPU5200L Module Block Diagram

### 6.2.2—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.

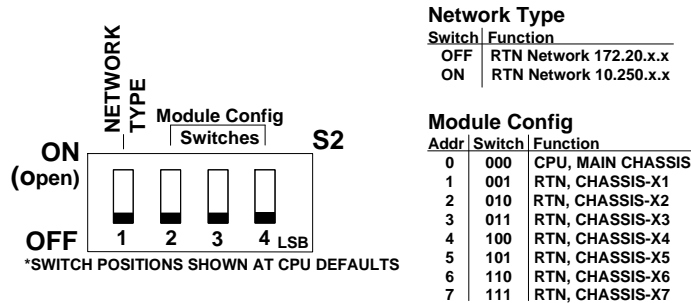


Figure 6-10—CPU5200L Module Hardware Configuration

**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 port #1 is NOT active and AppManager will not be available.

## 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

CPU5200L does not support RTN port communications for expansion racks.

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

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

## Network Configuration

Ethernet port (ENET1) can be configured for the customer network as desired. See the on-site Network Administrator to define an appropriate I/P address configuration for ENET1.

### 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

## 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/ic/software](http://www.woodward.com/ic/software). A PC connection must be made to Ethernet #1 (ENET1) using a RJ45 Ethernet cable.

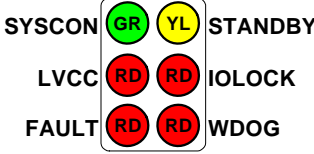

- Locate the Control Name on the module faceplate and highlight it in *AppManager*.
- To VIEW the IP address configuration, select menu option CONTROL - CONTROL INFORMATION. Look for the Ethernet adapter addresses under the Footprint Description.
- To CHANGE the IP address configuration, select menu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

## 6.2.3—Front Panel Indicators (LEDs)

The MicroNet PowerPC CPU5200L module has the following front-panel LEDs.

Table 6-6—CPU5200L Module Front Panel LEDs

LED	Name	Description
 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.
	TX/RX	TX/RX (GREEN)—Active GREEN when data is transmitted or received.
	LINK	LINK ACTIVE (YELLOW)—A valid Ethernet connection to another device exists
	SYSCON	System Controller (GREEN)—Active when this CPU or 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	<u>Low VCC Power Fault (RED)</u> —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	<u>IOLOCK (RED)</u> —This LED indicates that an I/O LOCK condition exists either locally on the CPU itself and/or on the VMEbus.  <b>Note:</b> 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.
	FAULT	<u>CPU FAULT (RED)</u> —Actively flashes CPU fault codes as necessary.
	WATCHDOG	<u>CPU Watchdog / Health Faults (RED)</u> —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. Port #2 is disabled.

### 6.2.4—Module Reset

#### 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.

#### CPU1 and CPU2 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+, and RST2- 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.

#### Reset Notes:

- Resetting a CPU or Remote RTN module creates a HealthFault that immediately sets the WDOG light RED.
- Any System running with one healthy CPU. Reset detection will also drive IOLOCK and IORESET to place the Control System, its expansion racks, and all output signals into a known failsafe condition.
- Redundant Systems running with two healthy CPU's. Reset detection on the SYSCON (System Controller) causes an immediate "Failover" to the other STANDBY CPU who then becomes the new System Controller. 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**

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.

**6.2.5—10/100 BaseT Ethernet Ports**

Only one 10/100 BaseT Ethernet Port (RJ45) is available to the application software. This port is full duplex, auto switching, and does not require the use of an Ethernet shield box.

**IMPORTANT**

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

**6.2.6—RTN Ports**

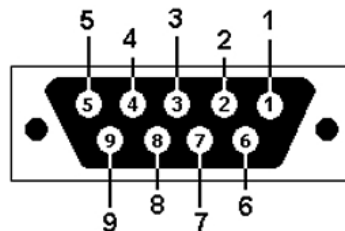
Expansion racks and Real Time Network functions are not supported on the CPU5200L module.

**6.2.7—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 Bd to 57.6 kBd. 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 6-11—CPU Communications Port (DB9F)

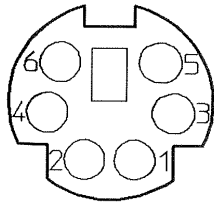
**6.2.8—RS-232 Service Port**

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 kBd, 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. 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.



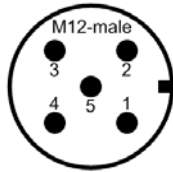


- Pin 1 – RS-232 Receive
- Pin 2 – RS-232 Transmit
- Pin 3 – Signal Ground
- Pin 4 – Not Used
- Pin 5 – Signal Ground
- Pin 6 – Not Used

Figure 6-12—CPU Service Port (mini-DIN6F)

### 6.2.9—CAN Communication Port

A single CAN port (M12 male connector) is 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. When using redundant CPU modules and a failover occurs, the CAN port automatically performs a failover from the SYSCON to the STANDBY CPU module.



- 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 6-13—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 6-7—CAN Network Trunk Line Specifications

Network Speed	Max Trunk Length (Thick cable)	Max Trunk Length (Thin cable)	Max Drop Length	Max Cumulative Drop Length
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

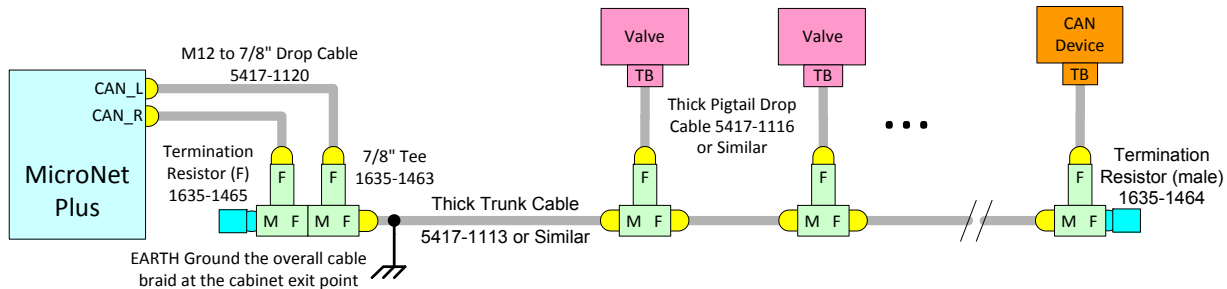
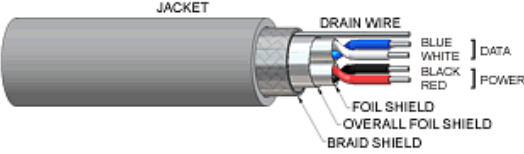


Figure 6-14—MicroNet to Valve CAN Interface

### 6.2.10—CAN Cable Specification

Thick cable is preferred and recommended for all uses. Most CAN / DeviceNet 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 6-8—CAN Cable Specification

	
<b>Impedance:</b>	120 $\Omega$ $\pm$ 10% at 1 MHz
<b>DC resistance:</b>	< 7 $\Omega$ per 1000 ft.
<b>Cable capacitance:</b>	12 pF/ft. at 1 kHz
<b>Propagation delay</b>	1.36 ns/ft. (maximum)
<b>Data Pair:</b>	19 strands, 1.0 mm <sup>2</sup> corresponds to 18 AWG, individually tinned, 3 twists/foot
<b>Power Pair:</b>	19 strands, 1.5 mm <sup>2</sup> corresponds to 15 AWG, individually tinned, 3 twists/foot
<b>Drain / Shield Wire:</b>	19 strands Tinned Copper shielding braid or shielding braid and foil
<b>Cable type:</b>	twisted pair cable. 2x2 lines
<b>Bend Radius:</b>	20x diameter during installation or 7x diameter fixed position
<b>Signal attenuation:</b>	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 6-9—Recommended Bulk Cable

Manufacturer	part number	Website
Belden	3082A DeviceNet Thick Cable–Grey	<a href="http://www.belden.com">www.belden.com</a>
Belden	3083A DeviceNet Thick Cable–Yellow	<a href="http://www.belden.com">www.belden.com</a>
Lapp Cable	2710-250 Unitronic DeviceNet Thick	<a href="http://www.lappcable.com">www.lappcable.com</a>
Lumberg	STL 613	<a href="http://www.lumbergusa.com">www.lumbergusa.com</a>
Turck	Type 575, DeviceNet Thick Cable – Grey	<a href="http://www.turck.com">www.turck.com</a>

### 6.2.11—Troubleshooting / Flash Codes

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 6-10—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

## 6.3—Windows NT Pentium CPU Module

(Obsolete 4th Quarter 2012)

### 6.3.1—Module Description

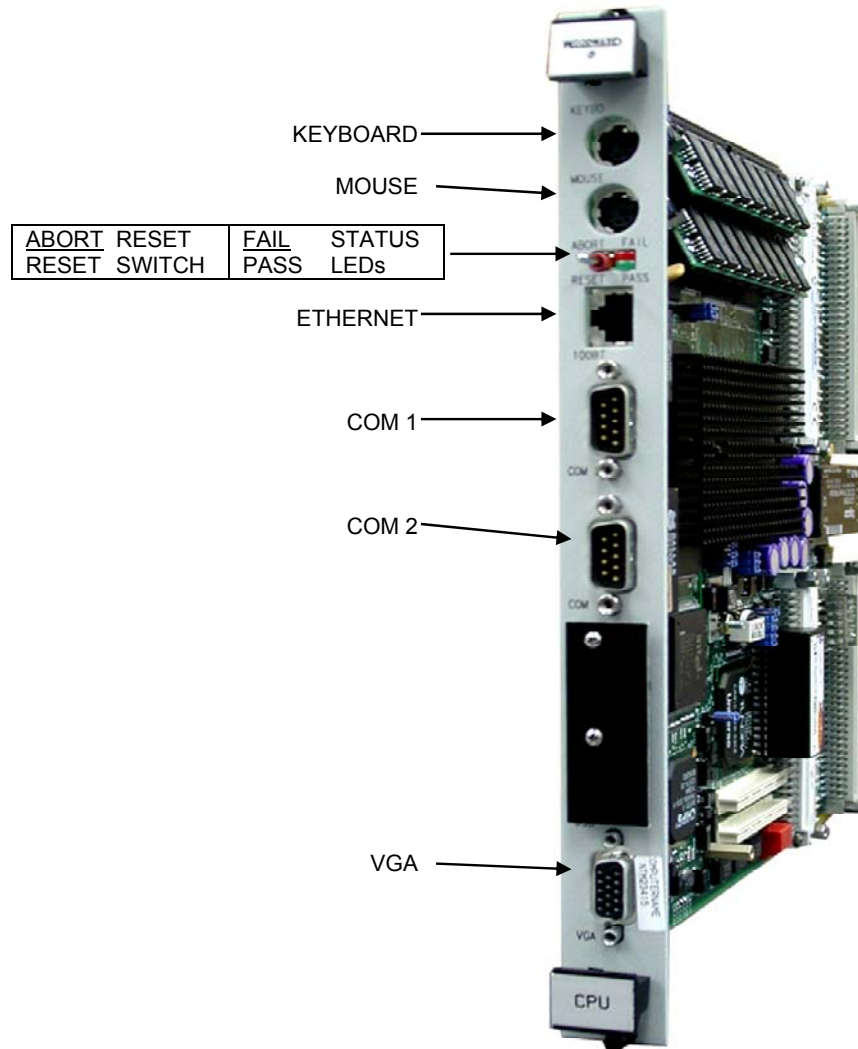


Figure 6-15—CPU (Pentium) Module

Every Simplex MicroNet control contains one CPU module located in the first slot of the MicroNet chassis. The description of the CPU module contained in this section is the Windows NT CPU.

For CPU module installation and replacement instructions, see the instructions for installing and replacing the VME module in Chapter 15, Installation and Replacement Procedures.

The NT CPU module runs the application program. Figure 6-12 is a block diagram of the NT CPU Module. It supports Windows NT with real-time extensions to maintain a rigorous real-time environment. NT functions are not documented in this manual. Please refer to the applicable Microsoft Windows NT manual if necessary.

There is a solid state Hard-Drive (FDOC Fixed Disk on Chip), on the module which uses the standard Windows file system. The hard-drive has the Windows NT Operating System with the real-time extensions and the application program. The CPU has a standard interface to the VME bus to read and write to I/O modules

**NOTICE** The NT operating system on the hard drive is an embedded version of Windows NT that is designed for use with a real-time system only. No other applications are allowed.

**NOTICE** Live insertion of the NT CPU is allowed. It is not recommended to plug/ unplug the monitor, keyboard, or mouse during execution of the application.

**NOTICE** Do not plug or unplug any non-isolated device directly into the CPU during execution of the application. Refer to the NT CPU Interface Connections section of this chapter for more details on interface requirements.

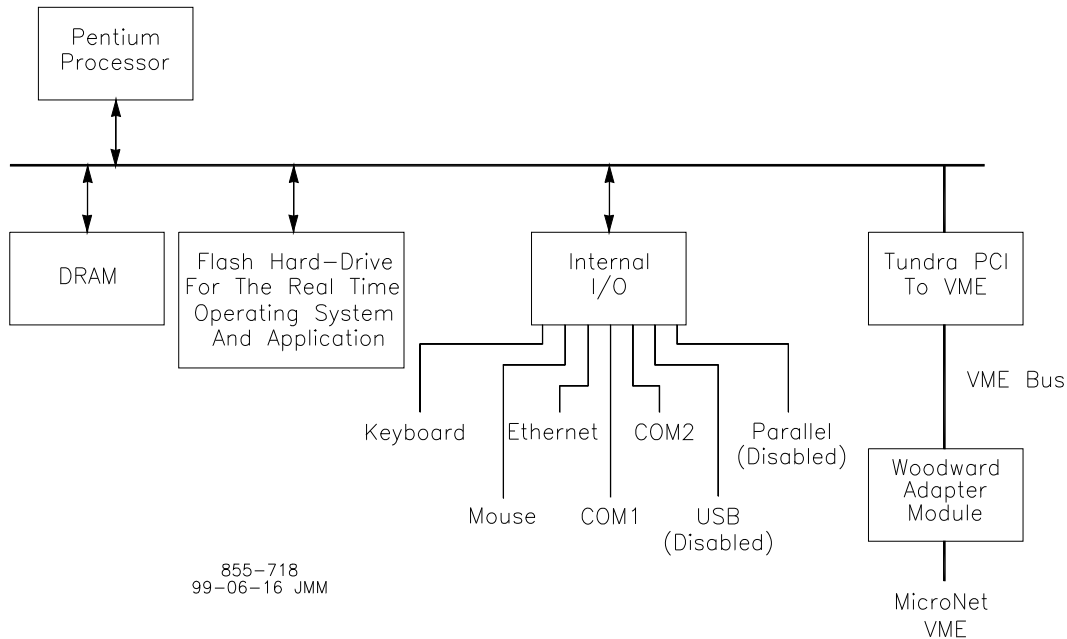


Figure 6-16—Windows NT CPU Block Diagram

### 6.3.2—NT CPU Interface Connections

The NT CPU consists of cable connections for the following devices. These connectors, pinouts, and their interface requirements are detailed in this section.

Table 6-11—NT CPU Connectors

Supported Interfaces	Service Interfaces*	Un-supported Interfaces
10/100 Base-TX Ethernet	PS/2 Keyboard	Parallel Port
COM1 Serial Port	PS/2 Mouse	Universal Serial Bus (USB)
COM2 Serial Port	XVGA Video	

\* Woodward does not recommend permanent connection to these ports—these are for service use only.

### 6.3.3—CPU Reset Switch

The CPU incorporates a reset switch which can be used to manually reset the entire system. This reset will cause the CPU to immediately re-boot. In addition, the VME backplane is also reset by its pulling of SYSRESET\*, IOLOCK\*, and IORESET\* low. All Woodward VME modules are placed into IOLOCK mode and held in reset appropriately.

### 6.3.4—PS/2 Keyboard and Mouse

Two PS/2 ports are available to support keyboard and mouse devices. Since these ports allow for unrestricted access to the control's operating system, usage of the keyboard and mouse should be restricted to trained service personnel for troubleshooting or service access only. The keyboard and mouse must *not* be connected for long-term use or operational use.


**IMPORTANT**

The mouse and keyboard must be installed prior to RESET or POWER UP for the CPU to recognize them.

The PS/2 ports are non-isolated. A shielded cable and the Video Interface FTM are required to avoid susceptibility to EMI noise and ground loops related to PC connections and typical industrial environments. See the Video Interface FTM section for more details.

Most PC industry peripherals such as keyboards, mice, and monitors connect Signal Common to Chassis GND. When using a PS/2 device avoid making this chassis GND connection to ensure the floating power supply system operates as designed. The keyboard or mouse must be connected through the Video Interface FTM.

Table 6-12—PS/2 Pinout

Connector	Signal Mnemonic
Mini-Din 6F 	Shielded circular Mini-Din 6 female receptacle
1	DATA
2	n/c
3	Signal Common
4	+5 V
5	CLOCK
6	n/c
Shield	Chassis GND

### 6.3.5—10/100 Base-TX Ethernet


An auto-switching 10/100 Base-TX RJ45 Ethernet connector is available for system use. This connection will be used for control configuration, data gathering, remote monitoring, maintenance, and networking of multiple controls. Additionally, this port will be relied upon for interfacing TCP/IP Distributed I/O devices into the control system.

To ensure signal integrity and robust operation of Ethernet devices, an Ethernet Interface FTM (Field Termination Module) is required when using this port. Its primary function is to implement EMI shielding and cable shield termination of the Ethernet cable. Along with the Ethernet Interface FTM, double shielded Ethernet cables (SSTP) are required for customer installations. See the Ethernet Interface FTM section for more details.

**IMPORTANT**

To fully realize 100 Base-TX connectivity, downstream devices must be capable of 100 Base-TX. As such, when using an Ethernet hub for multiple connections, either a fixed 100 Base-TX or an auto-switching 10/100 Base-TX hub would be necessary.

Table 6-13—RJ45 10/100 Base-TX Pinout

Connector	Signal Mnemonic
RJ45 	Shielded RJ45 female receptacle
1	TX+
2	TX-
3	RX+
4	n/c
5	n/c
6	RX-
7	n/c
8	n/c
Shield	Chassis GND

**6.3.6—RS-232 Serial Ports COM1, COM2**

Two high speed 16550 compatible RS-232 serial ports are available for system use. These ports can be used with various protocols and devices to communicate information with serial devices. For example, these ports can be configured for Modbus, master or slave, Servlink Protocol, Control Assistant Protocol, Tunable Maintenance, or even modem access.

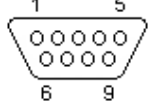
These communication ports are non-isolated. Shielded cable and a Serial Port Isolator/ Converter are required when using this port to avoid susceptibility to EMI noise and ground loops related to PC connections and typical industrial environments. The following standard options are available:

- RS-232–RS-232 Isolator
- RS-232–RS-485 Isolator/Converter
- RS-232–RS-422 Isolator/Converter

**IMPORTANT**

A Serial Port Isolator/Converter must be properly installed, grounded, and powered prior to connection with the CPU. Once properly installed, it may be connected to a field device at any time. Alternatively, the isolator may be connected to the field device. However, it must be properly installed, grounded, and powered prior to connection to the CPU.

Table 6-14—COM1 and COM2 Pinout

Connector	Signal Mnemonic
DB9M 	Shielded DB9 male connector
1	DCD
2	RX
3	TX
4	DTR
5	Signal Common
6	DSR
7	RTS
8	CTS
9	RI
Shield	Chassis GND

### 6.3.7—Universal Serial Bus (USB)

The USB port is not supported on this CPU due to the lack of software support in the Windows NT 4.0 operating system.

### 6.3.8—Parallel Port

The parallel port is not currently supported on this CPU due to the lack of driver support in the operating system.



**WARNING**

**Use of the LPT1 and USB ports is not ALLOWED. CPU FAILURE may result.**

### 6.3.9—XVGA Video

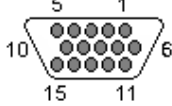
The CPU has a standard analog video port which is available for service use. The video interface supports 24 bit true color modes and is capable of 1280 x 1024 max resolution.

The video port is non-isolated. A shielded cable and the Video Interface FTM are required to avoid susceptibility to EMI noise and ground loops related to PC connections and typical industrial environments. See the Video Interface FTM section for more details.

Most PC industry peripherals such as keyboards, mice, and monitors connect Signal Common to chassis GND. When using a monitor avoid making this chassis GND connection to ensure the floating power supply system operates as designed. The monitor must be connected through the Video Interface FTM, an isolated power supply, and be “floating” with respect to chassis GND.



Table 6-15—Video Pinout

Connector	Signal Mnemonic
Connector 	Shielded high density DB15 female receptacle (HD DB15F)
1	RED
2	GREEN
3	BLUE
4	DDC.ID2
5	Signal Common
6	Red GND
7	Green GND
8	Blue GND
9	KEY
10	Synch GND
11	DDC.ID0
12	DDC.ID1
13	HSYNC
14	VSYNC
15	DDC.CLK
Shield	Chassis GND

### 6.3.10—NT CPU Power Requirements

Table 6-16—Power Requirements

+24 V	125 mA (max)
+5 V	6.0 A (max), 5.43 A (typical)

### 6.3.11—Installation

To set the Local IP Address, you must have a local monitor, keyboard, and mouse. Push Start-Settings-Control Panel and double click the Network icon. Select Protocols-properties and click the Specify and IP Address box, then enter valid data on the IP Address, SubNet Mask, and Default Gateway.

#### **IMPORTANT**

An example of a valid address would be: IP Address=190.41.99.100, SubNet Mask=255.255.0.0, Default Gateway=190.41.100.1. Your address will be defined by the network to which you are connected.

To find the Windows NT CPU on the Workstation:

1. In a command prompt, type "net view /DOMAIN:micronet". The Workstation will tell you the name of all the computers on the local network. This is done to find the name of the PC on the local network. Another method to determine the name of the NT CPU is; if a monitor, keyboard, and mouse are available on the NT CPU, select Start-Settings-Control Panel-Network, and then select the Identification tab. The name of the computer is displayed.
2. In the NT explorer "tools-find-computer", type in the name of the computer to which you want to make a connection (determined in step #1).
3. Explorer will display the "Name", "Location", and "Comment" of the computer to which you are attempting to connect.

4. Double click the displayed “Name” and connect to the Windows NT CPU by entering the Logon of “ServiceUser” with the password “ServiceUser”.
5. A window connected to the Windows NT CPU will be opened. Normal file transactions may now be performed.

Create the application.exe and the application.rtss (a matched set) on the programming workstation by using the GAP and Coder. Copy the file set to the Windows NT CPU.

## IMPORTANT

The application can be started automatically upon power-up of the CPU by placing a shortcut to the application.exe in the start-up path on the Windows NT CPU.

### 6.3.12—Transferring Files from a Workstation to the NT CPU

Transferring files from a workstation to the Windows NT CPU can be accomplished with the App Manager Utility Software.

### 6.3.13—MicroPanel Service Tool

MicroPanel is a 20-line service tool for MicroNet Windows NT CPU module. MicroPanel allows access to control variables for monitoring and tuning both locally and remotely through an established Windows NT network. See Figure 4-3.



Figure 6-17—MicroPanel Display Screen

#### Status Bar and Window Title

The right-hand panes of the MicroPanel status bar show connection information. The first indicates whether the connection is local or remote. The second indicates which communication device is being used. The communication device number is specific to the control application.

The window title indicates either a local connection or the computer name of the MicroNet NT CPU to which the MicroPanel is connected.

## Display Lines

There are 20 display lines on the left-hand side of the MicroPanel screen.

## Button Functions

The buttons on the screen expose all the service functions of the MicroPanel. With the exception of the 'Fast' and 'Slow' buttons, all buttons will repeat while they are held down. The 'Fast' and 'Slow' buttons have mutually exclusive toggle functionality.

## Navigation Button

The large, diamond shaped button in the center of the screen allows navigation through the application. Each corner of the button represents a direction of navigation, up, down, left and right.

## Numeric Buttons

The numbers 0 through 9, unary negation, and a decimal point are represented by the numeric buttons. The '0' and '1' double as 'NO' and 'YES' buttons and are labeled appropriately. In addition, the '7' and '8' provide 'previous' and 'next' alphabetical category functionality in debug mode.

## Line Positioning Buttons

The 'Line Up' and 'Line Down' buttons are used to change the current selected display line in the appropriate service modes. The current line can also be changed by left clicking the mouse on a specific display line.

## Adjust Buttons

The 'Fast' and 'Slow' buttons have a special functionality. They operate as mutually exclusive toggle buttons and select the adjust mode: fast, normal, or slow. The up and down arrow shaped buttons allow adjustment up or down.

## Command Buttons

The 'Enter', 'Exit' and 'Serv/Debug' buttons have specific functionality depending on the current service mode.

## Keyboard

All functions of MicroPanel can be accessed from the keyboard.

Keys	Button Functions
Arrow	Direction navigation
'0' – '9'	Numeric
'0' and '1'	'NO' and 'YES'
'7' and '8'	Previous and next alphabetical category
'Page Up' and 'Page Down'	Line up and line down
'Shift'	Fast toggle
'Ctrl'	Slow toggle
'Insert' and 'Delete'	Adjust up and adjust down
'Enter'	Enter command
'Esc'	Exit command
','	Serv/Debug selection

In addition, the keyboard can be used as the sole means of input into the Windows NT operating system. See the Windows NT help for more information.

## Mouse

All functions of MicroPanel are available to the mouse through the buttons on the MicroPanel display. Use the mouse cursor and LEFT click to activate the buttons.

The mouse also has special functionality when used within the display line area. Left click to set the currently selected display line and right click to access the Branch To dialog.

### Touch Screen

If your MicroNet CPU is configured with a touch screen device, all MicroPanel functionality is available through the touch screen. The touch screen emulates the mouse and all mouse functions are available.

### Command Line Options

MicroPanel supports two command line options:

MicroPanel [-L]-R "computername"]

- -L : connect locally
- -R "computername": connect to remote computer computername, the quotation marks are necessary if computername contains white spaces or special symbols.

### Pipes

MicroPanel communicates with the control application through named-shared pipes. If no open pipes are available MicroPanel cannot connect and will terminate.

**Note:** See the GAP help for information on how to add pipes to a GAP application.

### Local Connection

A local connection is a connection through the memory of the NT operating system on the same machine. No networking is necessary for a local connection. Multiple instances of MicroPanel can be used as long as there are available pipes in the control application.

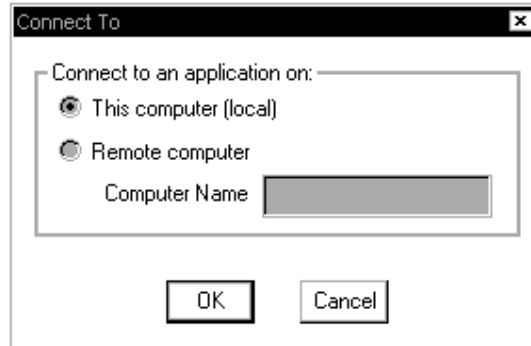


Figure 6-18—Local Connection Dialog Box

### Remote Connection

A remote connection is a connection between two Windows NT computers over an established network. Access permissions must be established (through the Explorer, for instance) before a connection can be made. The control application must have an open pipe for the connection to succeed. Refer to the P\_PIPE block in GAP help for more information on configuring this option. Multiple instances of MicroPanel can be used when configured properly. The remote computer may be specified by name or IP Address (NTM01234 or 190.41.99.10).

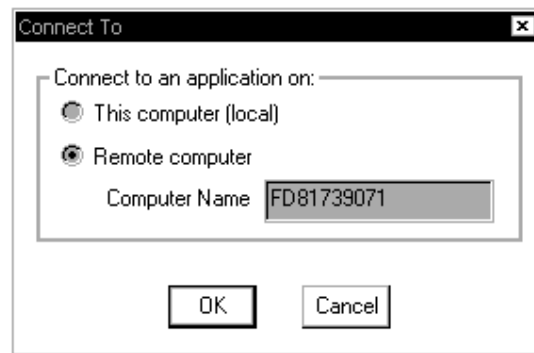


Figure 6-19—Remote Connection Dialog Box

### About Box Information

When MicroPanel is connected to a control application locally, the about box contains information about the FDoc device on the MicroNet NT CPU. The information includes serial number, computer name, part number, revision, and a description. This information is not available through a remote connection.

### **NOTICE**

**Live insertion of the NT CPU is allowed. It is not recommended to plug/ unplug the monitor, keyboard, or mouse during execution of the application.**

**Do not plug or unplug any non-isolated device directly into the CPU during execution of the application. Refer to the NT CPU Interface Connections section of this chapter for more details on interface requirements.**

### 6.3.14—Installation

In any installation with long cable runs, it is possible that the local ground connections at either end of the cable are at different voltages. You can see this by grounding a long cable at one end and measuring the voltage level between the far end of the cable and a ground connection nearby. You can think of the two ground connections as the positive and negative connections of a battery. If both ends of a cable shield are coupled directly to these local ground connections, it is possible to establish a ground loop, which looks just like an electrical short across the terminals of the battery. Depending on the particular local conditions, it is possible that significant and potentially hazardous electrical currents could be flowing on the cable shield. To prevent these ground loops, it is recommended that one end of the cable shield be tied to its' local ground and the other end be connected to its local ground through a capacitor. This will break the ground loop.

### 6.3.15—Connecting to the Network

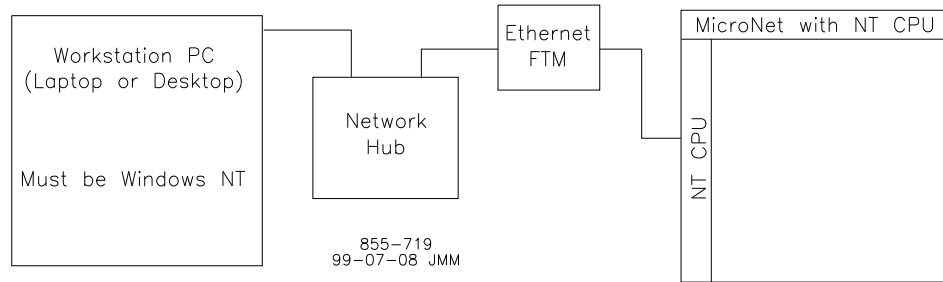


Figure 6-20—Network Block Diagram

The Windows NT CPU has a built in 10/100 BaseT connector on the front of the CPU. To connect a workstation PC to the Windows NT CPU, connect a cable from the workstation to the CPU through a network hub. This hub performs a cross-over function as well as allowing many networked devices to be connected together.

## 6.4—Windows NT CPU (Pentium with Dual Ethernet) Module

(Obsolete 4th Quarter 2012)

### 6.4.1—Module Description

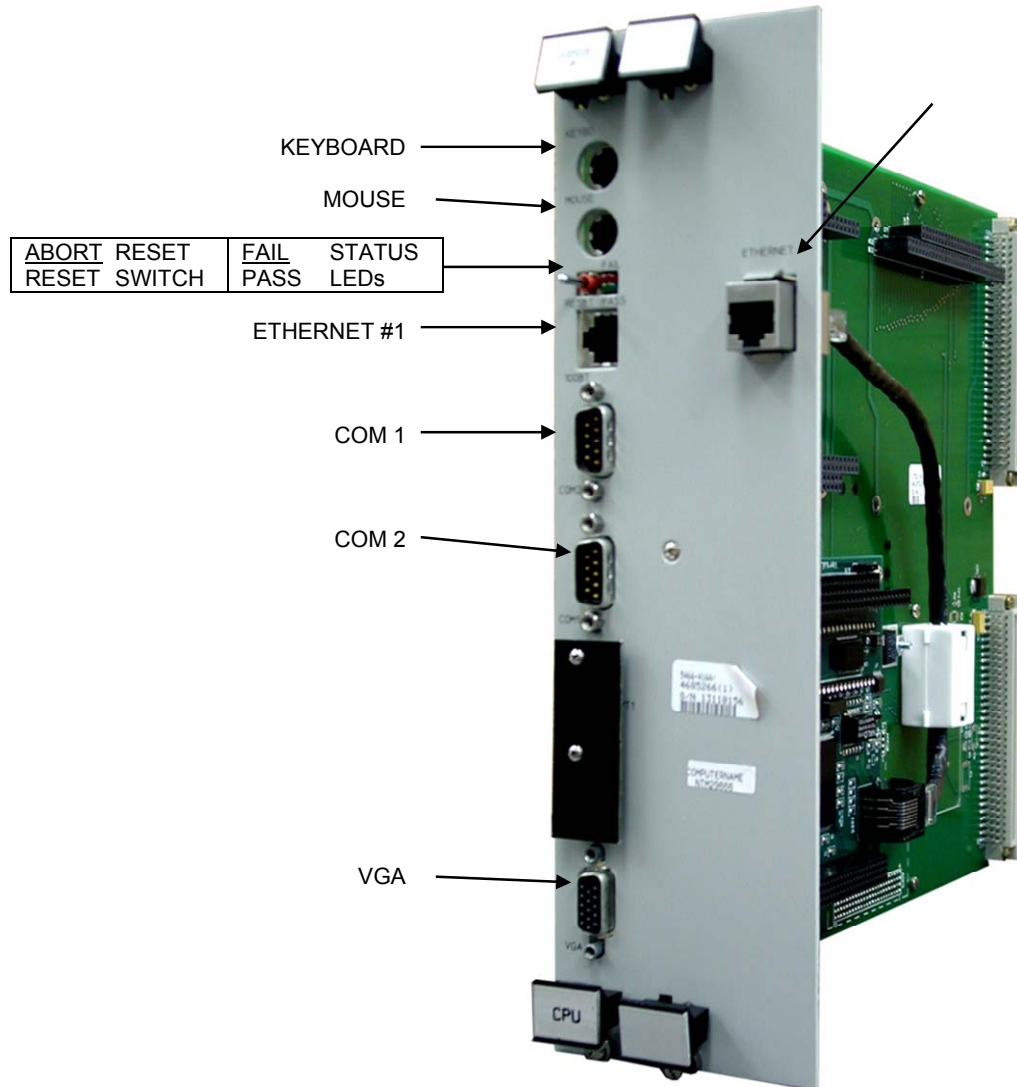


Figure 6-21—NT CPU (Pentium with Dual Ethernet) Module

Every Simplex MicroNet control contains one CPU module located in the first slot of the MicroNet chassis. The description of the CPU module contained in this chapter is the Windows NT CPU with Dual Ethernet.

For CPU module installation and replacement instructions, see the instructions for installing and replacing the VME module in Chapter 15, Installation and Replacement Procedures.

The NT CPU module runs the application program. Figure 6-18 is a block diagram of the NT CPU Module. This module is a standard PC on a VME card. It supports Windows NT with real-time extensions to maintain a rigorous real-time environment. NT functions are not re-documented in this manual. Please refer to the applicable Microsoft Windows NT manual if necessary.

There is a solid state Hard-Drive on the module which uses the standard Windows file system. The hard-drive has Windows NT Operating System with the real-time extensions and the Application program. It has a standard interface to the VME bus to read and write to I/O modules

**NOTICE**

The NT operating system on the hard drive is an embedded version of Windows NT that is designed for use with a real-time system only. No other applications are allowed.

**NOTICE**

Live insertion of the NT CPU is allowed. It is not recommended to plug/ unplug the monitor, keyboard, or mouse during execution of the application.

**NOTICE**

Do not plug or unplug any non-isolated device directly into the CPU during execution of the application. Refer to the NT CPU Interface Connections section of this chapter for more details on interface requirements.

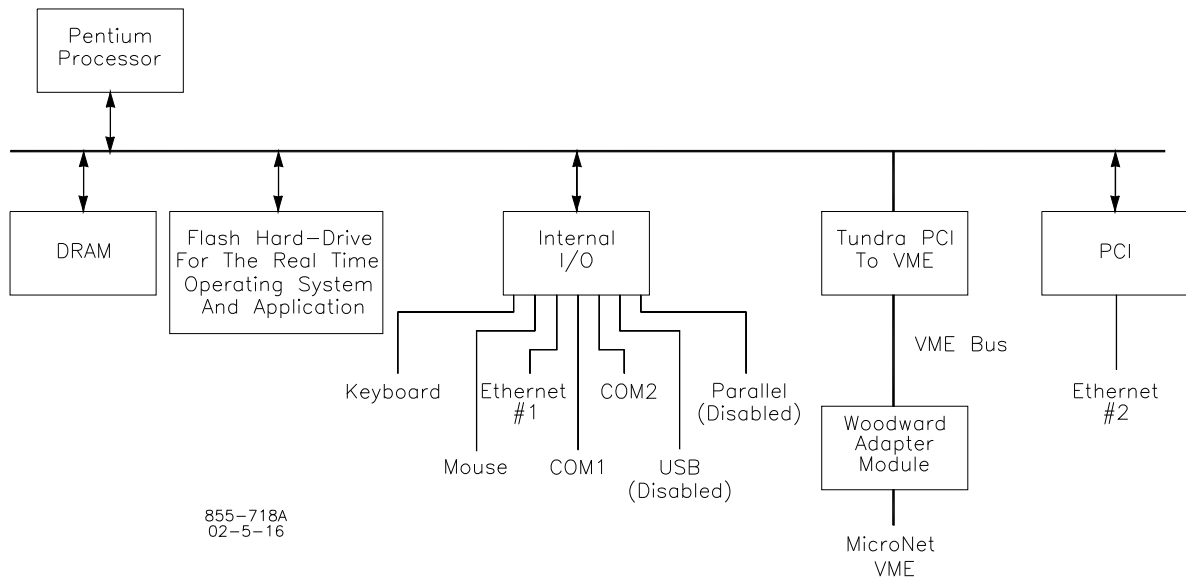


Figure 6-22—Windows NT CPU Block Diagram



### 6.4.2—NT CPU Interface Connections

The NT CPU consists of cable connections for the following devices. These connectors, pinouts, and their interface requirements are detailed in this section.

Table 6-17—NT CPU Connectors

Supported Interfaces	Service Interfaces*	Un-supported Interfaces
10/100 Base-TX Ethernet	PS/2 Keyboard	Parallel Port
COM1 Serial Port	PS/2 Mouse	Universal Serial Bus (USB)
COM2 Serial Port	XVGA Video	

\* Woodward does not recommend permanent connection to these ports; these are for Service use only.

### 6.4.3—CPU Reset Switch

The CPU incorporates a reset switch which can be used to manually reset the entire system. This reset will cause the CPU to immediately re-boot. In addition, the VME backplane is also reset. All Woodward VME modules are placed into IOLOCK mode and held in reset appropriately.

### 6.4.4—PS/2 Keyboard and Mouse

Two PS/2 ports are available to support keyboard and mouse devices. Since these ports allow for unrestricted access to the control's operating system, usage of the keyboard and mouse should be restricted to trained service personnel for troubleshooting or service access only. The keyboard and mouse must **not** be connected for long-term use or operational use.

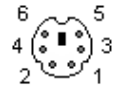
**IMPORTANT**

The mouse and keyboard must be installed prior to RESET or POWER UP for the CPU to recognize them.

The PS/2 ports are non-isolated. A shielded cable and the Video Interface FTM are required to avoid susceptibility to EMI noise and ground loops related to PC connections and typical industrial environments. See the Video Interface FTM section for more details.

Most PC industry peripherals such as keyboards, mice, and monitors connect Signal Common to Chassis GND. When using a PS/2 device avoid making this chassis GND connection to ensure the floating power supply system operates as designed. The keyboard or mouse must be connected through the Video Interface FTM.

Table 6-18—PS/2 Pinout

Connector	Signal Mnemonic
Mini-Din 6F 	Shielded circular Mini-Din 6 female receptacle
1	DATA
2	n/c
3	Signal Common
4	+5 V
5	CLOCK
6	n/c
Shield	Chassis GND

### 6.4.5—10/100 Base-TX (Ethernet #1)


An auto-switching 10/100 Base-TX RJ45 Ethernet connector is available for system use. This connection will be used for control configuration, data gathering, remote monitoring, maintenance, and networking of multiple controls. Additionally, this port will be relied upon for interfacing TCP/IP Distributed I/O devices into the control system.

To ensure signal integrity and robust operation of Ethernet devices, an Ethernet Interface FTM (Field Termination Module) is required when using this port. Its primary function is to implement EMI shielding and cable shield termination of the Ethernet cable. Along with the Ethernet Interface FTM, double shielded Ethernet cables (SSTP) are required for customer installations. See the Ethernet Interface FTM section for more details.

#### **IMPORTANT**

To fully realize 100 Base-TX connectivity, downstream devices must be capable of 100 Base-TX. As such, when using an Ethernet hub for multiple connections, either a fixed 100 Base-TX or an auto-switching 10/100 Base-TX hub would be necessary.

Table 6-19—RJ45 10/100 Base-TX Pinout (Ethernet # 1)

Connector	Signal Mnemonic
Mini-Din 6F 1 8 	Shielded RJ45 female receptacle
1	TX+
2	TX-
3	RX+
4	n/c
5	n/c
6	RX-
7	n/c
8	n/c
Shield	Chassis GND

### 6.4.6—10/100 Base-TX (Ethernet #2)


The Windows NT Pentium CPU module is be configured to provide a second auto-switching 10/100 Base-TX RJ45 connector by mating it to a special carrier board and a PC104Plus Ethernet communications card. This special configuration occupies three card slots in the MicroNet chassis. This connection will be used for control configuration, data gathering, remote monitoring, maintenance, and networking of multiple controls. Additionally, this port will be relied upon for interfacing TCP/IP Distributed I/O devices into the control system.

To ensure signal integrity and robust operation of Ethernet devices, an Ethernet Interface FTM (Field Termination Module) is required when using this port. Its primary function is to implement EMI shielding and cable shield termination of the Ethernet cable. Along with the Ethernet Interface FTM, double shielded Ethernet cables (SSTP) are required for customer installations. See the Ethernet Interface FTM section for more details.

**IMPORTANT**

To fully realize 100 Base-TX connectivity, downstream devices must be capable of 100 Base-TX. As such, when using an Ethernet hub for multiple connections, either a fixed 100 Base-TX or an auto-switching 10/100 Base-TX hub would be necessary.

Table 6-20—RJ45 10/100 Base-TX Pinout (Ethernet # 1 and # 2)

Connector	Signal Mnemonic
Mini-Din 6F 1 8 	Shielded RJ45 female receptacle
1	TX+
2	TX-
3	RX+
4	n/c
5	n/c
6	RX-
7	n/c
8	n/c
Shield	Chassis GND

**NOTICE**

CPUs may not be upgraded in the field to include dual Ethernet because of BIOS and operating system software updates that must be done at the factory.

Applications engineers using this module should familiarize themselves with the GAP help files to ensure proper operation of dual Ethernet ports.

**6.4.7—RS-232 Serial Ports COM1, COM2**

Two high speed 16550 compatible RS-232 serial ports are available for system use. These ports can be used with various protocols and devices to communicate information with serial devices. For example, these ports can be configured for Modbus master or slave, Servlink Protocol, Control Assistant Protocol, Tunable Maintenance, or even modem access.

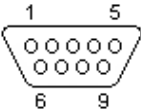
These communication ports are non-isolated. Shielded cable and a Serial Port Isolator/ Converter are required when using this port to avoid susceptibility to EMI noise and ground loops related to PC connections and typical industrial environments. The following standard options are available:

- RS-232–RS-232 Isolator
- RS-232–RS-485 Isolator/Converter
- RS-232–RS-422 Isolator/Converter

**IMPORTANT**

A Serial Port Isolator/Converter must be properly installed, grounded, and powered prior to connection with the CPU. Once properly installed, it may be connected to a field device at any time. Alternatively, the isolator may be connected to the field device. However, it must be properly installed, grounded, and powered prior to connection to the CPU.

Table 6-21—COM1 and COM2 Pinout


Connector	Signal Mnemonic
DB9M 	Shielded DB9 male connector
1	DCD
2	RX
3	TX
4	DTR
5	Signal Common
6	DSR
7	RTS
8	CTS
9	RI
Shield	Chassis GND

### 6.4.8—Universal Serial Bus (USB)

The USB port is not supported on this CPU due to the lack of software support in the Windows NT 4.0 operating system.

### 6.4.9—Parallel Port

The parallel port is not currently supported on this CPU due to the lack of driver support in the operating system.

 <b>WARNING</b>	<b>Use of the LPT1 and USB ports is not ALLOWED. CPU failure may result.</b>
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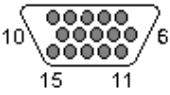
### 6.4.10—XVGA Video

The CPU has a standard analog video port which is available for service use. The video interface supports 24 bit true color modes and is capable of 1280 x 1024 max resolution.

The video port is non-isolated. A shielded cable and the Video Interface FTM are required to avoid susceptibility to EMI noise and ground loops related to PC connections and typical industrial environments. See the Video Interface FTM section for more details.

Most PC industry peripherals such as keyboards, mice, and monitors connect Signal Common to chassis GND. When using a monitor avoid making this chassis GND connection to ensure the floating power supply system operates as designed. The monitor must be connected through the Video Interface FTM, an isolated power supply, and be “floating” with respect to chassis GND.

Table 6-22—Video Pinout

Connector	Signal Mnemonic
	Shielded high density DB15 female receptacle (HD DB15F)
1	RED
2	GREEN
3	BLUE
4	DDC.ID2
5	Signal Common
6	Red GND
7	Green GND
8	Blue GND
9	KEY
10	Synch GND
11	DDC.ID0
12	DDC.ID1
13	HSYNC
14	VSYNC
15	DDC.CLK
Shield	Chassis GND

#### 6.4.11—NT CPU Power Requirements

Table 6-23—Power Requirements

+24 V	125 mA (max)
+5 V	6.3 A (max), 5.73 A (typical)

#### 6.4.12—Installation

To set the Local IP Address, you must have a local monitor, keyboard, and mouse. Push Start-Settings-Control Panel and double click the Network icon. Select Protocols-properties and click the Specify and IP Address box, then enter valid data on the IP Address, SubNet Mask, and Default Gateway.

### **IMPORTANT**

**An example of a valid address would be: IP Address=190.41.99.100, SubNet Mask=255:255:0:0, Default Gateway=190.41.100.1. Your address will be defined by the network to which you are connected.**

To find the Windows NT CPU on the Workstation:

1. In a command prompt, type "net view /DOMAIN:micronet". The Workstation will tell you the name of all the computers on the local network. This is done to find the name of the PC on the local network. Another method to determine the name of the NT CPU is; if a monitor, keyboard, and mouse are available on the NT CPU, select Start-Settings-Control Panel-Network, and then select the Identification tab. The name of the computer is displayed.
2. In the NT explorer "tools-find-computer", type in the name of the computer to which you want to make a connection (determined in step #1).
3. Explorer will display the "Name", "Location", and "Comment" of the computer to which you are attempting to connect.

4. Double click the displayed "Name" and connect to the Windows NT CPU by entering the Logon of "ServiceUser" with the password "ServiceUser".
5. A window connected to the Windows NT CPU will be opened. Normal file transactions may now be performed.

Create the application.exe and the application.rtss (a matched set) on the programming workstation by using the GAP and Coder. Copy the file set to the Windows NT CPU.

## IMPORTANT

The application can be started automatically upon power-up of the CPU by placing a shortcut to the application.exe in the start-up path on the Windows NT CPU.

### 6.4.13—Transferring Files from a Workstation to the NT CPU

Transferring files from a workstation to the Windows NT CPU can be accomplished with App Manager Utility Software.

### 6.4.14—MicroPanel Service Tool

MicroPanel is a 20-line service tool for MicroNet Windows NT CPU module. MicroPanel allows access to control variables for monitoring and tuning both locally and remotely through an established Windows NT network. See Figure 4-9.



Figure 6-23—MicroPanel Display Screen

#### Status Bar and Window Title

The right-hand panes of the MicroPanel status bar show connection information. The first indicates whether the connection is local or remote. The second indicates which communication device is being used. The communication device number is specific to the control application.

The window title indicates either a local connection or the computer name of the MicroNet NT CPU to which the MicroPanel is connected.

## Display Lines

There are 20 display lines on the left-hand side of the MicroPanel screen.

## Button Functions

The buttons on the screen expose all the service functions of the MicroPanel. With the exception of the 'Fast' and 'Slow' buttons, all buttons will repeat while they are held down. The 'Fast' and 'Slow' buttons have a mutually exclusive toggle functionality.

## Navigation Button

The large, diamond shaped button in the center of the screen allows navigation through the application. Each corner of the button represents a direction of navigation, up, down, left and right.

## Numeric Buttons

The numbers 0 through 9, unary negation, and a decimal point are represented by the numeric buttons. The '0' and '1' double as 'NO' and 'YES' buttons and are labeled appropriately. In addition, the '7' and '8' provide 'previous' and 'next' alphabetical category functionality in debug mode.

## Line Positioning Buttons

The 'Line Up' and 'Line Down' buttons are used to change the current selected display line in the appropriate service modes. The current line can also be changed by left clicking the mouse on a specific display line.

## Adjust Buttons

The 'Fast' and 'Slow' buttons have a special functionality. They operate as mutually exclusive toggle buttons and select the adjust mode: fast, normal, or slow. The up and down arrow shaped buttons allow adjustment up or down.

## Command Buttons

The 'Enter', 'Exit' and 'Serv/Debug' buttons have specific functionality depending on the current service mode.

## Keyboard

All functions of MicroPanel can be accessed from the keyboard.

Keys	Button Functions
Arrow	Direction navigation
'0' – '9'	Numeric
'0' and '1'	'NO' and 'YES'
'7' and '8'	Previous and next alphabetical category
'Page Up' and 'Page Down'	Line up and line down
'Shift'	Fast toggle
'Ctrl'	Slow toggle
'Insert' and 'Delete'	Adjust up and adjust down
'Enter'	Enter command
'Esc'	Exit command
','	Serv/Debug selection

In addition, the keyboard can be used as the sole means of input into the Windows NT operating system. See the Windows NT help for more information.

## Mouse

All functions of MicroPanel are available to the mouse through the buttons on the MicroPanel display. Use the mouse cursor and right click to activate the buttons.

The mouse also has special functionality when used within the display line area. Left click to set the currently selected display line and right click to access the Branch To dialog.

## Touch Screen

If your MicroNet CPU is configured with a touch screen device, all MicroPanel functionality is available through the touch screen. The touch screen emulates the mouse and all mouse functions are available.

## Command Line Options

MicroPanel supports two command line options:

MicroPanel [-L]-R "computername"]

- -L : connect locally
- -R "computername": connect to remote computer computername, the quotation marks are necessary if computername contains white spaces or special symbols.

## Pipes

MicroPanel communicates with the control application through named-shared pipes. If no open pipes are available MicroPanel cannot connect and will terminate.

See the GAP help for information on how to add pipes to a GAP application.

## Local Connection

A local connection is a connection through the memory of the NT operating system on the same machine. No networking is necessary for a local connection. Multiple instances of MicroPanel can be used as long as there are available pipes in the control application.

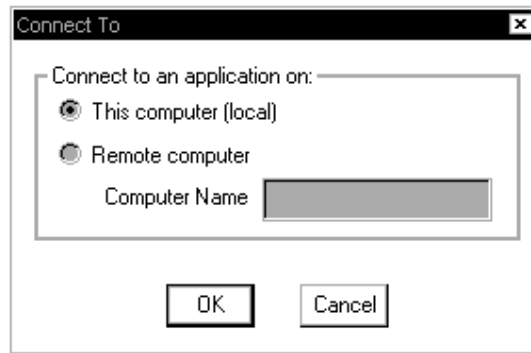


Figure 6-24—Local Connection Dialog Box

## Remote Connection

A remote connection is a connection between two Windows NT computers over an established network. Access permissions must be established (through the Explorer, for instance) before a connection can be made. The control application must have an open pipe for the connection to succeed. Refer to the P\_PIPE block in GAP help for more information on configuring this option. Multiple instances of MicroPanel can be used when configured properly. The remote computer may be specified by name or IP Address (NTM01234 or 190.41.99.10).



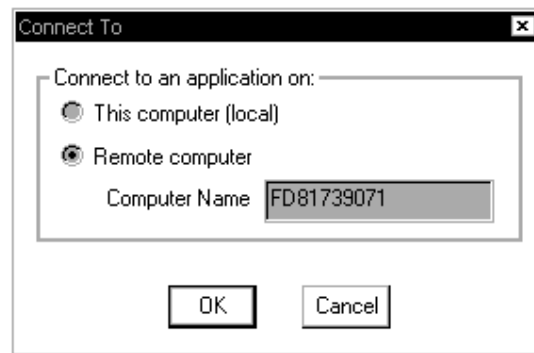


Figure 6-25—Remote Connection Dialog Box

### About Box Information

When MicroPanel is connected to a control application locally, the about box contains information about the FDoc device on the MicroNet NT CPU. The information includes serial number, computer name, part number, revision, and a description. This information is not available through a remote connection.



### **WARNING**

**Live insertion of the NT CPU is allowed. It is not recommended to plug/ unplug the monitor, keyboard, or mouse during execution of the application.**

**Do not plug or unplug any non-isolated device directly into the CPU during execution of the application. Refer to the NT CPU Interface Connections section of this chapter for more details on interface requirements.**

### 6.4.15—Installation

In any installation with long cable runs, it is possible that the local ground connections at either end of the cable are at different voltages. You can see this easily by grounding a long cable at one end and measuring the voltage level between the far end of the cable and a ground connection nearby. You can think of the two ground connections as the positive and negative connections of a battery. If both ends of a cable shield are coupled directly to these local ground connections, it is possible to establish a ground loop, which looks just like an electrical short across the terminals of the battery. Depending on the particular local conditions, it is possible that significant and potentially hazardous electrical currents could be flowing on the cable shield. To prevent these ground loops, it is recommended that one end of the cable shield be tied to its local ground and the other end be connected to its local ground through a capacitor. This will break the ground loop.

## 6.4.16—Connecting to the Network

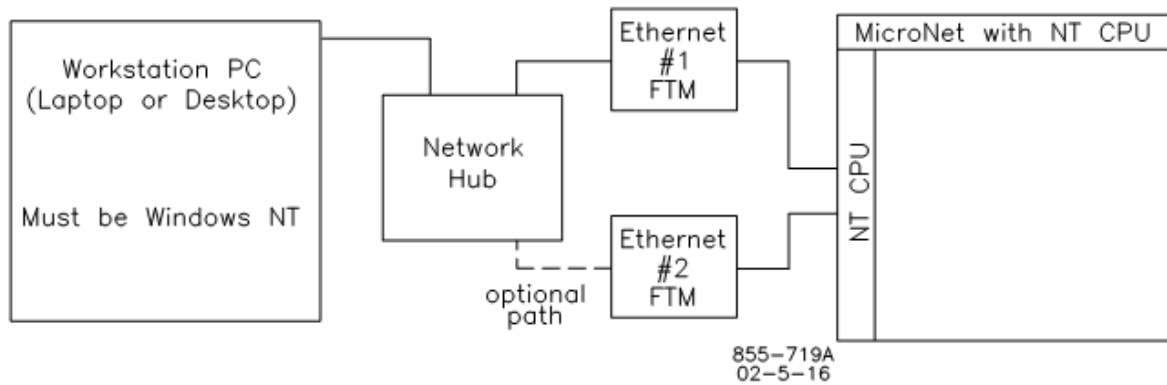


Figure 6-26—Network Block Diagram

The Windows NT CPU has a built in 10/100 BaseT connector on the front of the CPU. To connect a workstation PC to the Windows NT CPU, connect a cable from the workstation to the CPU through a network hub. This hub performs a cross-over function as well as allowing many networked devices to be connected together. (See Chapter 13 for more information.)

## 6.5—040 CPU Module (Motorola 68040)

### 6.5.1—Module Description

Every Simplex MicroNet control contains one CPU module located in the first I/O slot of the MicroNet chassis.



Figure 6-27—040 CPU Module

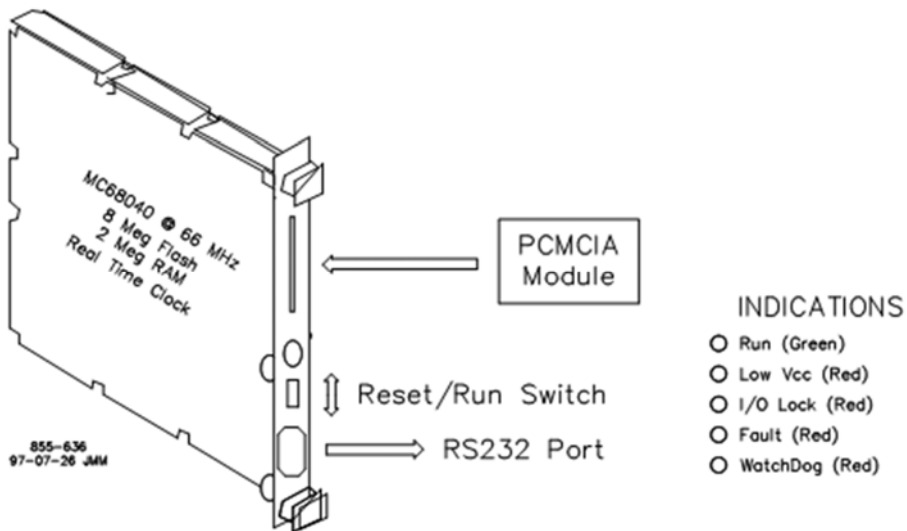


Figure 6-28—CPU Module

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

The CPU module runs the application program. Figure 6-25 is a block diagram of a CPU module. When the reset switch is toggled to the Run position, the CPU module will perform diagnostic tests, then run the application program.

The CPU has a PCMCIA (Personal Computer Memory Card International Association) slot on its front panel. The PCMCIA slot is used to download application files to the CPU module.

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. During normal operation, on-board circuitry keeps the battery charged. Once the battery is fully charged (taking a maximum of three days), the battery will continue to run the clock for a minimum of three months without power to the control. If power is removed from the CPU module for longer than three months, the real time clock may need to be reset. The resolution of the real time clock is 10 milliseconds.

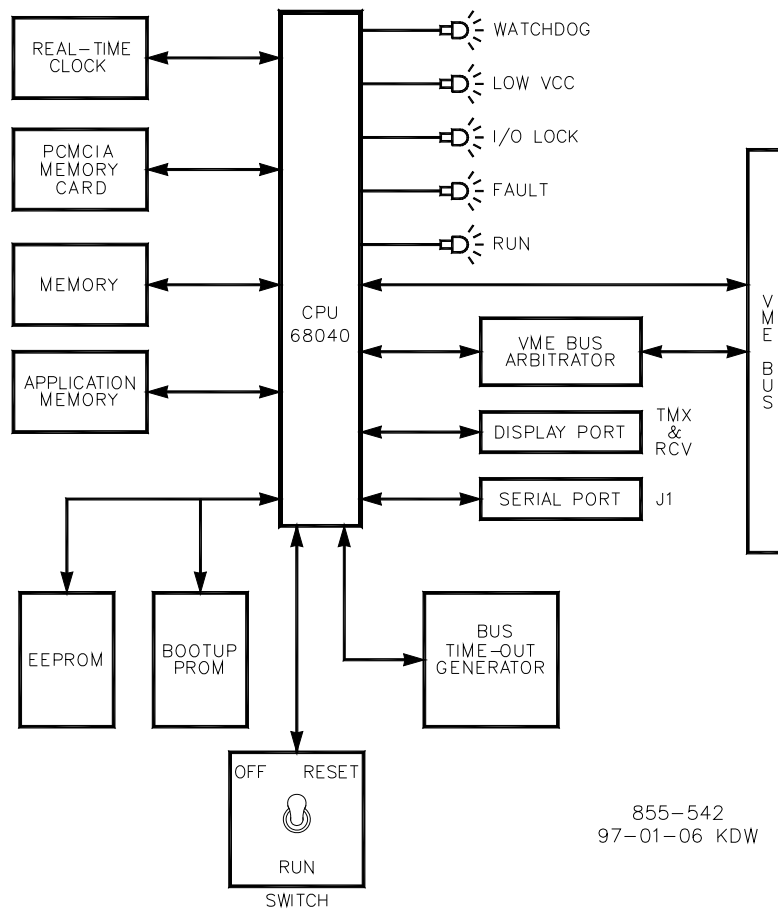


Figure 6-29—CPU Module Block Diagram

### 6.5.2—RS-232 Serial Port COM1

An RS-232 serial port is located on the front of the CPU module. This port should only be connected to a device with an isolated serial port. Baud rate is selectable from 300 Bd to 38.4 kBd. Before this port can be used, Woodward kit P/N 8298-096 must be installed. To install this kit, the CPU must have screw posts. Some of Woodward's earlier CPU modules have slide lock posts. These must be sent to Woodward for upgrade before the port may be used. See Chapter 13 for details on how to install this port filter kit. 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.

This communication port is non-isolated. Shielded cable and a Serial Port Isolator/ Converter is required when using this port to avoid susceptibility to EMI noise and ground loops related to PC connections and typical industrial environments. The following standard options are available:

- RS-232–RS-232 Isolator and Filter
- RS-232–RS-485 Isolator/Converter and Filter
- RS-232–RS-422 Isolator/Converter and Filter

#### **IMPORTANT**

**A Serial Port Isolator/Converter must be properly installed, grounded, and powered prior to connection with the CPU. Once properly installed, it may be connected to a field device at any time. Alternatively, the isolator may be connected to the field device. However, it must be properly installed, grounded, and powered prior to connection to the CPU.**

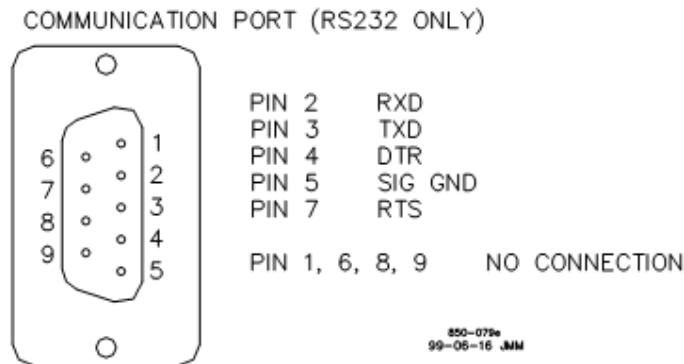


Figure 6-30—68040 CPU Communications Port

### 6.5.3—FTM Reference

Refer to Appendix A to determine the appropriate FTM selection for your CPU. Specific installation and application information can be found in Chapter 13.

## 6.5.4—Troubleshooting and Tuning

The MicroNet Operating System runs both off-line and on-line diagnostics. Diagnostics are run at power-up or when the Reset switch is toggled (off-line), and automatically when operating under application-program control (on-line).

### 68040 CPU Off-Line Diagnostics

The following table shows the tests run by off-line diagnostics, and the order in which they are run. Off-line diagnostics are started immediately after the Reset has toggled.

Table 6-24—Off-line Tests

TEST	EXPLANATION OF TEST
1. CSR (Control Status Register) Test	The CSR register of the CPU is tested by writing to it, reading from it, and then testing the value read back.
2. Simple DUART (dual universal asynchronous transmitter)	This test checks the DUART counter/timer, and on Channel A of the CPU module, it does a receiver/internal wrap-around test. If the Channel passes the test, the display is initialized, and communication with the VFD (vacuum-fluorescent display) is set up. If the VFD does not respond, the system sets up for a dumb terminal.
3. Local RAM Test	This test checks all of the local RAM installed by performing the following tests: A. Marching One test (writes to a bit location in memory, then reads that location back to verify it his is repeated for every bit-location in memory. B. Write Byte, read word; write word, read byte, etc. C. If memory is less than 512 KB, perform wraparound test (writes past word boundaries). D. Misalign test (accesses memory on a misaligned word boundary).
4. Application RAM Test	This test determines whether the memory for the application is RAM or PROM. If application memory is PROM, no tests are done. If application memory is RAM, the following tests are performed. A. Marching One test. B. Write Byte, read word; write word, read byte, etc. C. If me D. Misalign test.
5. Extensive DUART Test	This test checks both channels of the DUART with: A. Internal wrap-around test B. Different Baud rates, data bits, etc.
6. Clock interrupt Test	This test enables the interrupt timer and checks that the interrupts are being generated.
7. Local Bus Timeout Test	This test writes to a location on the Woodward I/O bus with no memory (module) installed, and checks that a bus error occurs.
8. VME Bus Timeout Test	This test writes to a location on the VME bus with no module installed, and verifies that a bus error occurs.
9. PROM Write Test	This test makes the CPU think that PROM is installed. It then writes to a location and verifies that the CPU generates a bus error.
10. EEPROM Test	This test uses the last few locations in the EEPROM. It writes to a location, reads the data back, and checks to see if the write was successful. It then repeats the procedure for different locations.
11. FPU (Floating Point)	This test checks the register locations on the Unit) Test co-processor, does some math calculations with known answers, and checks to be sure the answers returned are correct.
12. BOOT	If the self-test has been successful so far, the system checks to see if PROM is installed. If PROM is installed, and if it has a valid application program in it, that program will be executed. If RAM is installed, the system checks the VME bus to see if there is a memory module with a valid application program. If it finds one, it will download it to the CPU RAM and execute it. If there is no application program, the system sets up for a download and requests the operator to download an application program. If PCMCIA module is installed, the CPU will download the application from the PCMCIA module and execute it.

If during diagnostics, a particular test fails, testing stops and a message identifying the cause of the failure will be displayed. Also, the FAILED LED on the CPU module will periodically repeat bursts of flashes; the number of flashes in each burst indicates the test that failed as shown in Table 6-15.

Table 6-25—Flash Codes

FLASHES IN BURST	ERROR DETECTED
1	Start Up test failed
2	Control Status Register test failed
3	DUART test Failed
4	Local RAM test failed
5	Local RAM Misaligned test failed
6	Application RAM test Failed
7	Application RAM Misaligned test failed
8	Clock Interrupt test failed
9	Local Bus Timeout test failed
10	VME Bus Timeout test failed
11	PROM Write test failed
12	EEPROM test failed
13	Floating Point Math Co-processor test failed

### 68040 CPU On-Line Diagnostics

As soon as the application program starts running, the system will use a small portion of run time to continuously run the following on-line diagnostic tests.

Table 6-26—On-Line Tests

TEST	EXPLANATION OF TEST
1. Local Memory Test	This test gets a location from memory, saves the data from that location, and then writes several different values to that location. It reads each value back, and checks it to be sure it is correct. It then restores the saved original data back to the RAM and repeats the process at another location.
2. Application Memory Test	RAM only: If the memory is RAM, this test gets a location from memory, saves the data from that location, and then writes several different values to that location. It reads each value back, and checks it to be sure it is correct. It then restores the saved original data back to the RAM and repeats the process at another location. UVPRO, RAM and Flash: The test then calculates the sumcheck value and compares it to the sumcheck value previously calculated offline and stored in memory.
3. FPU (Floating Point Unit) Test	This test checks the register locations on the co-processor, does some math calculations with known answers, and checks to be sure the answers are returned correct.
4. Task Overview	This test checks the last eight locations in the task that has just completed to make sure that the values that were set up when the task was created have not changed. If they have, it indicates that the task has overflowed its memory, and destroyed memory in another task.

A failure of any one of the on-line tests results in the I/O lock being asserted and display of a message as shown in Table 6-17. The message will be displayed on the Service Panel at the time the error occurs, and it also will go into the Fault Mode Buffer so that it can be displayed in the Fault Mode.

Table 6-27—Test Failure Messages

TEST	MESSAGE ON FAILURE
Local RAM	Local RAM Failed
Application RAM	Application RAM Failed
FPU (Co-processor)	FPU C0-processor Failed
During execution, an operating system task ran out of memory, or its memory was corrupted by a different task	Task overrun

### 68040 CPU Operation Errors

Certain other errors can occur during system operation. These errors and their associated messages are listed in Tables 6-18 and 6-19.

Table 6-28—Operation Errors

MESSAGE	MEANING
Checksum Error	Local RAM Failed
System Error (#)	Application RAM Failed (ref. Table 6-19)
EEPROM Fault	FPU C0-processor Failed
Math Exception	The FPU (Co-processor) has received an illegal instruction
Rate Group Slip (#)	Rate group # (number) is scheduled to run and it did not complete its previous scheduled run.
EEPROM Initialization Fault	The CPU attempted to program the EEPROMs during system initialization and failed, or the EEPROM was detected bad (EEPROM FAULT). The system is not permitted to run because the EEPROM data is not current.
Exception Error Vector #	An error was detected by the processor. The vector number indicates which exception the 68040 processor took. For an explanation of exceptions, refer to page 8-5 of Motorola Manual M 68040 UM/AD, MC68040 Enhanced 32-bit Microprocessor Users Manual.

## IMPORTANT

If the application is using DATA\_LOG blocks, the CPU module must have the large RAM module option installed.

If the application is using the NV\_LOG block, the CPU module must have the large EEPROM option installed.



Table 6-29—Numbered System Errors

NUMBER OPER.	SYS. FILE	MEANING
1	CREATE	Cannot create task with priority less than one.
2	CREATE	Stack size requested is smaller than the minimum size.
3	NEWPID	The priority is greater than the maximum allowed.
4	NEWPID	The rate group Proctab entry is not free.
5	NEWPID	All the Proctab entries are full.
6	GETMEM	Tried to get a (zero-byte) block of memory.
7	GETMEM	No memory available.
8	GETMEM	Not enough memory available for block size requested.
9	FREEMEM	Returned a (zero-byte) block of memory.
10	FREEMEM	Returned a block of memory outside of heap boundaries.
11	FREEMEM	Unable to return the block of memory
12	NEWSEM	No semaphores available.
13	SUSPEND	Cannot suspend a task that is not current or ready.
14	SCOUNT	The semaphore number is invalid.
15	SCOUNT	The semaphore number passed in is undefined.
16	SCREATE	The initial count is smaller than zero.
17	SIGNAL	The semaphore number is invalid.
18	SIGNAL	The semaphore number passed in is undefined.
19	SIGNALN	The semaphore number is invalid.
20	SIGNALN	The semaphore number passed in is undefined.
21	SIGNALN	Must signal semaphore one or more times.
22	SRESET	The semaphore number is invalid.
23	SRESET	The semaphore number passed in is undefined.
24	RESET	Must set semaphore to zero or larger.
25	WAIT	The semaphore number is invalid.
26	WAIT	The semaphore number passed in is undefined.

### 68040 CPU Alarms

The possible system alarms are listed in Table 6-20. The numbered system alarms are listed in Table 6-21.

The ALARMS in Tables 6-20 and 6-21 do not automatically display; they are stored by the system and to see them, you must use the OPSYS\_FAULTS Mode of the Service Panel.

Table 6-30—System Alarms

MESSAGE	MEANING
SIO n Configuration Fails port x	A configuration error occurred on Port n of SIO x module. n (1-...) = SIO number x (1-4) = port number
SIO n Missing	SIO n module is not installed. n (1-...) = SIO number
SIO n Self-Test Failed	SIO n module failed its self-test. n (1-...) = SIO number
SIO n Initialization Failed	SIO n module failed to initialize. n (1-...) = SIO number
System Alarm # n	A numbered system alarm has occurred. The number of the alarm is n (see Table 20-8, Numbered System Alarms).
Divide by Zero	A divide by zero operation was performed.
Real to Int Conversion Overflow	An Overflow has occurred during a Real-to-integer conversion operation.

Table 6-31—Numbered System Alarms

NUMBER	OPER SYS. FILE	MEANING
1	CLOSE	The device number is invalid.
2	CONTROL	The device number is invalid.
3	GETC	The device number is invalid.
4	INIT	The device number is invalid.
5	OPEN	The device number is invalid.
6	PUTC	The device number is invalid.
7	READ	The device number is invalid.
8	RECVTIM	The time passed inn was less than zero.
9	SEND	The PID number is invalid.
10	SEND	Cannot send message to undefined task.
11	SEND	Process has message pending.
12	SENDF	The PID number is invalid.
13	SENDF	Cannot send message to undefined task.
14	WRITE	The device number is invalid.
15	IOERR	The function is not implemented for this device.
16	TTYCNTRL	Baud rate invalid.
17	TTYCNTRL	Mode (line/char) invalid.
18	TTYCNTRL	Function invalid.
19	TTYREAD	Attempt to read fewer than zero characters.
20	TTYWRITE	Attempt to write fewer than zero characters.
21	ICCCNTRL	Function invalid.
22	ICCINIT	Too many SIO modules are defined.

# Chapter 7.

## Communication

### 7.1—Remote RTN Module

#### 7.1.1—Module Description

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 Motorola MPC5200 processor, 128 MB DDR RAM, 64 MB of flash memory, a Real Time clock, and various communication peripherals. These peripherals include (2) 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.

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

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

For Remote RTN module installation and replacement instructions, see the instructions for installing and replacing the VME module in Chapter 15, Installation and Service, and Section 9.4.3—Installation. **This module will NOT automatically re-initialize to a running state after reset**, but the main-chassis CPU application can re-init this module upon request.

#### NOTICE



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.

#### Operation

For redundant systems, up to (2) Remote RTN modules may be installed into each 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 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 communicates with the CPU modules in the main chassis. Figure 7-3 is a block diagram of a Remote RTN module. When the power is applied, the Remote RTN module will perform diagnostic tests, before beginning communications.



Figure 7-1—Remote RTN Module

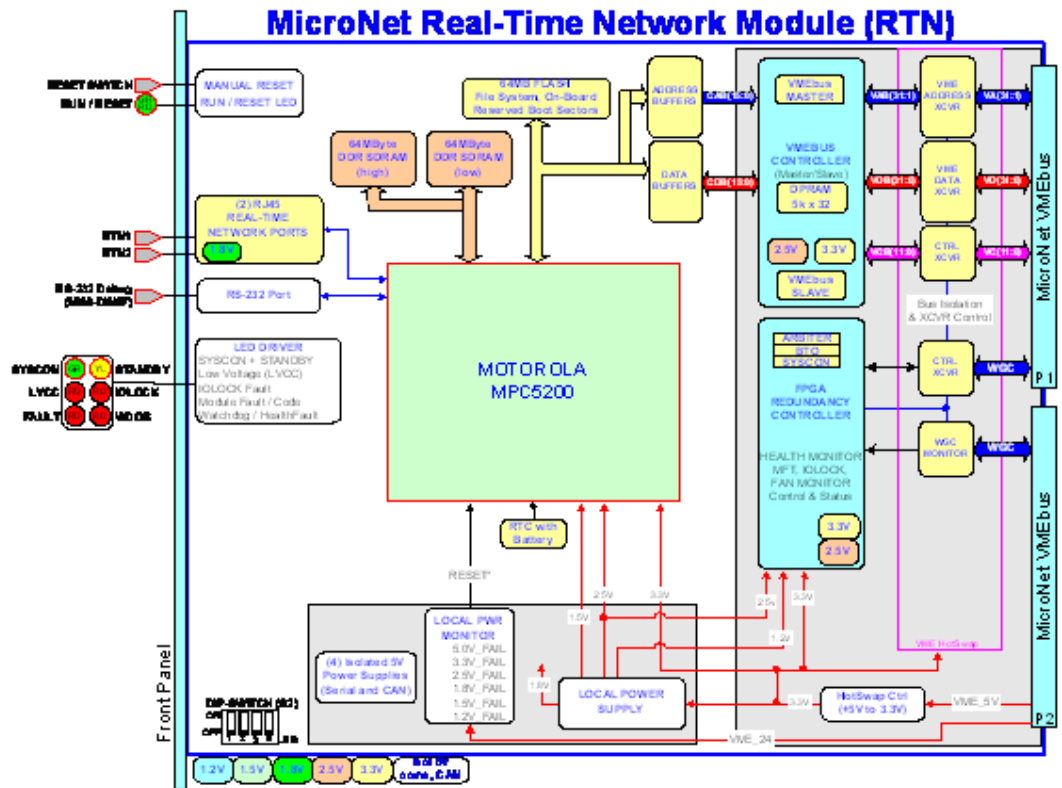


Figure 7-2—Remote RTN Module Block Diagram

### 7.1.2—RTN Expansion Chassis Configurations

The MicroNet Plus can expand from a single main rack to a maximum 8-rack system by using Remote RTN modules and copper or fiber optic Ethernet switches. A maximum of 7 MicroNet Plus expansion racks (14 slot or 8 slot versions) are supported in up to 7 different remote locations using fiber optic Ethernet switches. It is required to use Woodward approved hardware for robust operation.

Table 7-1-System Redundancy Options Using Remote RTN Modules

Redundancy Option	CPU and Remote RTN modules for Main and Expansion racks		
	Main Rack	Optional Exp #1..7	Optional Exp #1...7
Full Redundancy	Redundant CPU's	Redundant RTNs	Redundant RTNs
- Partial Redundancy	Redundant CPU's	Redundant RTNs	Single RTN
- Partial Redundancy	Redundant CPU's	Single RTN	Redundant RTNs
- Partial Redundancy	Redundant CPU's	Single RTN	Single RTN
Simplex	Single CPU	Single RTN	Single RTN

**Note:** See Chapters 2 and 3 for additional system diagrams.

### MicroNet Plus Redundant System

- Copper Expansion (Single, Dual, or Triple rack system)

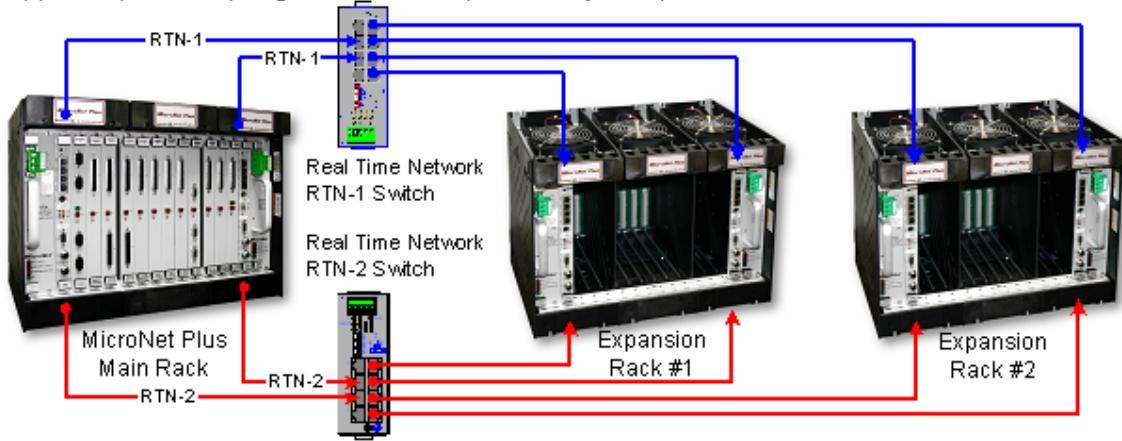


Figure 7-3—MicroNet Plus Redundant System (copper, 3-rack)

### MicroNet Plus Redundant (8-rack System)

- Copper Expansion

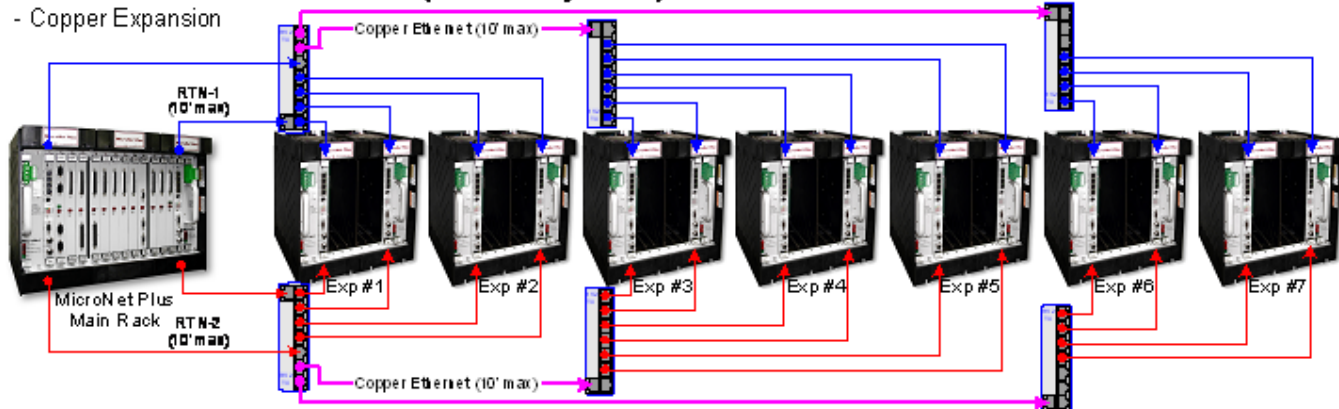


Figure 7-4—MicroNet Plus Redundant System (copper, 8-rack)

### MicroNet Plus Redundant System

- Fiber Optic Expansion to (1) Remote Location

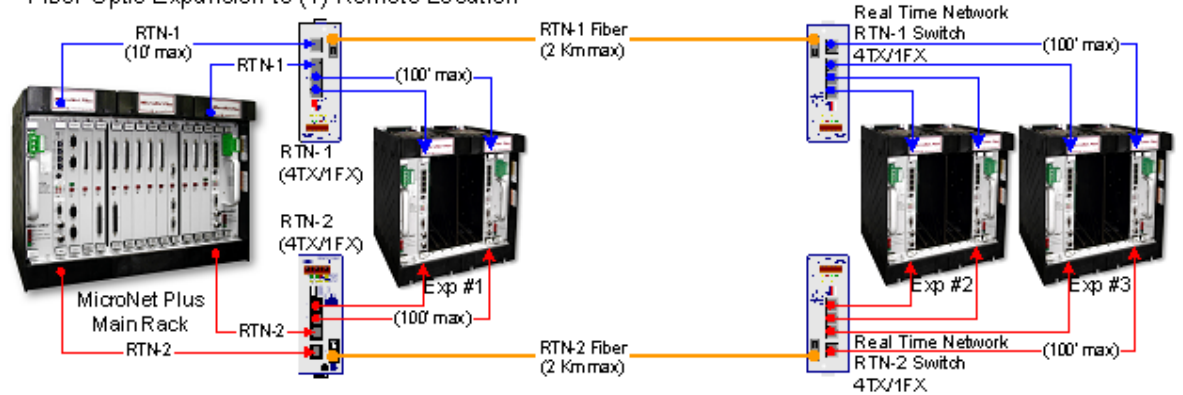


Figure 7-5—MicroNet Plus Redundant System (fiber, 2 locations)

### MicroNet Plus Redundant System

- Fiber Optic Expansion to (2) Remote Locations

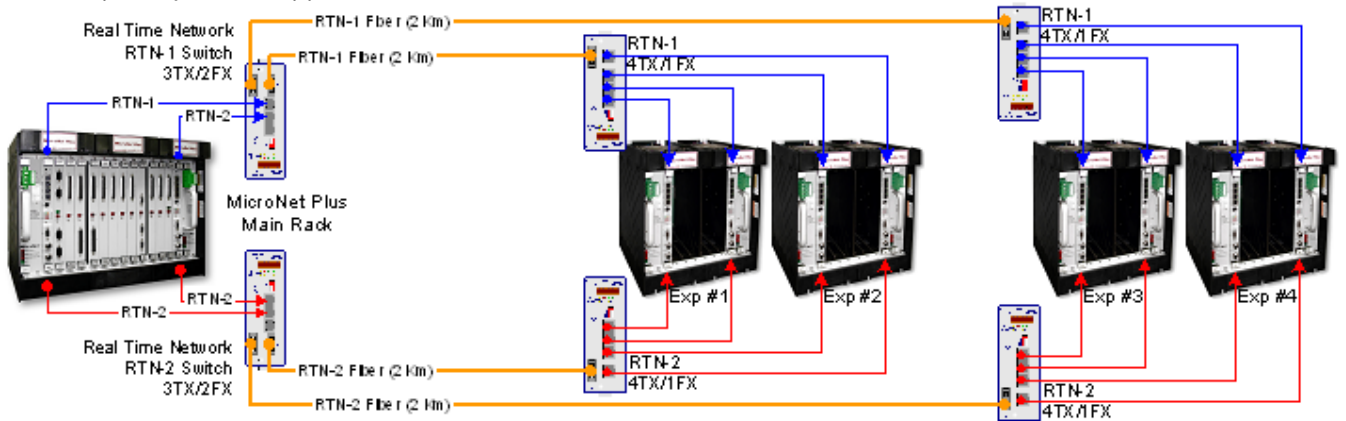


Figure 7-6—MicroNet Plus Redundant System (fiber, 3 locations)

# MicroNet Plus Redundant (8-rack System)

- Fiber Optic Expansion to (7) Remote Locations

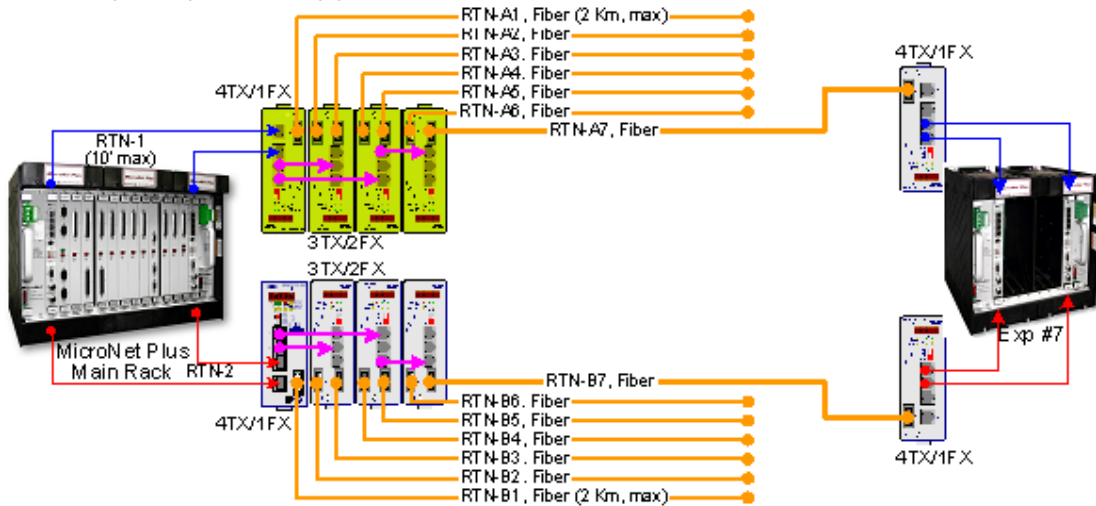


Figure 7-7—MicroNet Plus Redundant System (fiber, 8 locations)

## 7.1.3—Module Configuration

### Network Configuration

No network configuration is required. Only the RTN ports are active on this module. Ethernet ports (ENET1, ENET2) are disabled on the Remote RTN module by the Module Config switch (S2) and no IP address configuration is necessary.

### Hardware Configuration

The Module Configuration Dip-Switch (S2) must be configured properly for RTN mode with the expansion chassis address set appropriately for X1 through X7.

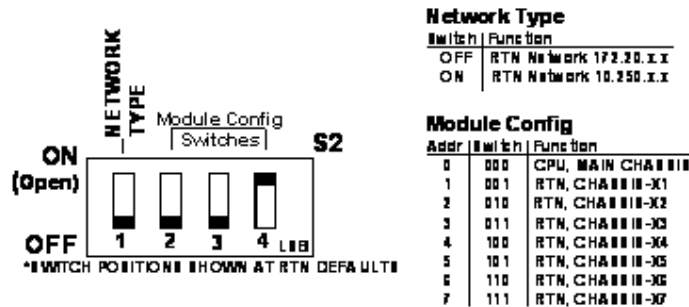


Figure 7-8—Remote RTN Module Hardware Configuration

### RTN Mode

The Module Config Switch (S2) is factory configured for RTN mode, expansion rack X1 operation (address 0x001). The Remote RTN module may be re-configured to as needed to operate as expansion chassis 1-7.

**Note:** RTN mode will disable Ethernet ports 1 and 2.



## 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.

**Note:** If CAN for GS6 or RTCnet/LINKnet HT operation is required from an expansion rack, a CPU module must be used in place of the Remote RTN module and configured for an RTN using the Module Configuration Switch (S2) as shown in section 7.1.3—Module Configuration above.

### **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



### 7.1.4—Front Panel Indicators (LEDs)

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

Table 7-2—Remote RTN Module Front Panel LED's

LED	Name	Description
 RUN	RUN	<u>RUN / RESET (GREEN/RED)</u> —Active RED when the user pushes the reset switch. Active GREEN upon release and after the CPU Operating system is loaded and running.
 	TX/RX	<u>TX/RX (GREEN)</u> —Active GREEN when data is transmitted or received.
	LINK	<u>LINK ACTIVE (YELLOW)</u> —A valid Ethernet connection to another device exists
     	SYSCON	<u>System Controller (GREEN)</u> —Active when this CPU or Remote RTN module is the VMEbus System Controller.
	STANDBY	<u>Standby Ready (YELLOW)</u> —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	<u>Low VCC Power Fault (RED)</u> —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	<u>IOLOCK (RED)</u> —This LED indicates that an I/O LOCK condition exists either locally on the CPU itself and/or on the VMEbus.  <b>Note:</b> 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.
	FAULT	<u>CPU FAULT (RED)</u> —Actively flashes CPU fault codes as necessary.
	WATCHDOG	<u>CPU Watchdog / Health Faults (RED)</u> —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.

### 7.1.5—Module Reset

#### 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.

#### 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.

#### Reset Notes:

- Resetting a CPU or Remote RTN module creates a HealthFault that immediately sets the WDOG light RED.
- Any Expansion chassis running with one healthy RTN. Reset detection will also drive IOLOCK and IORESET to place the expansion rack and all output signals into a known failsafe condition.
- Any Expansion chassis running with two healthy RTNs. 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



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.

### 7.1.6—RTN Ports

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

## IMPORTANT

- 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.

### 7.1.6—Ethernet Switch Hardware

For redundant systems, 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.

- 1752-423, Hirschmann copper Ethernet switch (RS2-TX, 8port)
- 1711-1069, Hirschmann Fiber Optic Switch (RS2-4TX/1FX)
- 1751-6077, Hirschmann Fiber Optic Switch (RS2-3TX/2FX)

### 7.1.7—Expansion Racks using Copper or Fiber cables

MicroNet Plus 8-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 7 MicroNet Plus expansion racks (14 slot or 8 slot versions) are supported in up to 7 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 1 fiber cable delay shall be allowed in any communication path.
- RTN cables from the main CPU rack to the local RTN switch hardware must be 3 m (10 ft. 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  $\mu\text{m}$  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

### 7.1.8—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 kBd, 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. This port is to be used by trained Field Service personnel 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.

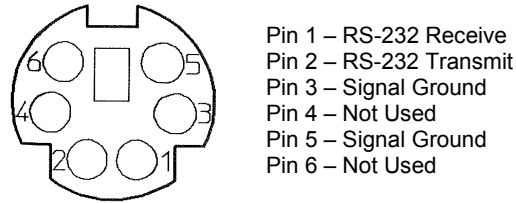


Figure 7-10—RTN Service Port (mini-DIN6F)

### 7.1.9—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 7-3-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

## 7.2—Simplex Main Transceiver (XCVR) Module

### 7.2.1—Module Description

The Main XCVR module allows extension of the VME back plane to the expansion I/O Chassis. The Main XCVR module sends and receives control, data, and address information to and from its associated Remote Transceiver module (see next section of this chapter) in an I/O chassis through a copper transceiver cable. The Main XCVR module is used in the Main Chassis. See Figure 7-9 for a block diagram of the module.

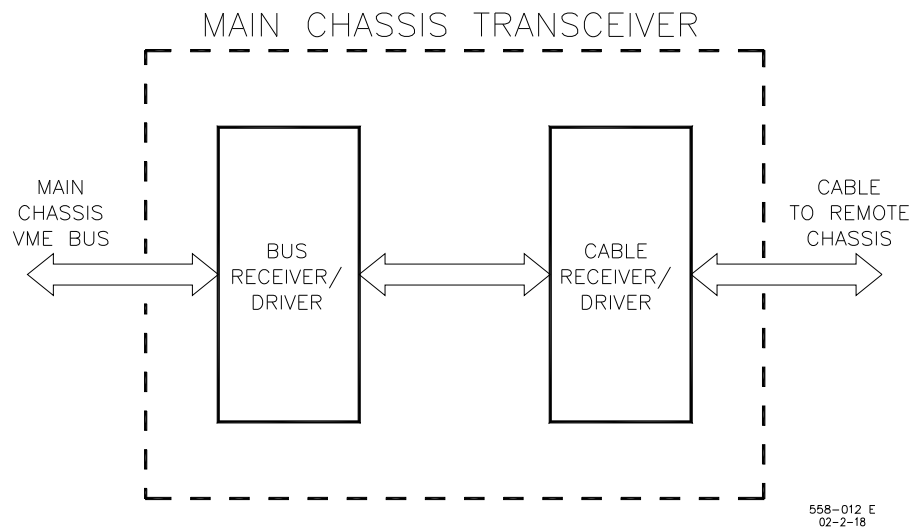


Figure 7-11—Main XCVR Module Block Diagram

### 7.2.2—Module Specification

Parallel Interface: High-speed, differential line drivers operating at VME transmission rate

Cable Interface: 100 pin metal shell Micro-D connector (2 per module)



Figure 7-12—Main XCVR Module

### 7.2.3—Installation

- The Main XCVR module can be installed in any slot in the Main Chassis.
- No jumpers are used to configure this module.
- This Transceiver module has no switches or LEDs.

### 7.2.4—Troubleshooting

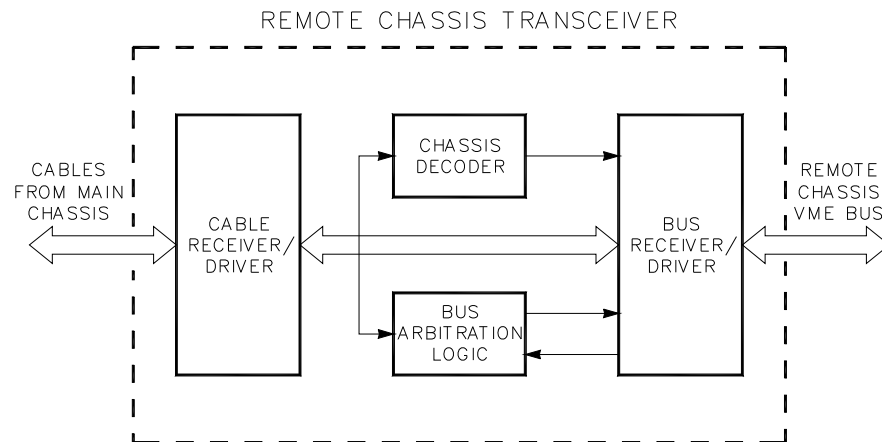
1. If the Main XCVR module is not functioning or not functioning properly, verify cable connections.
2. If the module is still not functioning properly after verifying the cable connections, replace the cables connecting to module.
3. If the module is still not functioning properly after replacing cables,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

## 7.3—Simplex Remote Transceiver (XCVR) Module

### 7.3.1—Module Description

The Remote XCVR module receives and sends control, data, and address information via cable to and from its associated Main XCVR module. This module must be used in each Remote I/O Chassis that is connected to the Main Chassis via copper cables.

The Remote XCVR module connects to the VME bus of the chassis. The bus receiver/driver of the Remote Transceiver module interfaces with the VME bus, exchanging control, data, and address information. The chassis decoder determines if this chassis is to be accessed, and if so, it activates the receiver/driver of this chassis' Remote Transceiver module to receive or send information. Figure 7-11 is a block diagram of the Remote Transceiver module.

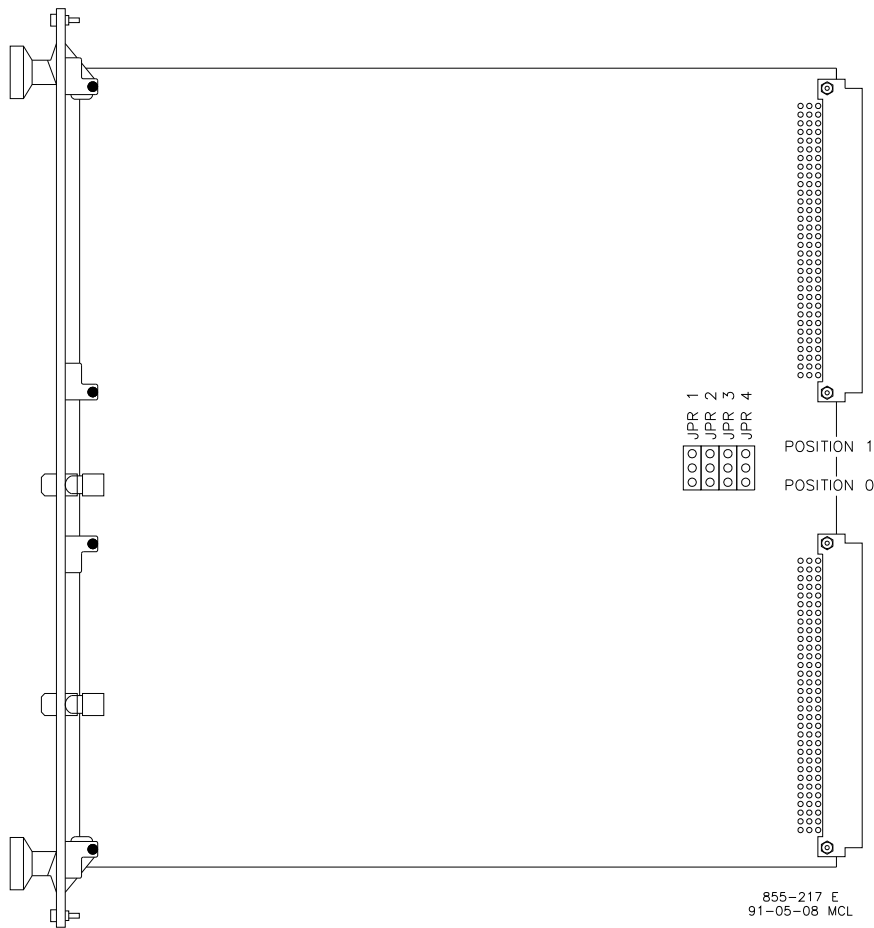


558-012  
91-04-12 MCL

Figure 7-13—Remote XCVR Module Block Diagram

The bus-arbitration logic determines priority of bus-access operations and controls the receiver/driver accordingly.

Table 7-4 shows the jumpers on the Remote XCVR module used to configure the chassis ID.



855-217 E  
91-05-08 MCL

Figure 7-14—Remote XCVR Module Jumpers

Table 7-4—Remote XCVR Module Jumpers (JPR1-4)

	JPR1	JPR2	JPR3	JPR4
<b>CHASSIS 1</b>	0	0	0	1
<b>CHASSIS 2</b>	0	0	1	0
<b>CHASSIS 3</b>	0	0	1	1
<b>CHASSIS 4</b>	0	1	0	0
<b>CHASSIS 5</b>	0	1	0	1
<b>CHASSIS 6</b>	0	1	1	0
<b>CHASSIS 7</b>	0	1	1	1
<b>CHASSIS 8</b>	1	0	0	0
<b>CHASSIS 9</b>	1	0	0	1
<b>CHASSIS 10</b>	1	0	1	0
<b>CHASSIS 11</b>	1	0	1	1
<b>CHASSIS 12</b>	1	1	0	0
<b>CHASSIS 13</b>	1	1	0	1
<b>CHASSIS 14</b>	1	1	1	0
<b>CHASSIS 15</b>	1	1	1	1



Figure 7-15—Remote XCVR Module

### 7.3.2—Module Specification

Parallel Interface:	High-speed, differential line drivers operating at VME transmission rate
Cable Interface:	100 pin metal shell Micro-D connector (2 per module)

### 7.3.3—Installation

- The Remote XCVR module has no switches or LEDs.
- All expansion chassis except for the last one in the chain should use the Remote XCVR module without termination resistors. This module must be installed in Slot 1.
- The last expansion chassis in the chain should use the Remote XCVR module with termination resistors. This module must be installed in Slot 1.

### 7.3.4—Troubleshooting

1. If the Remote XCVR 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.



## 7.4—Simplex Transceiver Accessories

### 7.4.1—Description

Each expansion chassis except the last one should have the T-Module mounted next to it. The 3-foot (0.9 m) cables should connect these expansion chassis to the T-Modules. Connections from the Main Chassis, the last Expansion Chassis, and connections between the T-Modules should be made with 10-foot (3 m) cables.

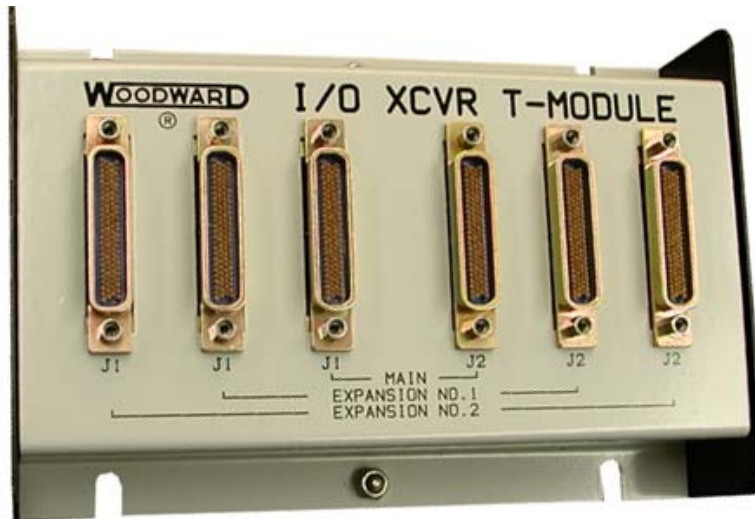


Figure 7-16—T-Module (I/O XCVR-Module)



Figure 7-17—Cables  
[Available in 3 ft. (0.9 m) and 10 ft. (3 m) lengths]

## 7.4.2—Module Specification

Parallel Interface:	High-speed, differential line drivers operating at VME transmission rate
Cable Interface:	100 pin metal shell Micro-D connector (2 per module)

## 7.4.3—Transceiver Accessories Installation (Outline)

### IMPORTANT

The Main and Remote Transceiver modules must be connected exactly as shown in the following diagrams (Figures 7-16 and 7-17). The following notes apply on these figures.

**Note 1:** The Main Transceiver module can be installed in any slot in the Main Chassis.

**Note 2:** All expansion chassis except for the last one in the chain should use the module without termination resistors. This module must be installed in Slot 1.

**Note 3:** The last expansion chassis in the chain should use the module with termination resistors. This module must be installed in Slot 1.

**Note 4:** All expansion chassis except the last one should have the T-Module mounted next to it. The three-foot (0.9 m) cables should connect these expansion chassis to the T-Modules. Connections from the Main Chassis, the last Expansion Chassis, and connections between the T-Modules should be made with ten-foot (3 m) cables.

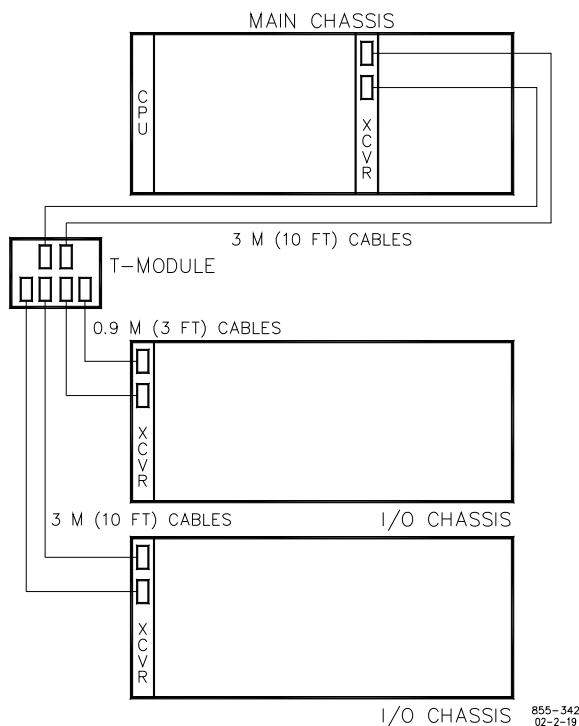


Figure 7-18—Expansion I/O Chassis

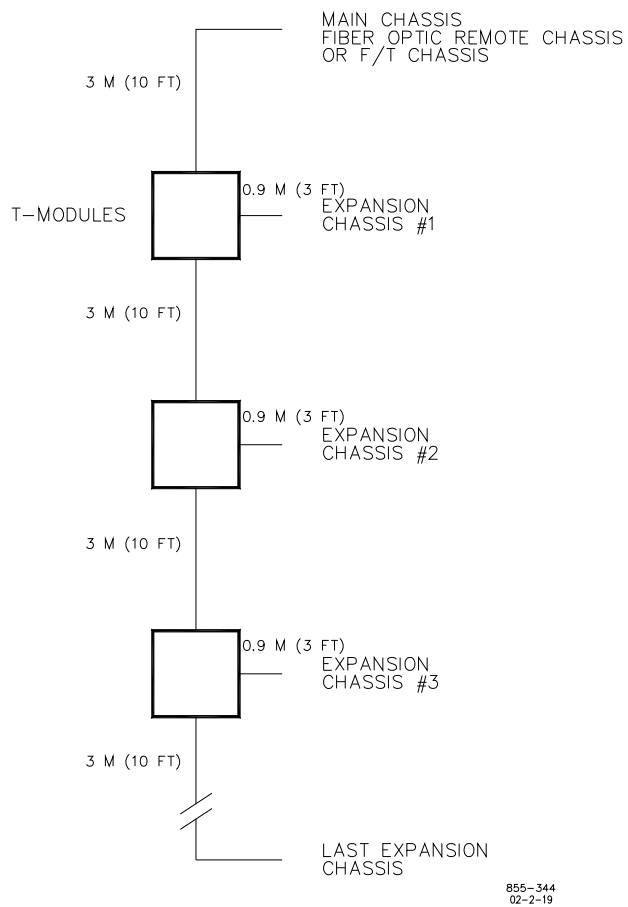


Figure 7-19—Termination

## 7.5—Ethernet Module

### 7.5.1—Module Description

The MicroNet Ethernet module is a 32 bit VME bus module which has been integrated into the MicroNet product family. The module is designed to fully support auto-switching 10/100 Base-TX Ethernet connections, but has been configured to operate at only 10 Mbps for use with legacy products.

The Ethernet module has a VME adapter board attached to allow its use in a MicroNet chassis. However, this module is not “hot swappable” due to signal integrity issues on the VME backplane. When inserted into a powered chassis, the module will interrupt VME bus backplane communications and cause other Woodward modules and expansion racks to shut down.

On power-up, the Ethernet board runs a series of self-tests that check the board hardware. After successful completion of the tests, the red FAIL LED will turn OFF. The self-tests may last 10–20 seconds.

**IMPORTANT**

Due to addressing conflicts with the Pentium CPU, this module can be used only with the Motorola CPU family.



Figure 7-20—Ethernet Module

### LED Annunciations

The following LEDs annunciate board failure as well as different functions related to Ethernet communications. When continuous communications are present, the RX and TX LEDs will be ON continuously.

Table 7-5—Ethernet Module LED Annunciations

LEDs	Name	LED Color	Description
	LINK	GREEN	Indicates the Ethernet connection is good.
	COL	RED	Indicates a collision on the Ethernet.
	100	GREEN	Indicates the Ethernet connection is functioning at 100 Mbps.
	RX	GREEN	Indicates data is being received.
	TX	GREEN	Indicates data is being received.
	FAIL	RED	Indicates a module reset or self-test failure.

### 10BaseT Ethernet

A 10BaseT RJ45 Ethernet connector is available for system use. This connection is used for control configuration, data gathering, and networking of multiple controls. In addition, this port may be relied upon for interfacing TCP/IP Distributed I/O devices into the control system.

To ensure signal integrity and robust operation of Ethernet devices, an Ethernet Interface FTM (Field Termination Module) is required when using this port. The FTM's primary function is to implement EMI shielding and cable shield termination of the Ethernet cable. Along with the Ethernet Interface FTM, double-shielded Ethernet cables (SSTP) are required. See the Ethernet Interface FTM section below for more details.

## 7.5.2—Module Specifications

### Ethernet Features

- Industry Standard 6U, VME-32 format
- Network interface conforming to the IEEE 802.3 standard
- Configured for 10BaseT communication support
- Module failure/reset, Link LED, Transmit, Receive, Collision, and 10/100 Mbps LEDs
- Supports Woodward communications such as Modbus, GAP Download, and Tunable Capture/Download.

### Electrical Specifications

Voltage:	5.0 Vdc, 5% tolerance
Power:	15.0 W max (13.5 W typical)
Processor:	PowerPC 750, 400 MHz
Memory:	64 MB DRAM, 2 MB boot flash, 32 MB user flash
Bus Interface:	32 bit VME bus
On board I/O:	RJ45 10 Mbps Ethernet port
Hardware Configuration:	VME address #1 or #2 configuration for using 2 modules in a system

## 7.5.3—Installation

### VME Address Configuration

The Ethernet module can be configured for an alternate VME address to support the use of two modules in a MicroNet system. For dual module operation, both the Woodward GAP and the module DIP switch must be configured properly.

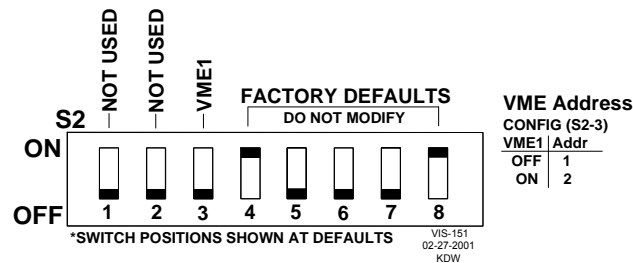
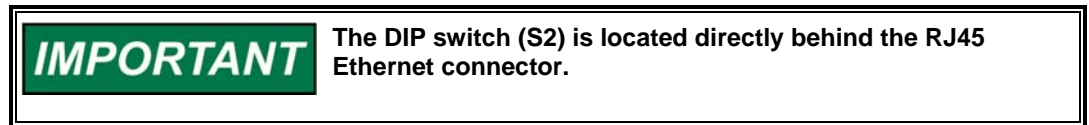
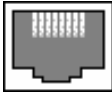


Figure 7-21—VME Address Configuration

Table 7-6— RJ45 Ethernet Pinout

Connector	Signal Mnemonic
RJ45 female 1 8 	Shielded RJ45 female receptacle
1	TX+
2	TX-
3	RX+
4	---
5	---
6	RX-
7	---
8	---
Shield	Chassis GND

### 7.5.4—FTM Reference

#### Ethernet Interface FTM

To ensure signal integrity and robust operation of Ethernet devices, an Ethernet Interface FTM (Field Termination Module) is required when interfacing Ethernet devices to the CPU. The FTM's primary function is to implement EMI shielding and cable shield termination of the Ethernet cable. Along with this FTM, double shielded Ethernet cables (SSTP) are required.

Please see Chapter 13 for the Ethernet Interface FTM specifications and wiring information.

### 7.5.5—Ethernet Module System Requirements

- The Ethernet module is only for use with the Motorola x040/060 CPUs and cannot be used with the Pentium CPU.
- System wiring requires using the Ethernet Interface FTM.
- System wiring requires using shielded RJ45 Ethernet cables (for part numbers, see Appendix A):
  - double shielded Cat-5 Ethernet cable (SSTP), 1.5 ft. (457 mm)
  - double shielded Cat-5 Ethernet cable (SSTP), 3 ft. (914 mm)
  - double shielded Cat-5 Ethernet cable (SSTP), 7 ft. (2.1 m)
  - double shielded Cat-5 Ethernet cable (SSTP), 10 ft. (3.0 m)
  - double shielded Cat-5 Ethernet cable (SSTP), 14 ft. (4.3 m)
  - double shielded Cat-5 Ethernet cable (SSTP), 25 ft. (7.6 m)
  - double shielded Cat-5 Ethernet cable (SSTP), 50 ft. (15 m)
  - double shielded Cat-5 Ethernet cable (SSTP), 100 ft. (30 m)

### 7.5.6—Troubleshooting

1. If the Ethernet 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.

## 7.6—SIO Module

### 7.6.1—Module Description

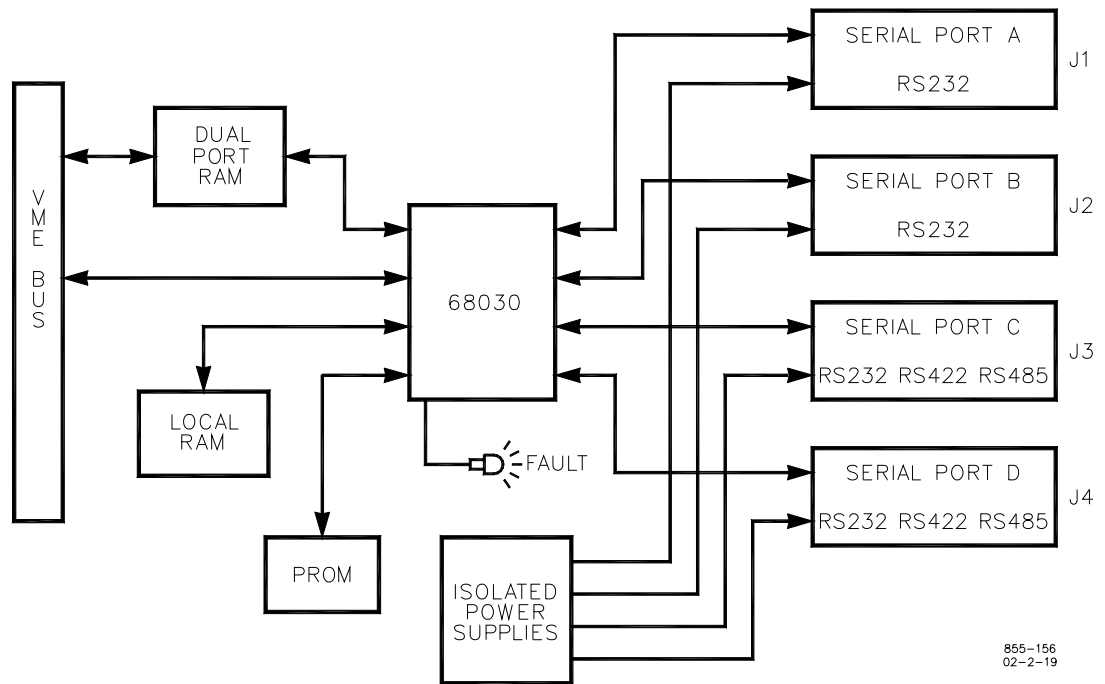
The SIO (Serial In/Out) Module interfaces four serial communication ports to the VME bus.

Figure 7-19 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 kBd or 57.6 kBd.

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.



855-156  
02-2-19

Figure 7-23—SIO Module Block Diagram





Figure 7-24—SIO Module

### 7.6.2—Module Specification

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

### 7.6.3—Installation

#### 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 7-21 is an example.

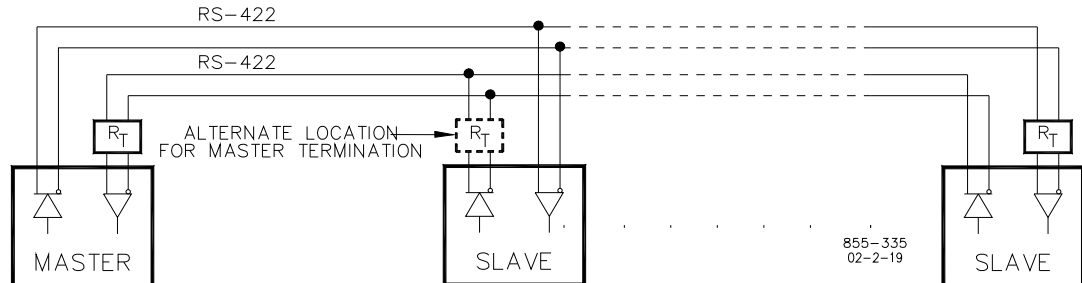


Figure 7-25—RS-422 Terminator Locations

For RS-485, termination should be at each end of the cable. If termination can't be located at the end of a cable, put it as close as possible to the ends. Figure 5-17 is an example.

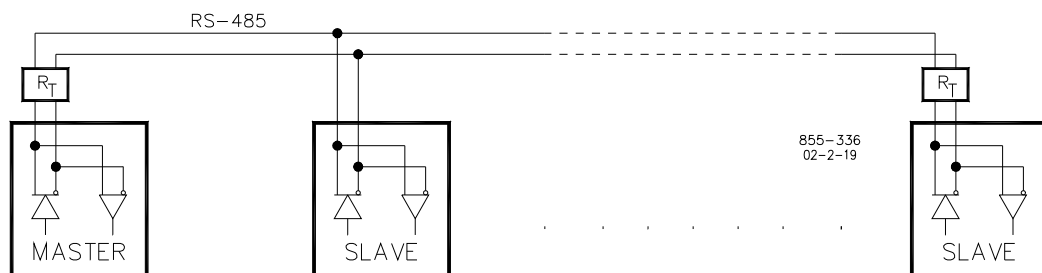


Figure 7-26—RS-485 Terminator Locations

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  $\Omega$ . 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 7-23 for termination and cable connection examples.

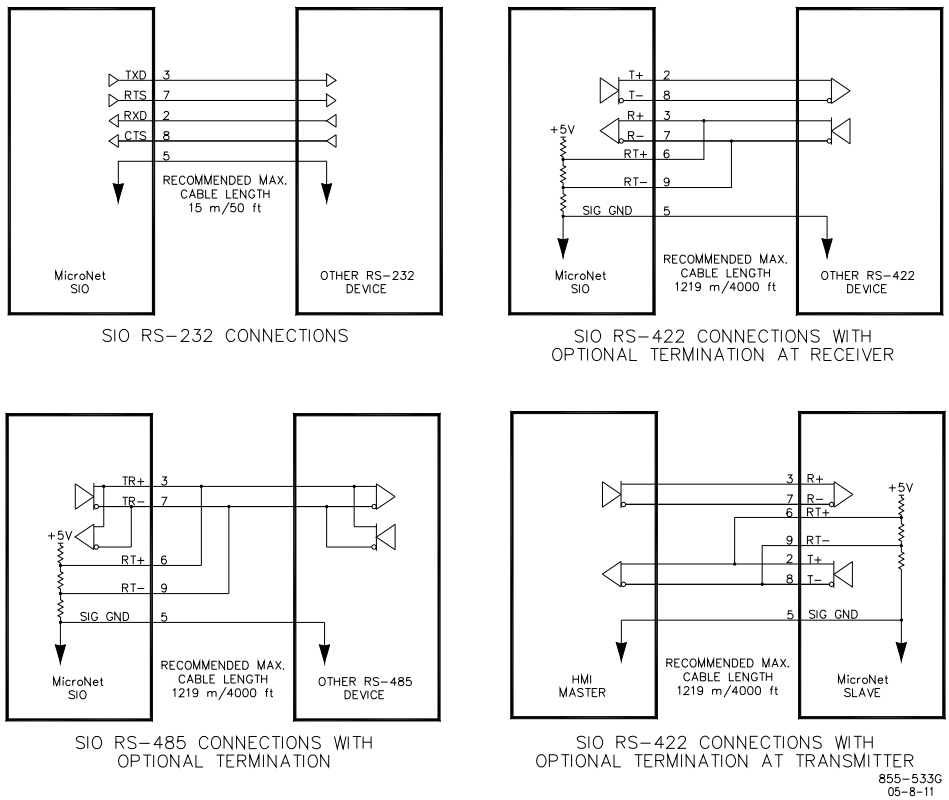


Figure 7-27—Termination and Cable Connection Examples

### 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 7-24 and 7-25 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 7-24 with the signal ground connection removed on those nodes only.

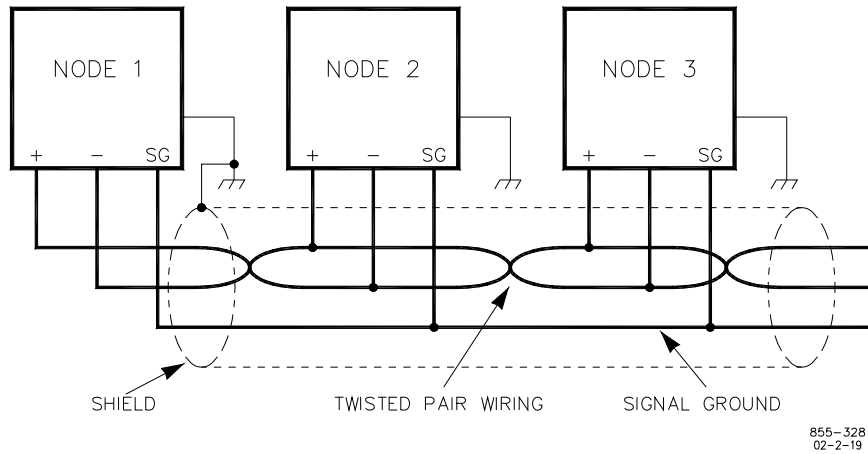


Figure 7-28—Preferred Multipoint Wiring Using Shielded Twisted-Pair Cable with a Separate Signal Ground Wire

**IMPORTANT**

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

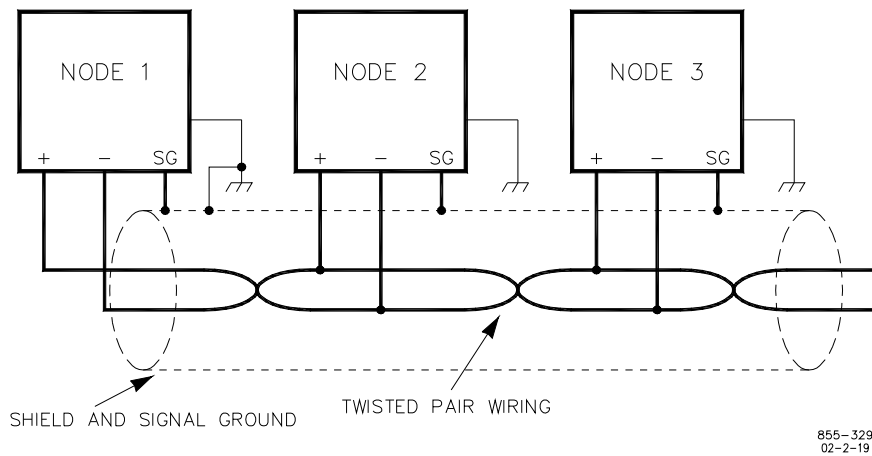


Figure 7-29—Alternate Multipoint Wiring Using Shielded Twisted-Pair Cable without a Separate Signal Ground Wire

### 7.6.4—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 8. Discrete I/O Modules

### 8.1—Introduction

There are five types of discrete I/O modules currently available with the MicroNet system. These include two types of 48/24 Discrete Combo module (48 discrete inputs, 24 discrete outputs), 48Ch DI module, 32Ch DO module, and the 64Ch DO module.

Discrete I/O field wiring requirements are detailed in Chapters 13 and 15.

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 where 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 cable ways, 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 and wetting voltage common wires with signal wires and 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.

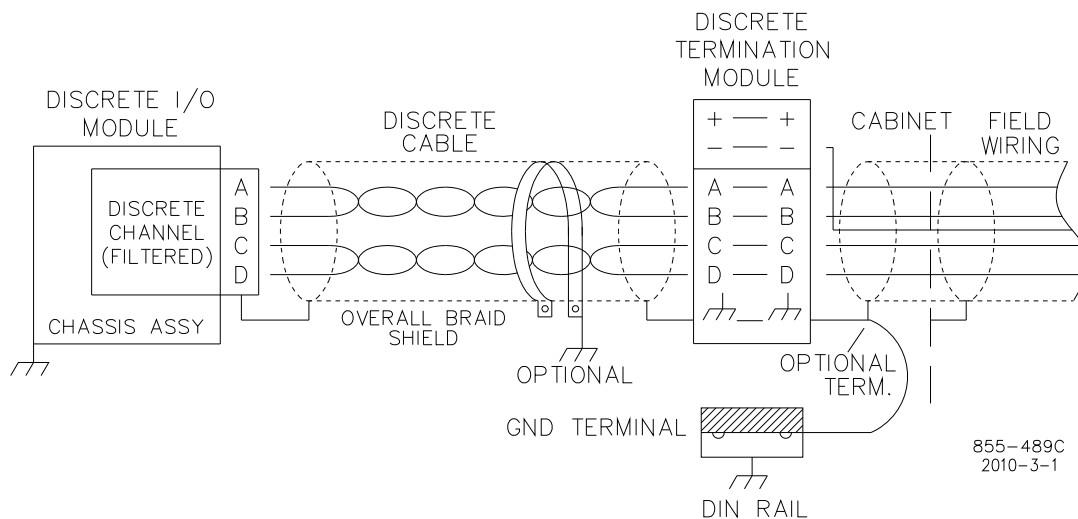


Figure 8-1—DI/DO Field Wire Shielding Example (Non-Marine)

## 8.2—MicroNet Discrete I/O Smart-Plus Module (HDDIO)

### 8.2.1—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 Figures 8-3 and 8-7 for examples of configurations.



Figure 8-2—Discrete Combo Module (HDDIO)

## 8.2.2—Module Specification

### Discrete Inputs

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

### 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 $\mu$ s resolution
Isolated 24 Vdc contact supply:	400 mA maximum

For the 24/12 Discrete FTM input specifications, see Chapter 13.

### 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 13.

**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.

## 8.2.3—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.

### 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.

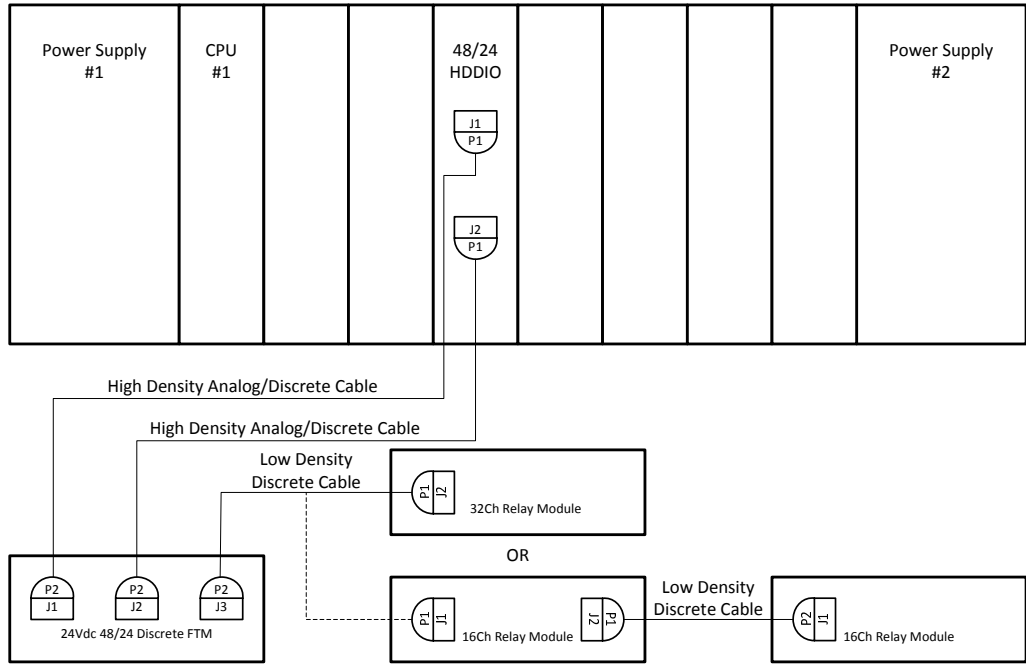
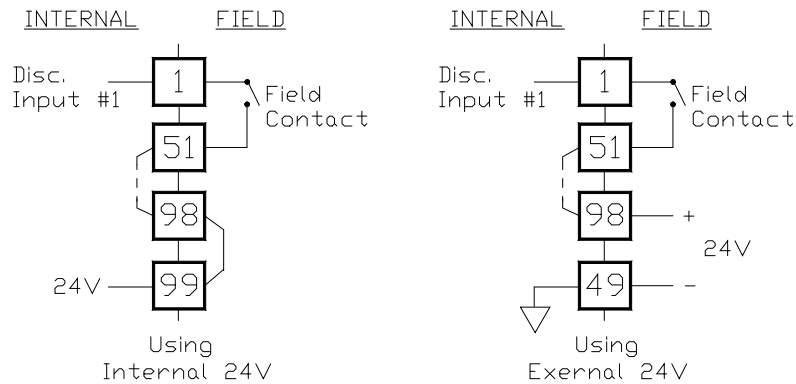


Figure 8-3—Configuration 1, One 48/24 Discrete FTM with Relay Module(s)

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 source 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.



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Figure 8-4—Discrete Input Interface Wiring to a 24 Vdc 48/24 Discrete FTM



**Configuration Notes:**

- Refer to Chapter 13 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  $100 \div V$ , 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 13 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 8-1—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 13 for field wiring of discrete output relays.

Figures 8-5 and 8-6 illustrate examples of different discrete output wiring configurations.

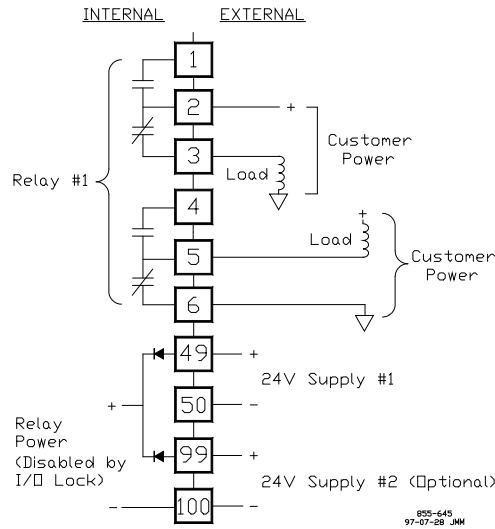


Figure 8-5—Relay Output Interface Wiring to a 16Ch Relay Module

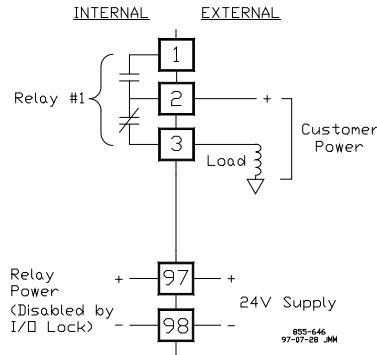


Figure 8-6—Relay Output Interface Wiring to a 32Ch Relay Module

**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.

**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.

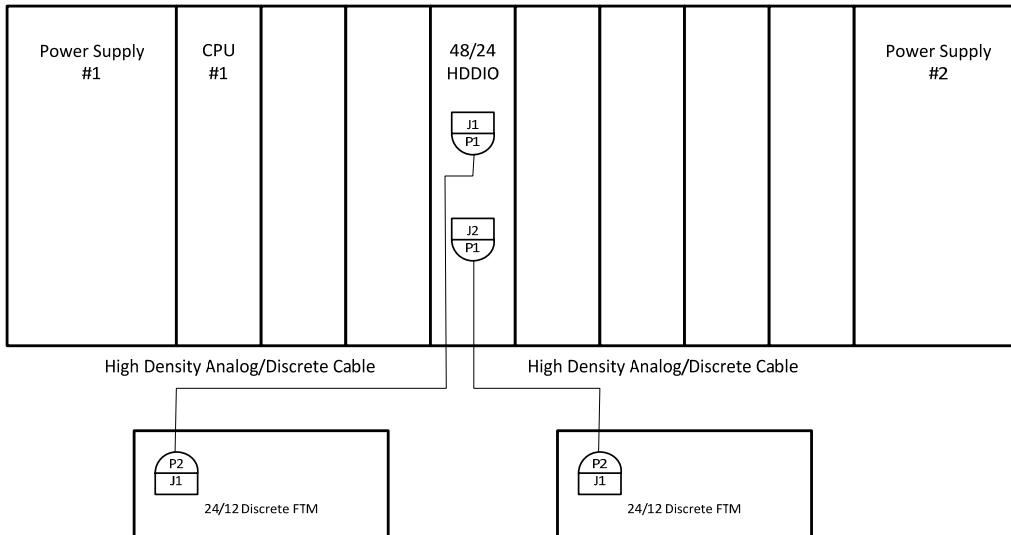


Figure 8-7—Configuration 2, Two 24/12 Discrete FTMs

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 13.

**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).

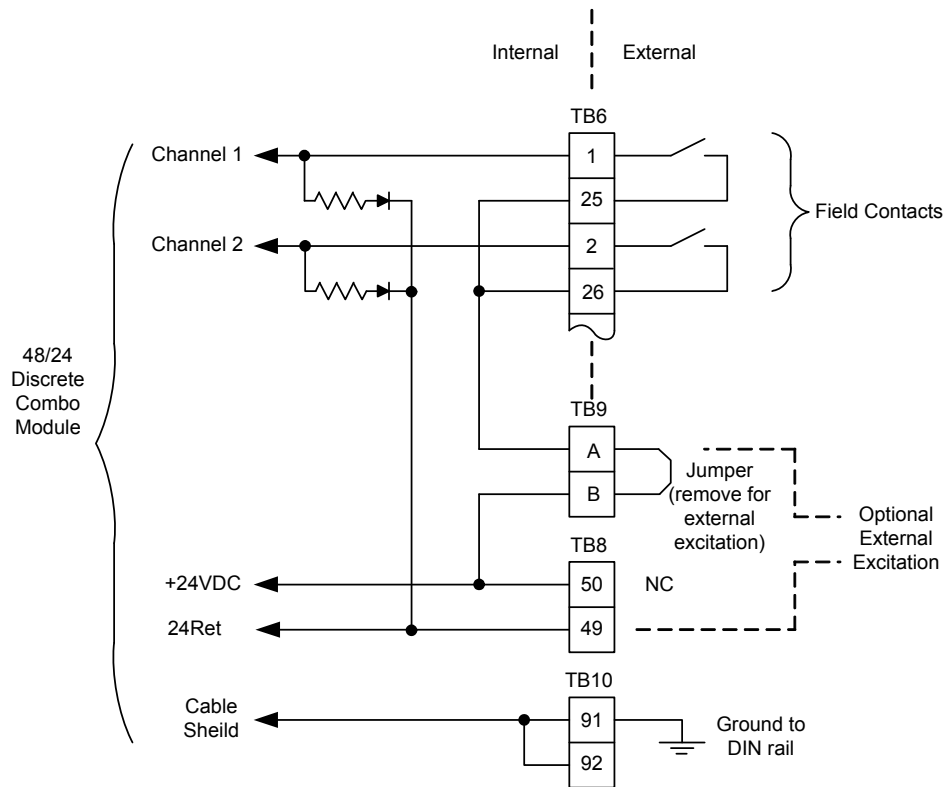


Figure 8-8—Discrete Input Interface Wiring to a 24/12 Discrete FTM

**Configuration Notes:**

- Refer to Chapter 13 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 8-8).
- If an external 24 Vdc is used, the common for the external 24 Vdc must be tied to the discrete input common (see Figure 8-8). 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 13 for field wiring of discrete output relays. Figure 8-9 illustrates an example of a discrete output wiring configuration.

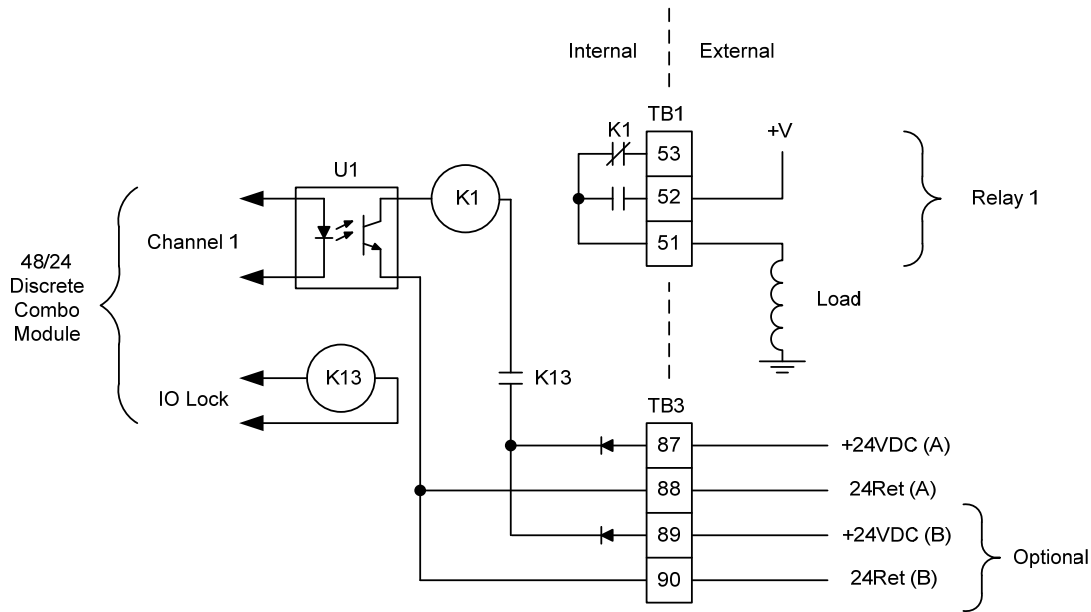


Figure 8-9—Relay Output Interface Wiring to a 24/12 Discrete FTM

**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.

**8.2.4—FTM Reference**

See Chapter 13 for detailed wiring of FTMs. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

### 8.2.5—Troubleshooting

#### 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 8-2—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 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.

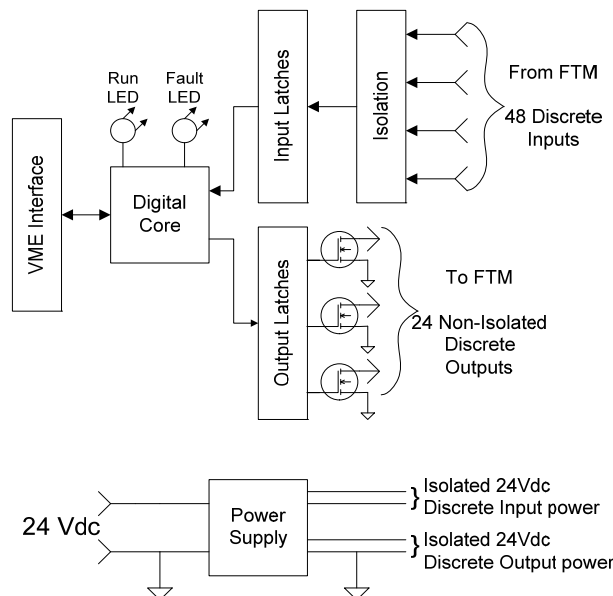


Figure 8-10—48/24 Discrete Combo Module Block Diagram

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.

### 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.
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 48/24 Discrete Combo module.
5. If the readings are incorrect on several channels of the 48/24 Discrete Combo module, corresponding to both cables, replace the 48/24 Discrete Combo 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.

### 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 48/24 Discrete Combo 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.

## 8.3—48/24 Discrete Combo Module (HDD)

### 8.3.1—Module Description

A 48/24 Discrete Combo module contains circuitry for forty-eight discrete inputs and twenty-four discrete 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. There are two different FTM I/O configurations for the 48/24 Discrete Combo Module.

Configuration 1 consists of one 48/24 Discrete FTM connected to the 48/24 Discrete Combo 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 48/24 Discrete Combo module via two High Density Analog/Discrete cables.

The discrete inputs are optically isolated and accessible through either the 48/24 Discrete FTM or the 24/12 Discrete FTM depending on the configuration. The discrete outputs are accessible through either the 24/12 Discrete FTM or the two 16Ch Relay Modules or the one 32Ch Relay Module when so configured. See Figures 8-12 and 8-17 for examples of configurations.



Figure 8-11—Discrete Combo Module



### 8.3.2—Module Specification

#### Discrete Inputs

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

#### 48/24 Discrete FTM

Input thresholds:	
Low voltage:	< 8 Vdc at 1.5 mA = "OFF" > 16 Vdc at 3 mA = "ON"
High voltage:	< 29 Vdc at 1.8 mA = "OFF" > 67 Vdc at 4 mA = "ON"
Input current:	4 mA @ 24 Vdc; 2.6–5 mA @ 125 Vdc
External input voltage:	18–32 Vdc (UL and LVD), or 100–150 Vdc (UL) w/ high Voltage FTM
Isolation voltage:	500 Vdc to earth ground, 1000 Vdc to control common
Time stamping:	1 ms resolution
Isolated 24 Vdc contact supply:	400 mA maximum

**Note:** For the 24/12 Discrete FTM input specifications, see Chapter 13.

#### 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 13.

### 8.3.3—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 48/12 Discrete Combo Module.

#### Configuration 1

Configuration 1 consists of one 24 Vdc or 125 Vdc 48/24 Discrete FTM connected to the 48/24 Discrete Combo module via two High Density Analog/Discrete cables. The top connector on the 48/24 Discrete Combo module, which is labeled J1, connects to J1 on the 48/24 Discrete FTM, and J2 connects to J2. There are two versions of the FTM, one for 24 Vdc inputs, and one for 125 Vdc inputs. The LVD applies only to the 24 Vdc version. The 24 Vdc 48/24 Discrete FTM handles 24 Vdc input signals and the 125 Vdc 48/24 Discrete FTM handles 125 Vdc input signals. Either 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 8-12 for an example of configuration.

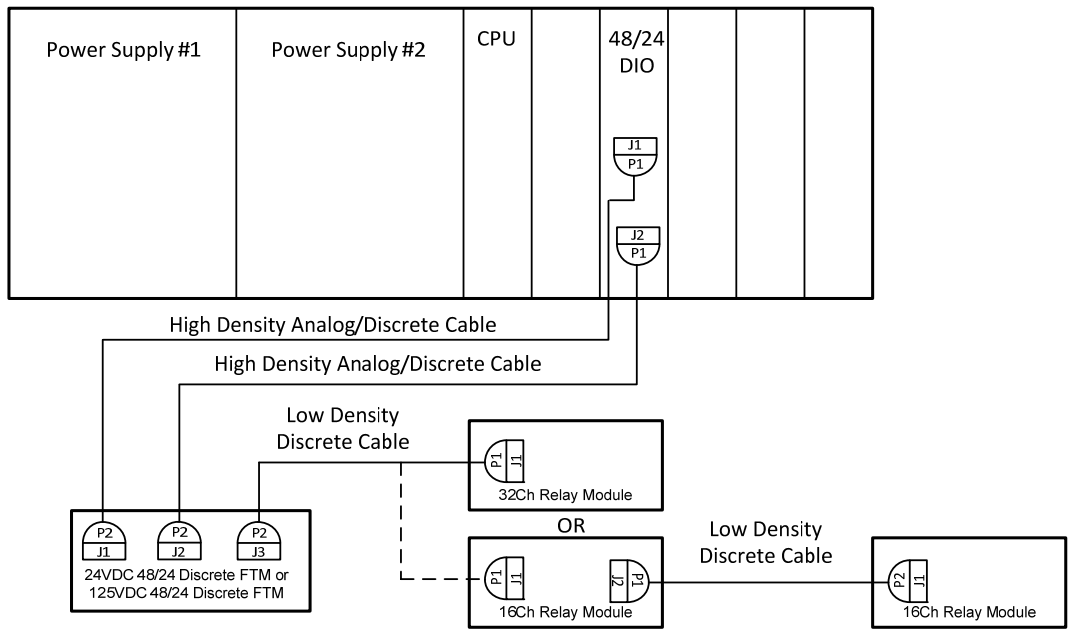


Figure 8-12—Configuration 1, One 48/24 Discrete FTM with Relay Module(s)

All of the discrete inputs on the module are accessible on the 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 48/24 Discrete Combo module accepts 48 contact inputs. The 48/24 Discrete FTM may supply contact wetting voltage. Optionally, an external 18–32 Vdc power source or an external 100–150 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 98 and 99. If an external power source is used for contact wetting, the external source common must be connected to the FTM’s discrete input common, terminal 49. If 125 Vdc contact inputs are needed, the High Voltage (125 Vdc) FTM must be used. The FTM provides a common cage-clamp terminal connection for customer field wiring. Figures 8-13 and 8-14 illustrate different discrete input wiring configurations based on the input voltage.

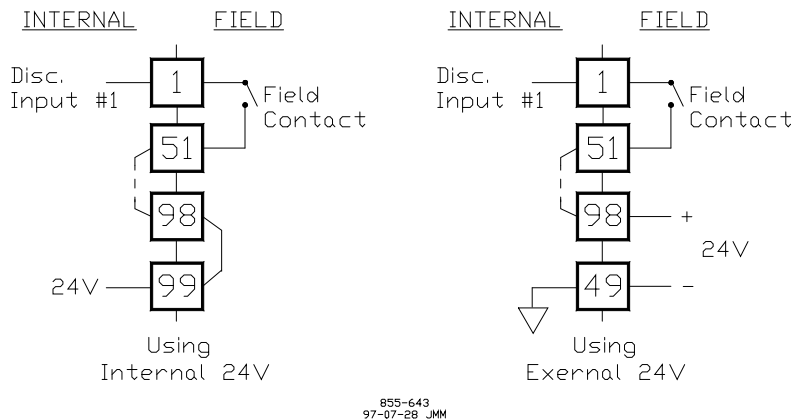


Figure 8-13—Discrete Input Interface Wiring to a 24 Vdc 48/24 Discrete FTM

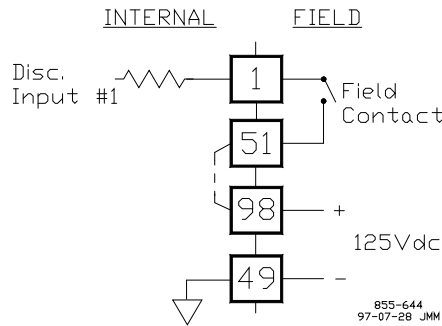


Figure 8-14—Discrete Input Interface Wiring to a 125 Vdc 48/24 Discrete FTM



## WARNING

**HIGH VOLTAGE**—If the high voltage FTM is being used, and there is 125 Vdc on the FTM terminal blocks, there will be 125 Vdc on the FTM sub D connectors and on the cable when it is connected to the FTM. For this reason, any power should be removed from the FTM terminal blocks before installing the 48/24 Discrete Combo module or the FTM.

### Configuration Notes:

- Refer to Chapter 13 for Discrete Input wiring.
- Each 48/24 Discrete I/O module can only accept one input voltage range, 24 Vdc (LVD and UL) or 125 Vdc (UL only).
- 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 8-13).
- 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 8-13). 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  $100 \div V$ , where V is the supply's rated voltage or 5 A, whichever is less).
- High Voltage FTM only—The common for the 125 Vdc must be tied to the discrete input common (see Figure 8-14).

### 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 13 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 8-3). 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 8-3—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

**Note:** See Chapter 13 for field wiring of discrete output relays.

Figures 8-15 and 8-16 illustrate examples of different discrete output wiring configurations.

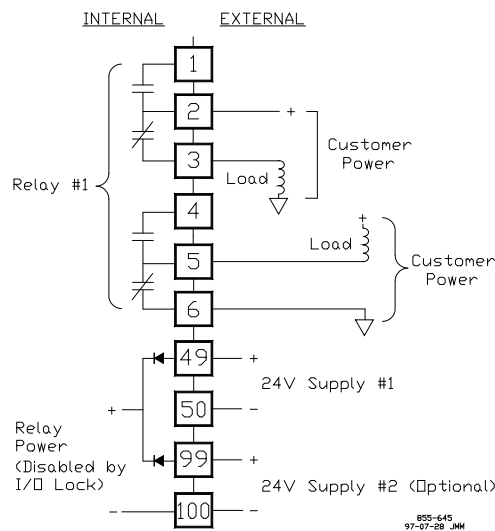


Figure 8-15—Relay Output Interface Wiring to a 16Ch Relay Module

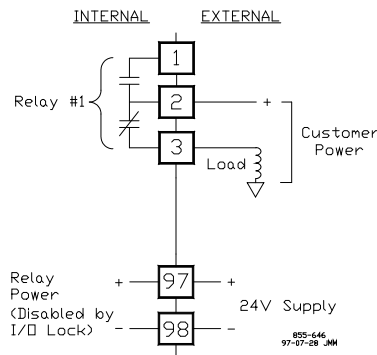


Figure 8-16—Relay Output Interface Wiring to a 32Ch Relay Module

## 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.

## Configuration 2

Configuration 2 consist of two 24/12 Discrete FTMs (DIN rail mounted) connected to the 48/24 Discrete Combo module via two High Density Analog/Discrete cables. See Figure 8-17 for an example of configuration.

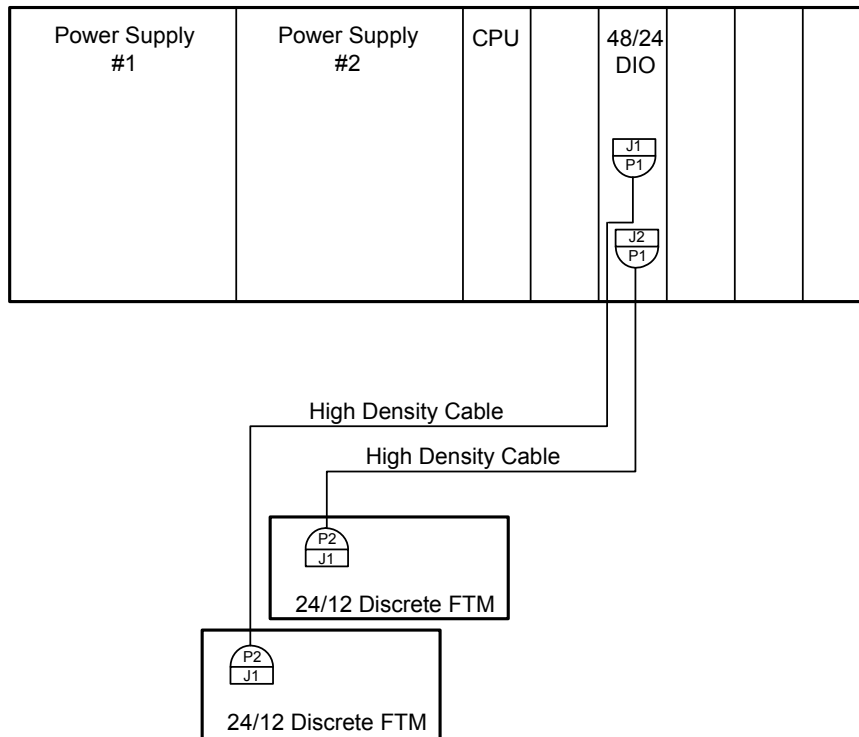


Figure 8-17—Configuration 2, Two 24/12 Discrete FTMs

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 13.

## 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 8-18).

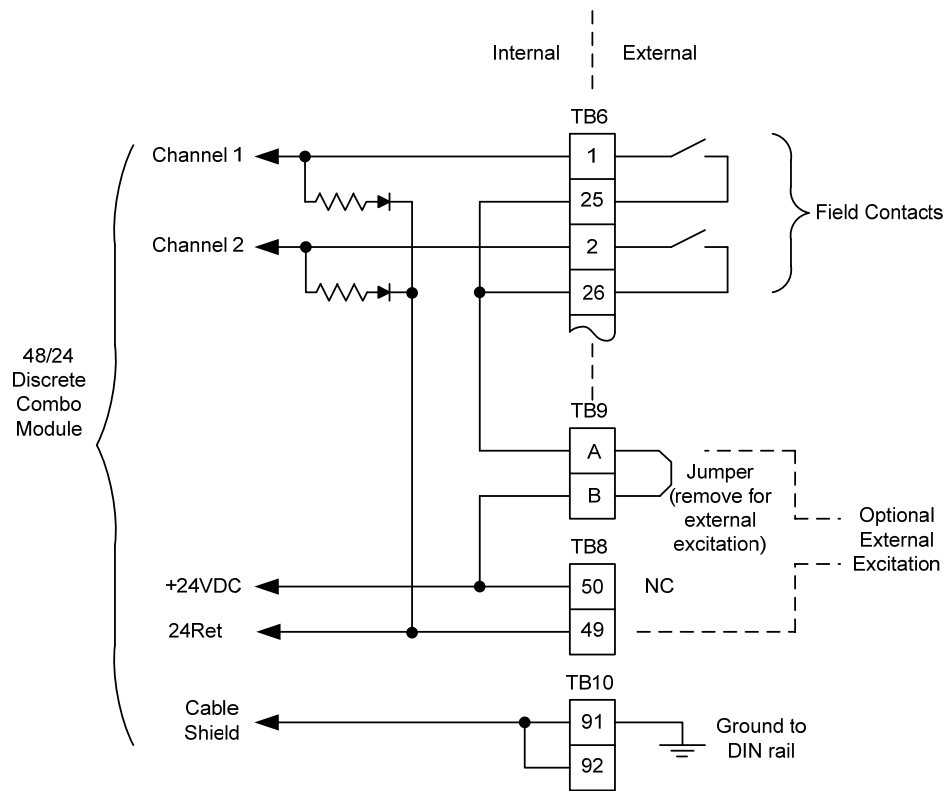


Figure 8-18—Discrete Input Interface Wiring to a 24/12 Discrete FTM

**Configuration Notes:**

- Refer to Chapter 13 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 8-18).
- If an external 24 Vdc is used, the common for the external 24 Vdc must be tied to the discrete input common (see Figure 8-18). 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 48/24 Discrete I/O module are non-isolated; the isolation takes place in the 24/12 Discrete FTM. See Chapter 13 for field wiring of discrete output relays. Figure 8-19 illustrates an example of a discrete output wiring configuration.

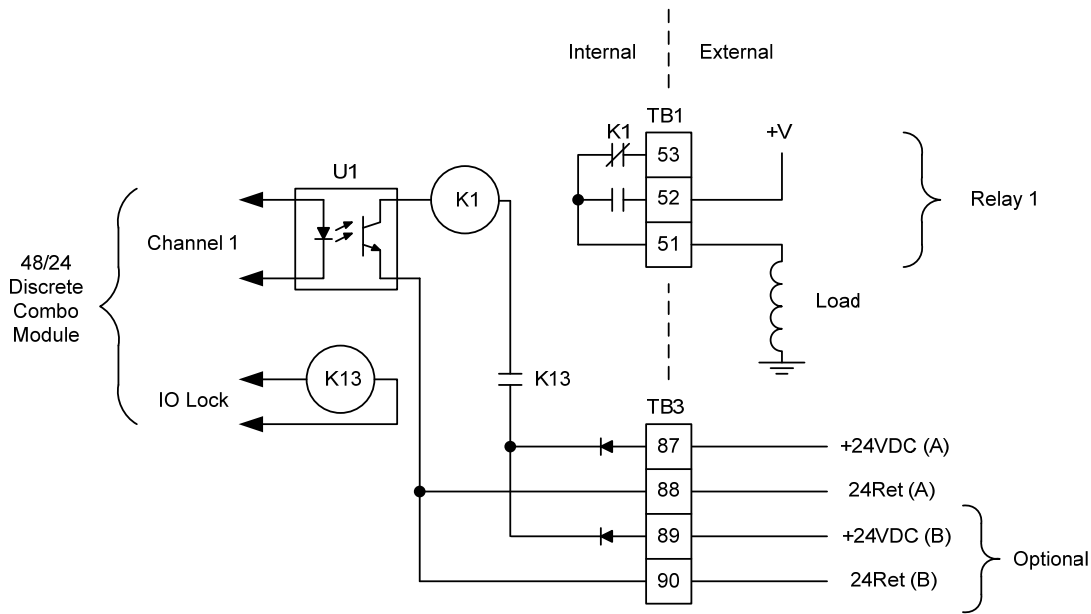


Figure 8-19—Relay Output Interface Wiring to a 24/12 Discrete FTM

**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.

**8.3.4—FTM Reference**

See Chapter 13 for detailed wiring of FTMs. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

### 8.3.5—Troubleshooting

#### Fault Detection (Module Hardware)

Each 48/24 Discrete Combo module has a red Fault LED that is turned on when the system is reset. During initialization of a 48/24 Discrete Combo module, which occurs after every CPU reset, the CPU turns the Fault LED on. The CPU then tests each 48/24 Discrete Combo 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 48/24 Discrete Combo 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
2	Micro-controller internal RAM test failure
3	External RAM high and low byte test failure
4	External RAM low byte failure
5	External RAM high byte failure
6	EEPROM failure
7	Software not running
8	System monitor fault
9	MFT pulses missing

#### Fault Detection (I/O)

In addition to detecting 48/24 Discrete I/O 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.

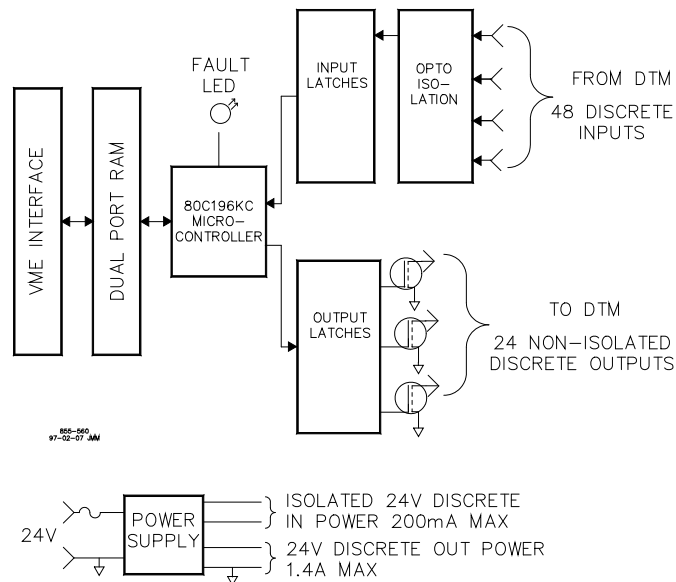


Figure 8-20—48/24 Discrete Combo Module Block Diagram



If during normal control operation all of a chassis' 48/24 Discrete Combo modules have Fault LEDs on, check the chassis' CPU module for a failure. If during normal control operation only the 48/24 Discrete Combo module's Fault LED is on or flashing, insure that it is installed in the correct slot. If it is, then replace that 48/24 Discrete Combo module. When a 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:

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. If the other channels on the 48/24 Discrete Combo module are not working either, check the fuse on the 48/24 Discrete Combo 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 48/24 Discrete Combo module.
6. If the readings are incorrect on several channels of the 48/24 Discrete Combo module, corresponding to both cables, replace the 48/24 Discrete Combo module.
7. If replacing the module does not fix the problem, replace the FTM. See the instructions in Chapter 15, Installation, for replacing the FTM.

### 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. If the other output channels on the 48/24 Discrete Combo module are not working either, check the fuse on the 48/24 Discrete Combo 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.
4. Check the software configuration to ensure that the output is configured properly.
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, exchange the cables at the FTM, so J1 is driving J2 and vice versa. If the problem moves to a different relay, replace the 48/24 Discrete Combo 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.

## 8.4—48 Channel Discrete Input Module

### 8.4.1—Module Description

Each 48 Channel Discrete Input (48Ch 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 48Ch DI Module; the 24 Vdc Discrete Input/Output FTM and the Discrete Input (With LEDs) FTM (see Chapter 13 for additional information on this FTM module). The 24 Vdc Discrete Input/Output FTM doesn't 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 8-21—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 48Ch DI Module of the same part number without any adjustment.

### 8.4.2—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

### 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.

Each 48Ch 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 8-22 for system installation configuration.

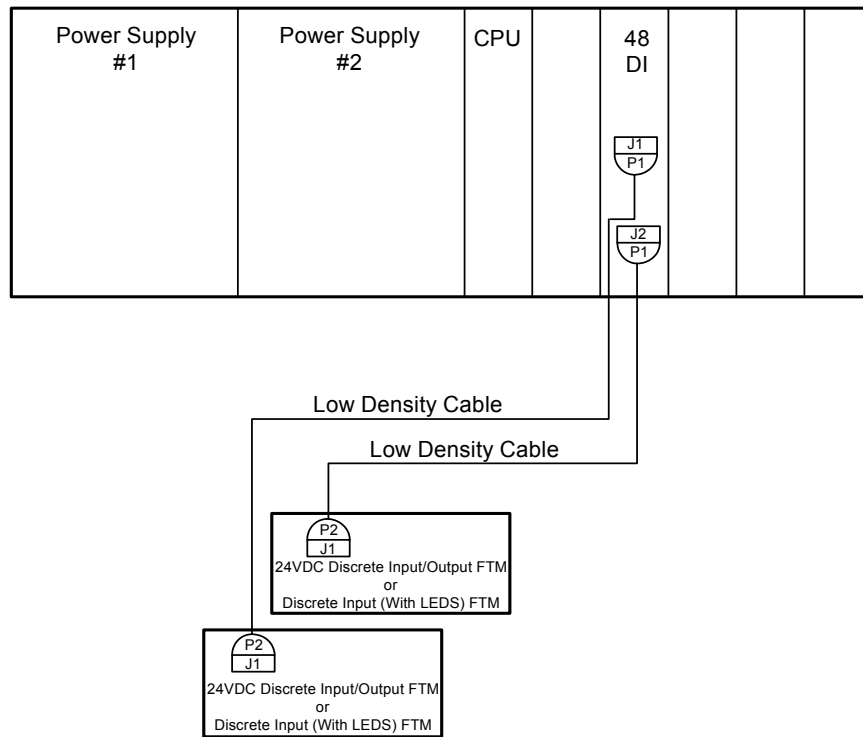


Figure 8-22—48Ch DI Module with two FTMs

Each 48Ch DI Module accepts 48 contact inputs. Contact wetting voltage may be supplied by the 48Ch 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 8-23 and 8-24 illustrate different discrete input wiring configurations based on internal or external power source.

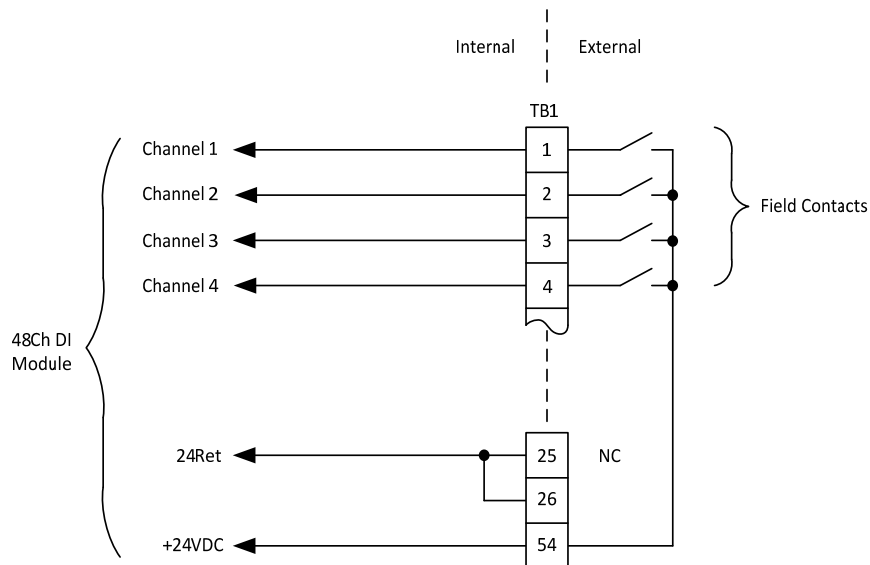


Figure 8-23—Discrete Input Interface Wiring with Internal Power Source to a 24 Vdc Discrete Input/Output FTM

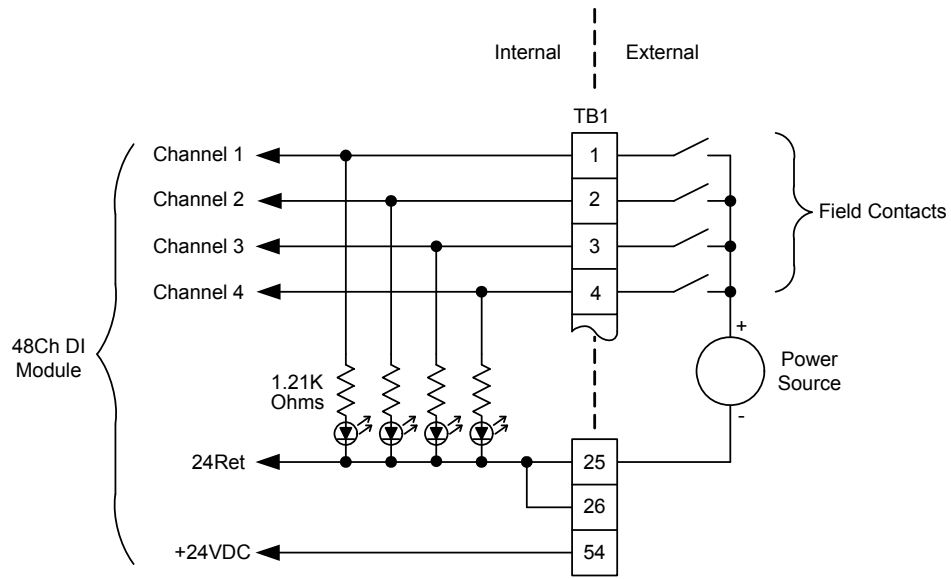


Figure 8-24—Discrete Input Interface Wiring with External Power Source to a Discrete Input (with LEDs) FTM

**Configuration Notes:**

- Refer to Chapter 13 for Discrete Input wiring.
- All contact inputs accept dry contacts.

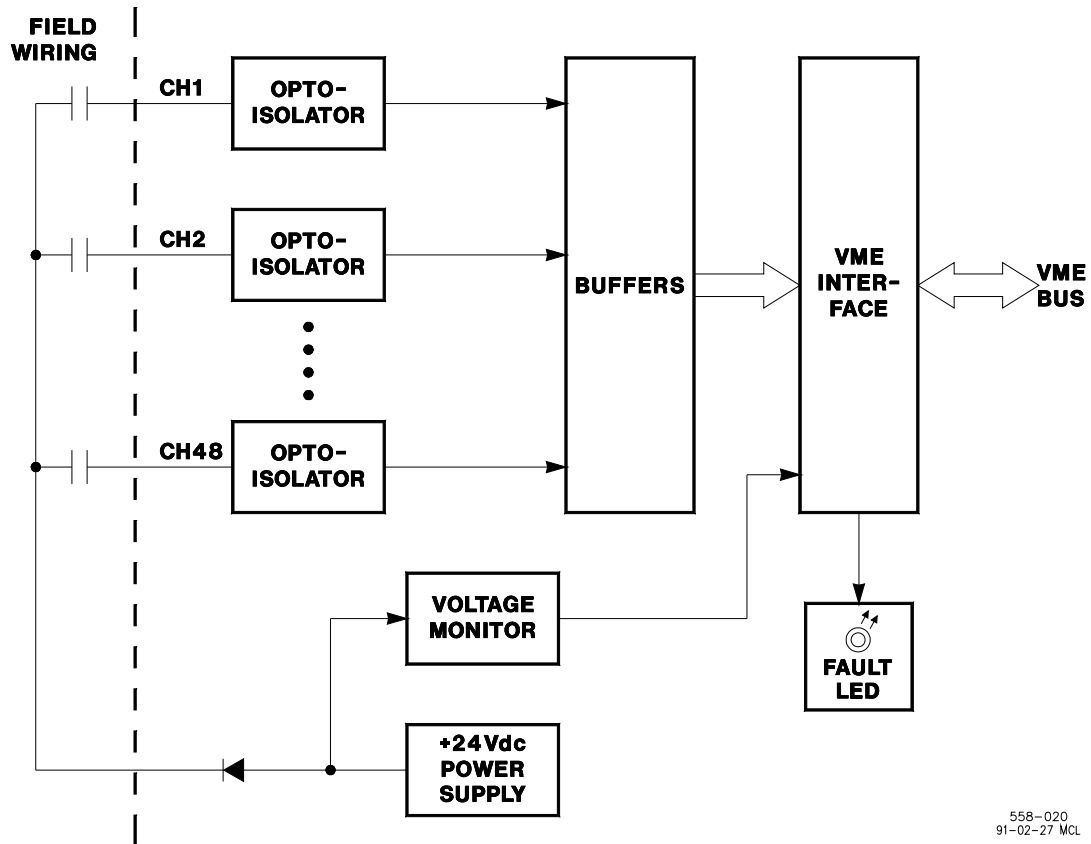
**8.4.4—FTM Reference**

See Chapter 13 for detailed wiring of FTMs. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

## 8.4.5—Troubleshooting

### Fault Detection (Module Hardware)

Each 48Ch DI module has a red Fault LED that is turned on when the system is reset. During initialization of a 48Ch 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.



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Figure 8-25—Discrete Input Module Block Diagram

Figure 8-25 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.

## 8.5—32 Channel Discrete Output Module

### 8.5.1—Module Description

The MicroNet control can provide discrete outputs to the prime mover from field wiring. Each Discrete Output (DO) module can individually control 32 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 two different FTM I/O configurations for the 32Ch DO Module. The module can be connected to one 32Ch Relay Module or two 16Ch Relay Modules (see Chapter 13 for additional information on the relay modules).

### 8.5.2—Module Specification

Number of channels:	32
Update time:	5 ms
Output Type:	Open drain drivers, intended for use with Woodward relay interface modules.
Fault Detection Read back:	Output channel status, relay status is not available
System Faults:	Outputs are turned off if communications with the CPU is lost.

For the 16Ch Relay Module and the 32Ch Relay Module output specifications, see Chapter 13.





Figure 8-26—Discrete Output Module

### 8.5.3—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 32 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 32Ch DO Module is connected through one low density discrete cable to a 32Ch Relay module or a 16Ch Relay module daisy chained to a second 16Ch Relay module with another low density cable. See Figure 8-27 for system installation configuration.

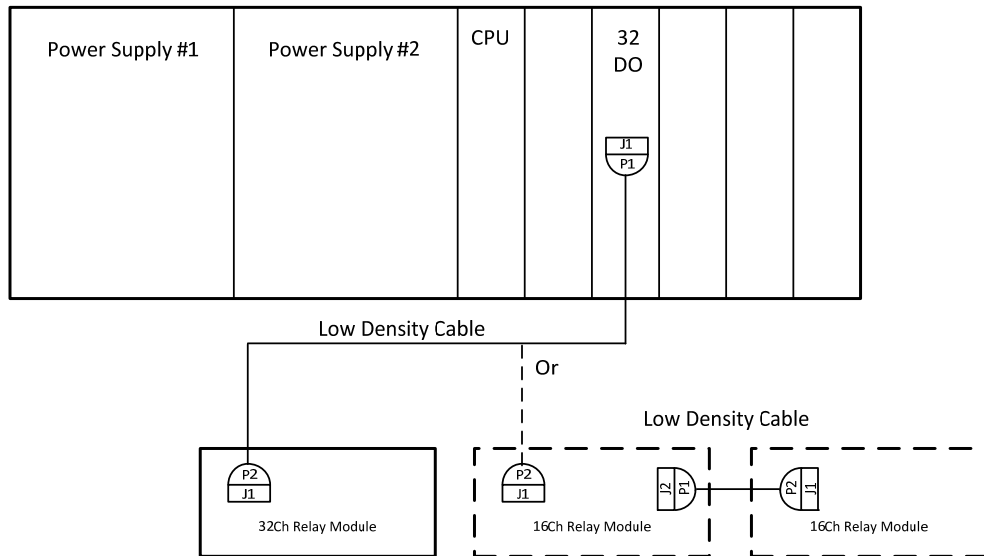


Figure 8-27—32Ch DO Module with Relay Modules

See Chapter 13 for field wiring of discrete output relays.

Figures 8-28 and 8-29 illustrate examples different discrete output wiring configurations.

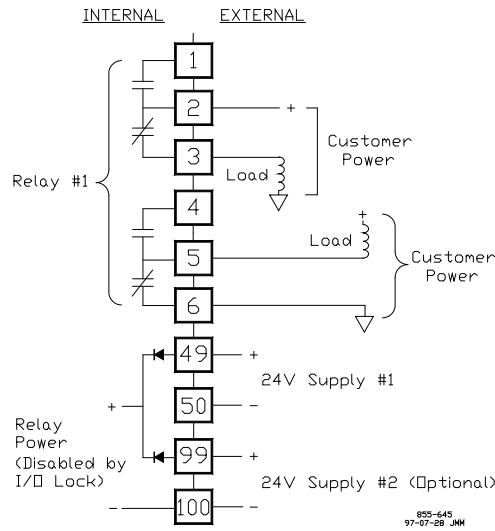


Figure 8-28—Relay Output Interface Wiring to a 16Ch Relay Module

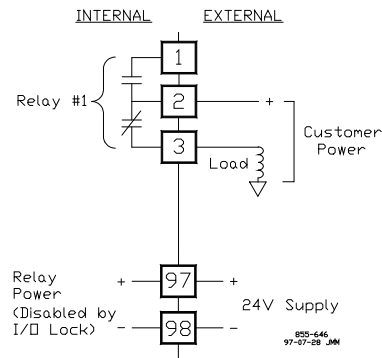


Figure 8-29—Relay Output Interface Wiring to a 32Ch Relay Module

### 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.

### 8.5.4—FTM Reference

See Chapter 13 for detailed wiring of relay modules. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

### 8.5.5—Troubleshooting

Figure 8-30 is a block diagram of the 32-Channel Discrete Output module. The CPU sends the address of this module and the address and state of the channel to be output to this module. This information is received by the VME interface and passed to the latches. The latch associated with the channel to be output stores the information and passes it to the drivers. The driver for that channel then energizes or de-energizes the relay for that channel.

Each channel has a read back buffer that indicates the status of the output driver (not the relay). The CPU compares this status to the value written to the channel and generates a fault signal if these two values are different. The relay module power is turned off if communications with the CPU are lost or a fault is detected.

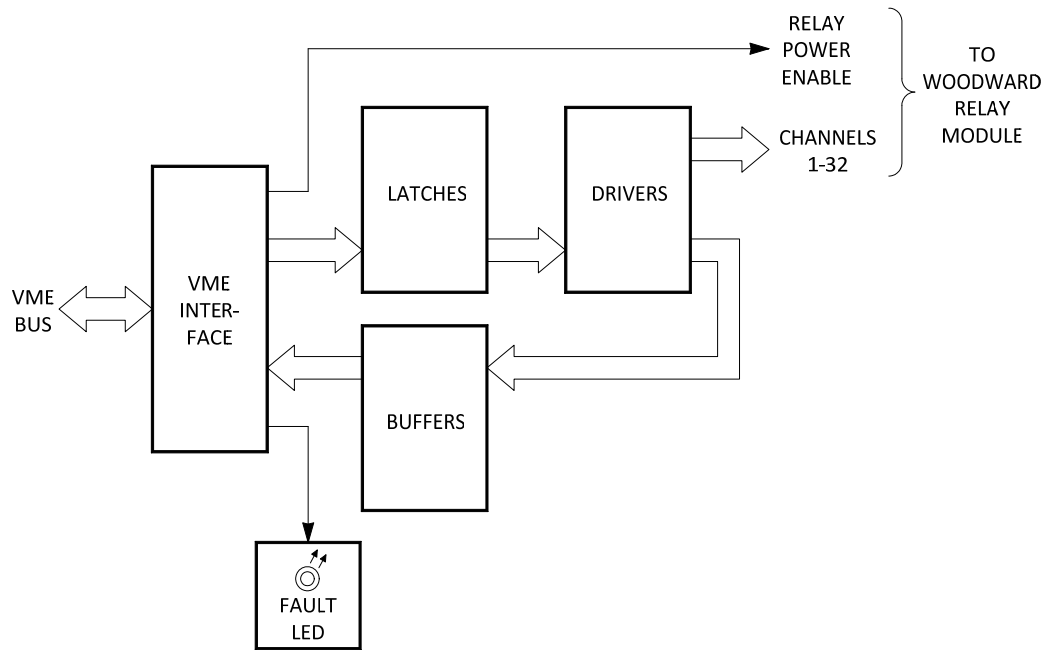


Figure 8-30—Discrete Output Module (32 Channel) Block Diagram

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. If the other output channels on the 32Ch DO module are not working either, check the fuse on the 32Ch DO 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.
4. Check the software configuration to ensure that the output is configured properly.
5. 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.

## 8.6—64 Channel Discrete Output Module

### 8.6.1—Module Description



Figure 8-31—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 64Ch DO Module. The module can be connected to two 32Ch Relay Module, four 16Ch Relay Modules, or a combination of the two types (see Chapter 13 for additional information on the relay modules).

## 8.6.2—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 Read back:	Output channel status, relay status is not available
System Faults:	Outputs are turned off if communications with the CPU is lost.

For the 16Ch Relay Module, and the 32Ch Relay Module output specifications, see Chapter 13.

## 8.6.3—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.

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 64Ch DO Module is connected through two low density discrete cables to two 32Ch Relay modules or two 16Ch Relay modules daisy chained to two additional 16Ch Relay modules with two additional low density cables. See Figure 8-32 for system installation configuration.

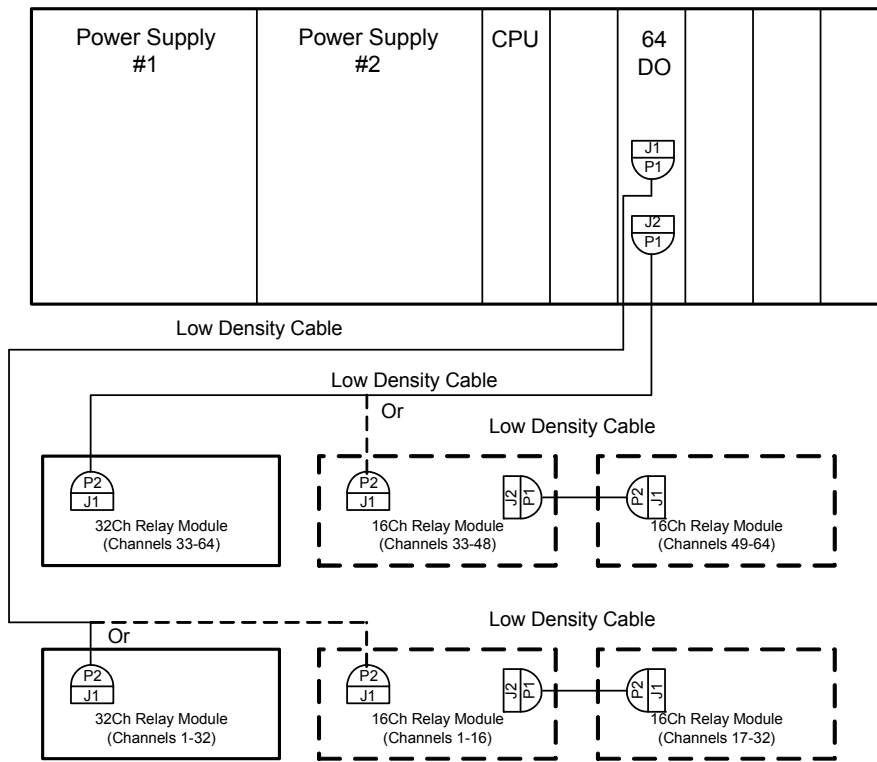


Figure 8-32—64Ch DO Module with Relay Modules

See Chapter 13 for field wiring of discrete output relays.

Figures 8-33 and 8-34 illustrate examples different discrete output wiring configurations.

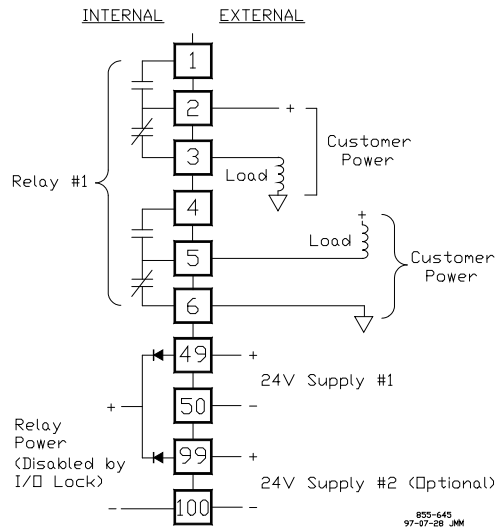


Figure 8-33—Relay Output Interface Wiring to a 16Ch Relay Module

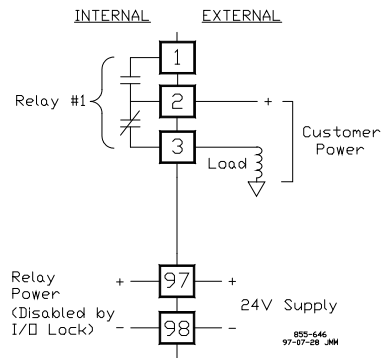


Figure 8-34—Relay Output Interface Wiring to a 32Ch Relay Module

**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.

**8.6.4—FTM Reference**

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

**8.6.5—Troubleshooting**

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



## Chapter 9.

# Analog I/O Modules

### 9.1—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.

### 9.2— Combination I/O Modules

There are four Analog Combination I/O modules available from Woodward. These are described in sections 9.3 through 9.6 and 9.28

### 9.3—24/8 Analog Module

#### 9.3.1—Module Description

A 24/8 Analog 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 Modules come in three different configurations.

1. 24 channels of 4-20 mA inputs with 8 channels of 4-20 mA outputs (2-pole 10 ms filter on all input channels).
2. 24 channels of 4-20 mA inputs with 8 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. 12 channels of 4-20 mA inputs, 12 channels 0-5 Vdc inputs with 8 channels of 4-20 mA outputs (2-pole 10 ms filter on all input channels).

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 9-1—24/8 Analog Module

### 9.3.2—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

#### **IMPORTANT**

The maximum voltage input 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 imp. (4-20 mA):	200 ohms
Anti-aliasing filter:	2 poles at 10 ms
Resolution:	16 bits
Accuracy:	Software calibrated to 0.1%, over 0-25 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

**IMPORTANT**

The 24 channel analog inputs are divided into two banks, with channel 1 through channel 12 data gathering at 1.8 ms after the MFT tick and channel 13 through channel 24 data gathering at 3.7 ms after the MFT tick.

**4–20 mA Output Ratings**

Number of channels:	8
Update time:	5 ms
Output Driver:	Pulse Width Modulated (PWM)
PWM frequency:	6.14 kHz
Filter:	3 poles at 500 $\mu$ s
Current output:	4–20 mA
Current output range:	0-25 mA
Isolation:	0 Vrms
Max load resistance:	600 ohms (load + wire resistance)
Current read back:	8 bits
Read back isolation:	60 dB CMRR, 200 Vdc common mode rejection voltage
Resolution:	11 bits
Accuracy:	Software calibrated to 0.2% of 0-25 mA full scale
Temperature drift:	125 ppm/C, maximum
Read back accuracy:	0.5% of 0-25 mA full scale
Read back temp drift:	400 ppm/C, maximum

**9.3.3—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 9-2 for an example.

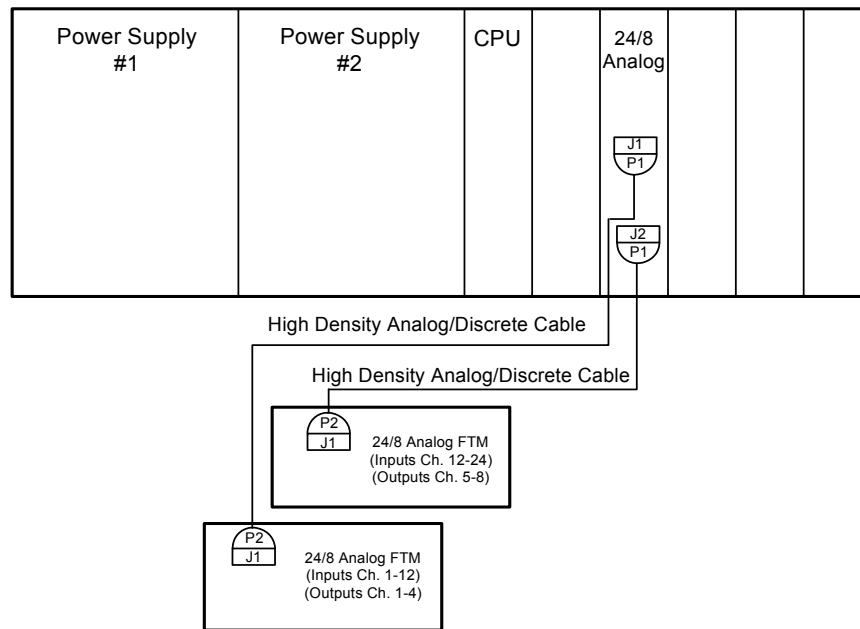


Figure 9-2—Simplex System Configuration Example

### 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 to prevent an inadvertent short from damaging the module. The 24 Vdc outputs are capable of providing 24 Vdc with  $\pm 10\%$  regulation. The maximum current is 0.8 A. 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**

When configuring the AI Combo block in GAP, set Conf. input field to 1 for all inputs when used with the 24/8 Analog FTM. This will allow the block to use the module factory calibration values for the 4-20 mA inputs that were calibrated with 200 ohm internal resistors on the 24/8 Analog Module.

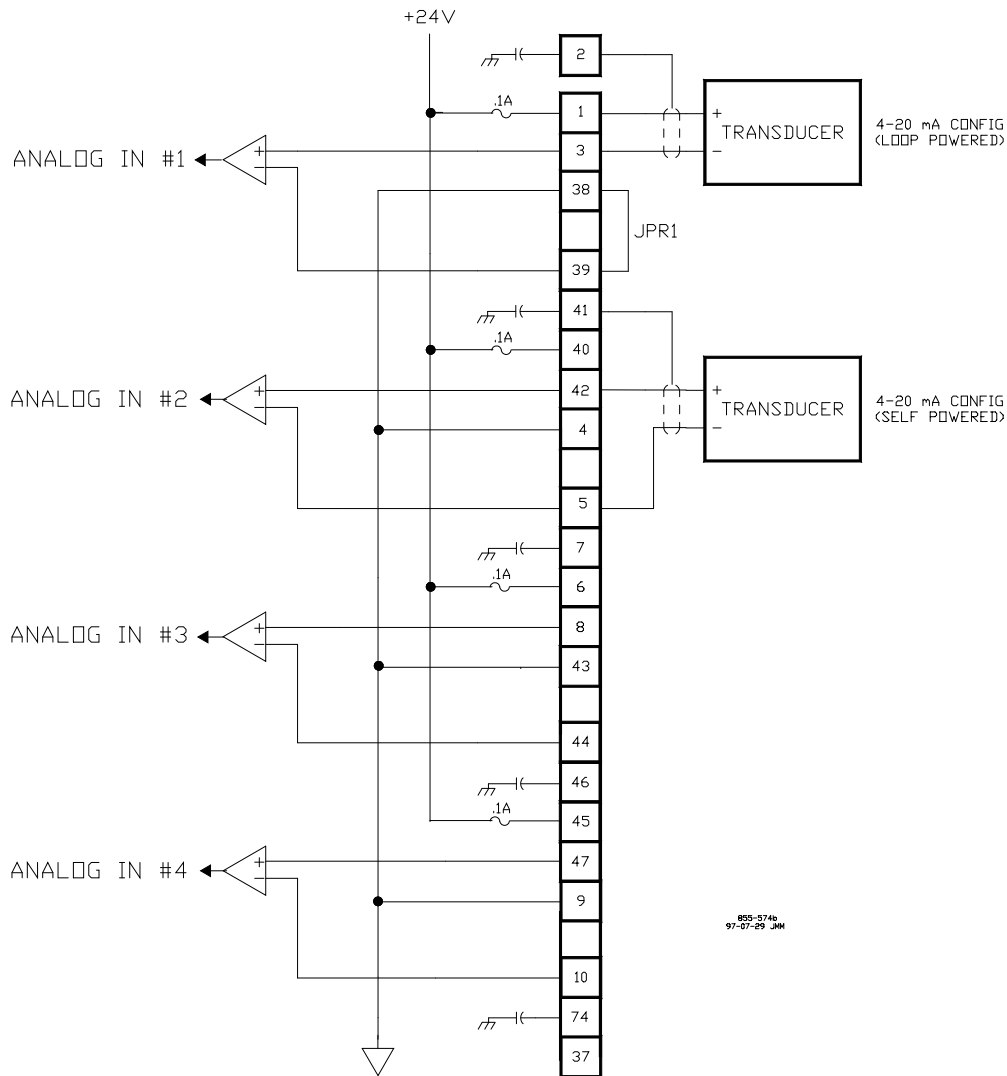


Figure 9-3—Analog Input Wiring for a 24/8 Analog FTM

### Analog Outputs

There are 8 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 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.

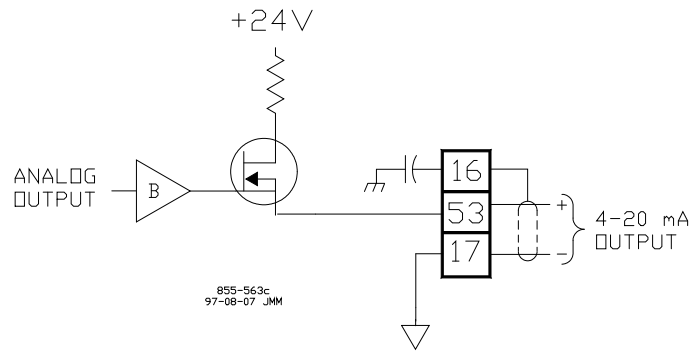


Figure 9-4—Analog Output Wiring for a 24/8 Analog FTM

### 9.3.4—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.

### 9.3.5—Troubleshooting

Each 24/8 Analog 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 is successful, the LED goes off. 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 9-1—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	EEPROM error is corrected (reset the module to continue)
9	Missing an A/D Converter interrupt

### 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 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.

## Troubleshooting Guide

If during normal control operation, all of the 24/8 Analog 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, 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.
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 all of the channels on the 24/8 Analog module are not working, check the fuse on the 24/8 Analog module. See instructions for module replacement in Chapter 15, Installation (System Level Installation). 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.
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 module.
9. If the readings are incorrect on several channels of the 24/8 Analog module, corresponding to both cables, replace the module.
10. 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. If all of the channels on the 24/8 Analog module are not working, check the fuse on the 24/8 Analog module. See instructions for module replacement in Chapter 15, Installation (System Level Installation). 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.
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 module.
9. If the readings are incorrect on several channels of the module, corresponding to both cables, replace the module.
10. 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).



## 9.4—Dataforth 24/8 Analog Module

### 9.4.1—Module Description

The Dataforth Analog Module uses the same board as utilized in the 24/8 Analog Module in section 9.3. The module is configured for 24 channels of 0-5 Vdc inputs and 8 channels of 4-20 mA outputs. In place of the two standard 24/8 Analog FTMs, two special Simplex Dataforth FTMs are connected through two high density analog/digital cables. The Simplex Dataforth FTM is designed to convert sensor input signals to a 0 to 5 V input compatible with the 24/8 Analog module. Each channel is individually configurable via a plug-in standard isolated Dataforth SCM7B converter that has been modified to meet Woodward's bandwidth and input temperature range requirements. Each module can plug into any of the 12 channels on the FTM. Each plug-in module converts the incoming signal to a 1 to 4 volt signal. No Calibration is required on the FTM or its plug-in modules. The plug-in modules are powered directly through the cable connector; resulting in no need for external power connections to the FTM. These plug-in modules currently include 4-20 mA input (internal shunt resistor), 0-5 Vdc input (pass through), 100  $\Omega$  RTDs, 200  $\Omega$  RTDs, and Type K Thermocouples. For Analog Outputs no plug-in modules are required. Isolation is provided on each channel. Channels are labeled to correspond to their software locations (e.g., analog input 1 on the FTM corresponds to analog input 1 in the application software.)



Figure 9-5—Dataforth 24/8 Analog Module

## 9.4.2—Specifications

To obtain overall signal input accuracy and bandwidth, the Dataforth FTM (0–5 V) module input accuracy and the Dataforth 24/8 Analog Module must be taken into account.

Table 9-2—Module Accuracy

Module	K Type Thermocouple	RTD 100 $\Omega$ Pt European Curve	Pass Through with 200 $\Omega$ Resistor (0.1%, 3 Watt)	Pass Through
Dataforth P/N	SCM7B47K-1458	SCM7B34-1459	SCM7BPT-1460	SCM7BPT
Woodward P/N	1784-653	1784-655	1784-659	1784-657
Input Range	-70°F (-56.67°C) to +2200°F (+1204.44°C)	-70°F (-56.67°C) to +500°F (+260°C)	0 to 25 mA (Limited by MicroNet card input range.)	0 to 5 V (limited by MicroNet card input range.)
Input Protection Continuous	120 Vrms max	120 Vrms max	None	None
Input Protection Transient	ANSI/IEEE C37.90.1-1989	ANSI/IEEE C37.90.1-1989	None	None
Output Range	1 to +5 V Linearized	1 to +5 V Linearized	0 to 5 V**	0 to 5 V
Isolation (Input to Output)	1500 Vrms	1500 Vrms	None	None
CMRR (50 or 60 Hz)	100 dB	100 dB	N/A	N/A
Accuracy Maximum	$\pm 0.32\%$ of Span*	$\pm 0.075\%$ of Span*	N/A	N/A
Gain Stability (-40 to +85°C)	$\pm 40$ ppm/°C	$\pm 60$ ppm/°C	$\pm 20$ ppm/°C	N/A
Input Offset Stability	$\pm 0.5$ $\mu$ V/°C	$\pm 1.0$ $\mu$ V/°C	N/A	N/A
Output Offset Stability	$\pm 0.002\%$ Span/°C	$\pm 0.002\%$ Span/°C	N/A	N/A
Open Input Response	Upscale	N/A	N/A	N/A
Open Input Detection Time	10 s. max	N/A	N/A	N/A
Bandwidth (-3 dB)	150 Hz	150 Hz	N/A	N/A
Step Response (0 to 90%)	3 ms	3 ms	N/A	N/A
Supply Voltage	14-35 Vdc	14-35 Vdc	None	None
Supply Current	30 mA max	30 mA max	N/A	N/A
Supply Sensitivity	$\pm 0.0001\%/ \%$ Vs	$\pm 0.0001\%/ \%$ Vs	N/A	N/A
Operating Temp. Range	+5 to +45°C	-40 to +85°C	-40 to +85°C	-40 to +85°C
Storage Temp. Range	-40 to +85°C	-40 to +85°C	-40 to +85°C	-40 to +85°C
Relative Humidity	0 to 90% Non-condensing	0 to 90% Non-condensing	0 to 90% Non-condensing	0 to 90% Non-condensing
Sensor Excitation Current	N/A	250 $\mu$ A	N/A	N/A
Lead Resistance Effect	N/A	$\pm 0.02^\circ\text{C}/\Omega$ max	N/A	N/A

\* Accuracy includes the effects of repeatability, hysteresis, and conformity. CJC sensor, thermocouple, or RTD sensor accuracy should be added to the module accuracy to compute the overall measurement accuracy.

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

Outputs can drive a maximum load of 600 ohms (load + wire resistance).

### 9.4.3—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.

Each Dataforth module is connected through two high density analog/discrete cables to two Simplex Dataforth FTMs. All I/Os on the module are accessible on the FTM. See Figure 9-6 for an example.

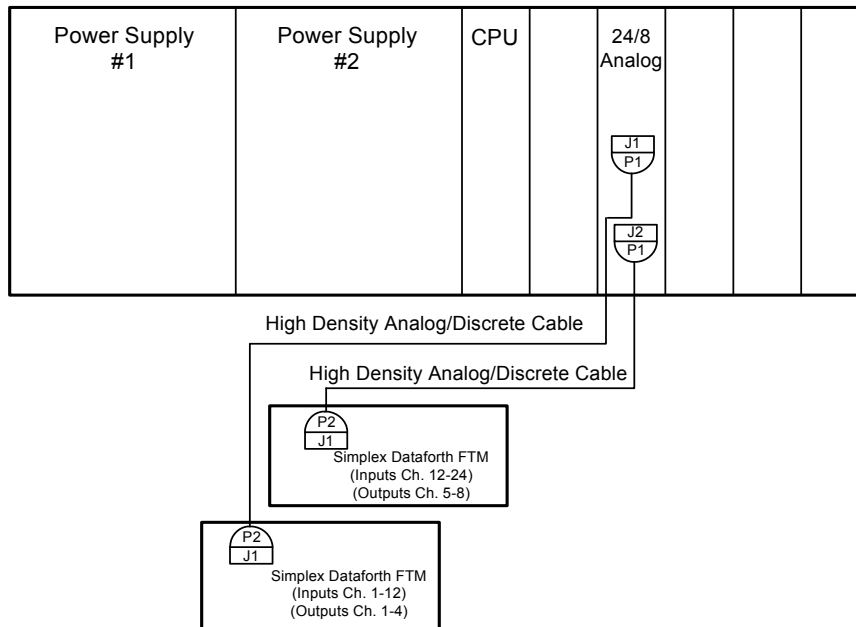


Figure 9-6—Simplex Dataforth Configuration Example

#### Field Wiring

See chapter 13 for detail wiring connections for the Simplex Dataforth FTM. Each input channel requires a Dataforth plug-in module per input. Install one of the five different Dataforth modules into each of the 12 plug-in slots on the FTM. It is not necessary to have a plug-in module in a slot if not used. With the Simplex Dataforth FTM connected to J1 of the Dataforth Module, channels 1-12 will be active. With the Simplex Dataforth FTM connected to J2 of the Dataforth Module, channels 13-24 will be active. Wire each channel per the following examples for each type of plug-in module. Install jumpers on FTM module as shown for specific type of input.

#### Thermocouple Plug-in Module

The Thermocouple Plug-in module accepts a single input from a type K thermocouple. The signal is filtered, isolated, amplified, linearized, and converted to a 1 to +5 V analog voltage for output to the Dataforth Module.

Linearization is achieved by creating a non-linear transfer function through the module itself. This non-linear transfer function is configured at the factory, and is designed to be equal and opposite to the thermocouple non-linearity.

The cold junction compensation (CJC) is performed by using an NTC thermistor, externally mounted on the FTM module, as shown in Figure 9-7. The thermocouple signal will fail high if an open wire is detected.

These modules incorporate both Thompson (Bessel) and Butterworth five-pole filter to maximize both time and frequency response. After the initial field side filtering, the input signal is chopped by a proprietary chopper circuit and transferred across the transformer isolation barrier. The signal is then reconstructed and filtered and scaled for 1 to 5 V for the Dataforth Module.

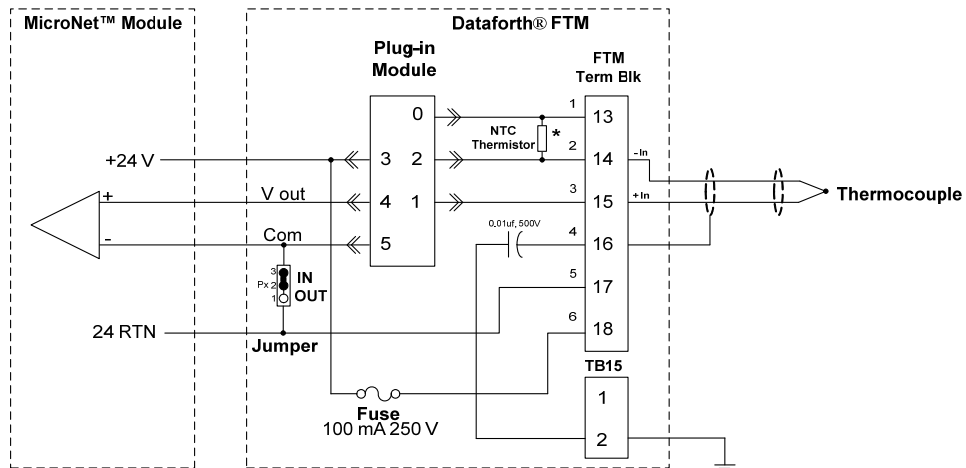


Figure 9-7—Thermocouple Wiring to Simplex Dataforth FTM

### RTD Plug-in Module

The RTD Plug-in module accepts a single connection from a 100 or 200 Ohm Platinum RTD, depending on the selected RTD Plug-in module as shown in Figure 9-8. The input signal is filtered, isolated, amplified, linearized, and converted to a 1 to +5 V analog voltage for output to High Density Analog I/O Module.

These modules incorporate both Thompson (Bessel) and Butterworth five-pole filter to maximize both time and frequency response. After the initial field side filtering, the input signal is chopped by a proprietary chopper circuit and transferred across the transformer isolation barrier. The signal is then reconstructed and filtered and scaled for 1 to 5 V for the Dataforth Module.

Linearization is achieved by creating a non-linear transfer function through the module itself. This non-linear transfer function is configured at the factory, and is designed to be equal and opposite to the specific RTD non-linearity. Lead compensation is achieved by matching two current paths thus canceling the effects of lead resistance.

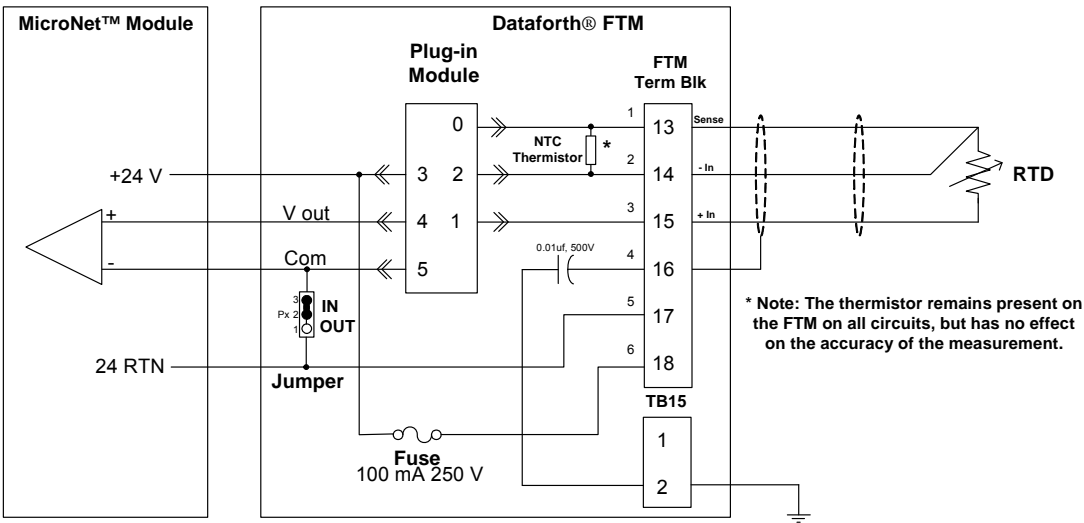


Figure 9-8—RTD Wiring to Simplex Dataforth FTM

### Current Input Plug-in Module

The Current Input Plug-in Module is a pass-thru module with a 200 ohm precision shunt resistor to convert the 4-20 mA input to 0.8 to 4 Vdc signal. No filtering is done on this module. See Figure 9-9 for an example of wiring a loop powered transducer and Figure 9-10 for a self-powered transducer.

**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 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.

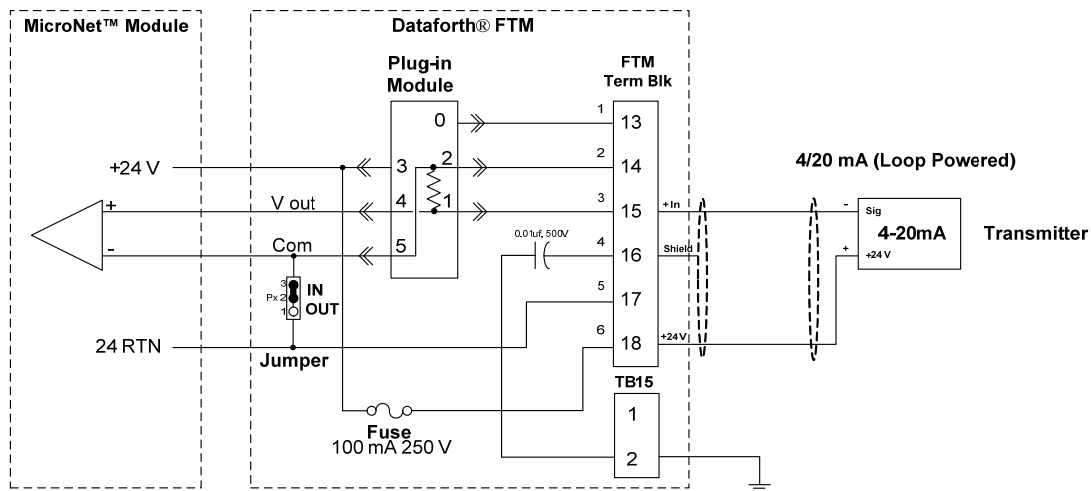


Figure 9-9—Loop powered 4-20 mA Signal Wiring to Simplex Dataforth FTM

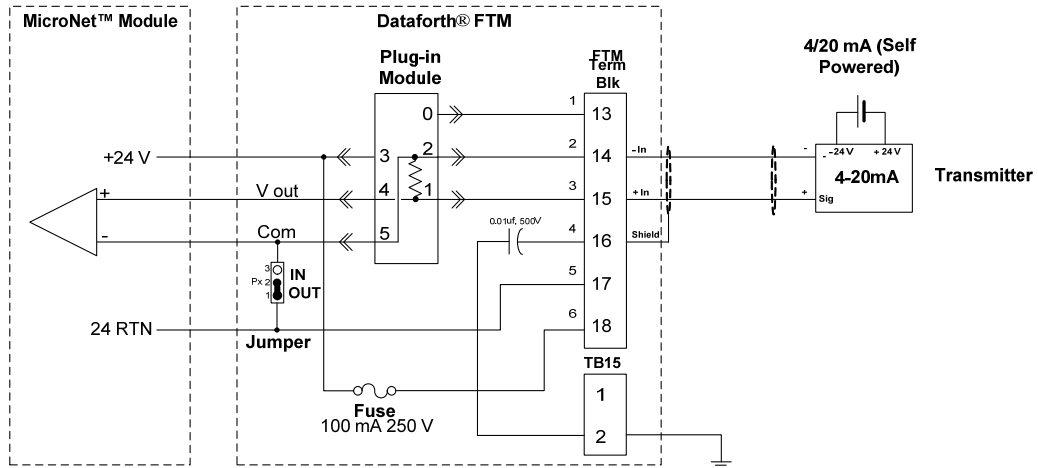


Figure 9-10—Self-powered 4–20 mA Signal Wiring to Simplex Dataforth FTM

### Voltage Input Plug-in Module

The Voltage Input Module is a pass-thru module and is capable of reading voltage signals between 0.8 and 4.8 Vdc. No filtering is provided by the Dataforth module. See section 9.5 Dataforth 24/8 Analog Module for filtering provided by the Dataforth Module. See Figure 9-11 for an example of wiring a voltage transducer.

IMPORTANT

When configuring the AI Combo block in GAP, set Conf. input field to 0 for all voltage inputs when used with the voltage input plug-in module. This will allow the block to use the module factory voltage calibration values with the Dataforth FTM.

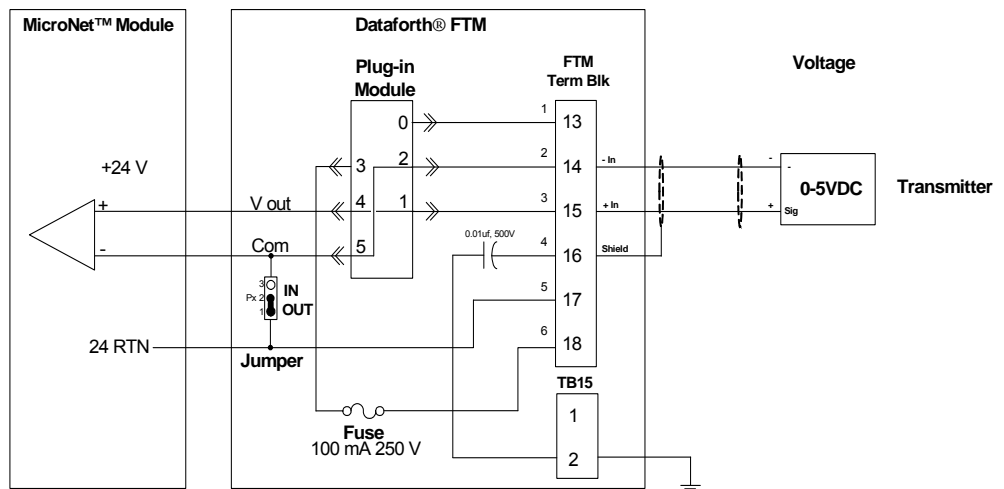


Figure 9-11—0–5 Vdc Signal Wiring to Simplex Dataforth FTM

**Analog Output Connection**

The Analog Output circuit doesn't use a plug-in module. No jumper connections are required. See Figure 9-12 for an example of wiring a 4-20 mA output device.

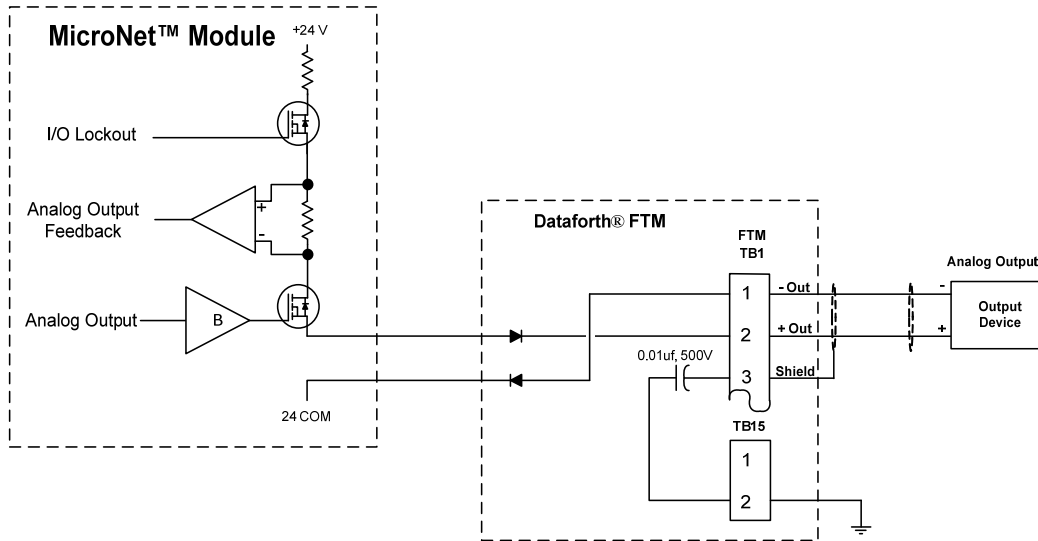


Figure 9-12—Analog Output Signal Wiring to Simplex Dataforth FTM

**9.4.4—FTM Reference**

See Chapter 13 for complete field wiring of the Simplex Dataforth FTM. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

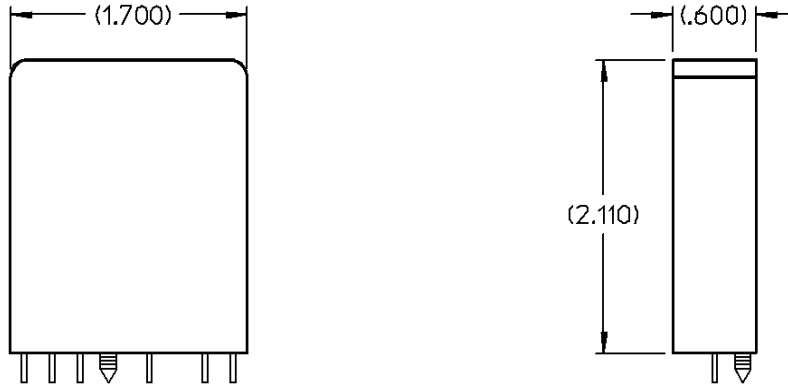


Figure 9-13—Dataforth Plug-in Modules

### 9.4.5—Troubleshooting

Each Dataforth 24/8 Analog 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 is successful, the LED goes off. 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 9-3—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	EEPROM error is corrected (reset the module to continue)
9	Missing an A/D Converter interrupt

#### 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 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.

#### Troubleshooting Guide

If during normal control operation all of a chassis' Dataforth 24/8 Analog Module have Fault LEDs on, check the chassis' CPU module for a failure. If during normal control operation only the Dataforth 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 should be disabled or de-energized.

#### Thermocouple Inputs

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

1. Verify that the correct Dataforth plug-in module is installed. Swap plug-in modules on FTM. Replace module if problem follows module.
2. 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).



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 full scale, 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.
5. Check the software configuration to ensure that the input is configured properly.
6. Verify that FTM module is within operating limits of +5 to 45 degrees C.
7. If all of the thermocouple channels on the Dataforth Module are not working, check the fuse on the Dataforth Module. See instructions for module replacement in Chapter 15, Installation (System Level Installation). 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.
8. If the readings are incorrect on several channels of the Dataforth Module, after replacing both cables, replace the module. If replacing the module does not fix the problem, replace the FTM. See instructions for replacing the FTM in Chapter 15, Installation (System Level Installation).

### RTD Inputs

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

1. Verify that the correct Dataforth plug-in module is installed. Swap plug-in modules on FTM. Replace module if problem follows module.
2. 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).
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 minimum scale or full scale, 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.
5. Check the software configuration to ensure that the input is configured properly.
6. If all of the RTD channels on the Dataforth Module are not working, check the fuse on the Dataforth Module. See instructions for module replacement in Chapter 15, Installation (System Level Installation). 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.
7. If the readings are incorrect on several channels of the Dataforth Module, after replacing both cables, replace the module. If replacing the module does not fix the problem, replace the FTM. See instructions for replacing the FTM in Chapter 15, Installation (System Level Installation).

### 4-20 mA Analog Inputs

If a 4-20 mA analog input is not functioning properly, verify the following:

1. Verify that the correct Dataforth plug-in module is installed.
2. Check that the cable is shielded and the shield is properly grounded.
3. Measure the input voltage on the FTM terminal block. It should be in the range of 0.8-4.0 V.
4. Verify that there are no or minimal AC components to the Analog Input signal. AC components can be caused by improper shielding.
5. 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.
6. Check the software configuration to ensure that the input is configured properly.
7. If all of the 4-20 mA channels on the Dataforth Module are not working, check the fuse on the Dataforth Module. See instructions for module replacement in Chapter 15, Installation (System Level Installation). 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.
8. If the readings are incorrect on several channels of the Dataforth Module, after replacing both cables, replace the module. If replacing the module does not fix the problem, replace the FTM. The 4-20 mA configured 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).

### 0-5 Vdc Analog Inputs

If an 0-5 Vdc analog input is not functioning properly, verify the following:

1. Verify that the correct Dataforth plug-in module is installed.
2. Check that the cable is shielded and the shield is properly grounded.
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 minimum scale or full scale, measure the input voltage on the FTM terminal block. It should be in the range of 0.8-4.8 V. Look for a loose connection on the terminal blocks, disconnected or misconnected cables on the terminal block.
5. Check the software configuration to ensure that the input is configured properly.
6. If all of the voltage channels on the Dataforth Module are not working, check the fuse on the Dataforth Module. See instructions for module replacement in Chapter 15, Installation (System Level Installation). 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.
7. If the readings are incorrect on several channels of the Dataforth Module, after replacing both cables, replace the module. If replacing the module does not fix the problem, replace the FTM.

## 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.
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. If all of the channels on the Dataforth Module are not working, check the fuse on the Dataforth Module. See instructions for module replacement in Chapter 15, Installation (System Level Installation). 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.
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 module.
9. If the readings are incorrect on several channels of the module, corresponding to both cables, replace the module.
10. 1 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).

## 9.5—Analog Combo Module

### 9.5.1—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 9-14—Analog Combo Module

**9.5.2—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, 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

**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 $\mu$ s
Current output:	4–20 mA current output range: 0 - 25 mA
Isolation:	0 Vrms
Max load resistance:	600 ohms (load + wire resistance)
Current read back:	11 bits
Read back 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
Read back accuracy:	0.2%, over 25 mA full scale
Read back 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 $\mu$ s
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
Read back	Actuator source and return currents
Read back 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
Read back accuracy	0.1% of 25 or 200 mA range
Read back temp drift	150 ppm/C, maximum

**9.5.3—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 9-15 for configuration.

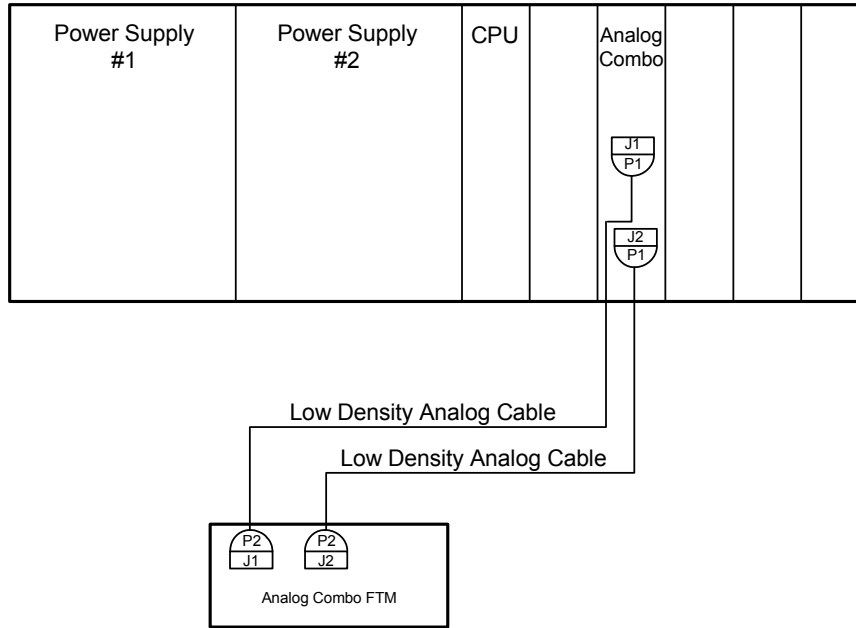


Figure 9-15—Simplex System Configuration Example

## Field Wiring

See Chapter 13 for detail wiring connections for the 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 off of high-current inductive loads when cables are longer than 30 m. If ground-bounce transients are present at an installation site 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 (longer than 30 m) with intervening isolators.

## 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 over speed 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 9-16.

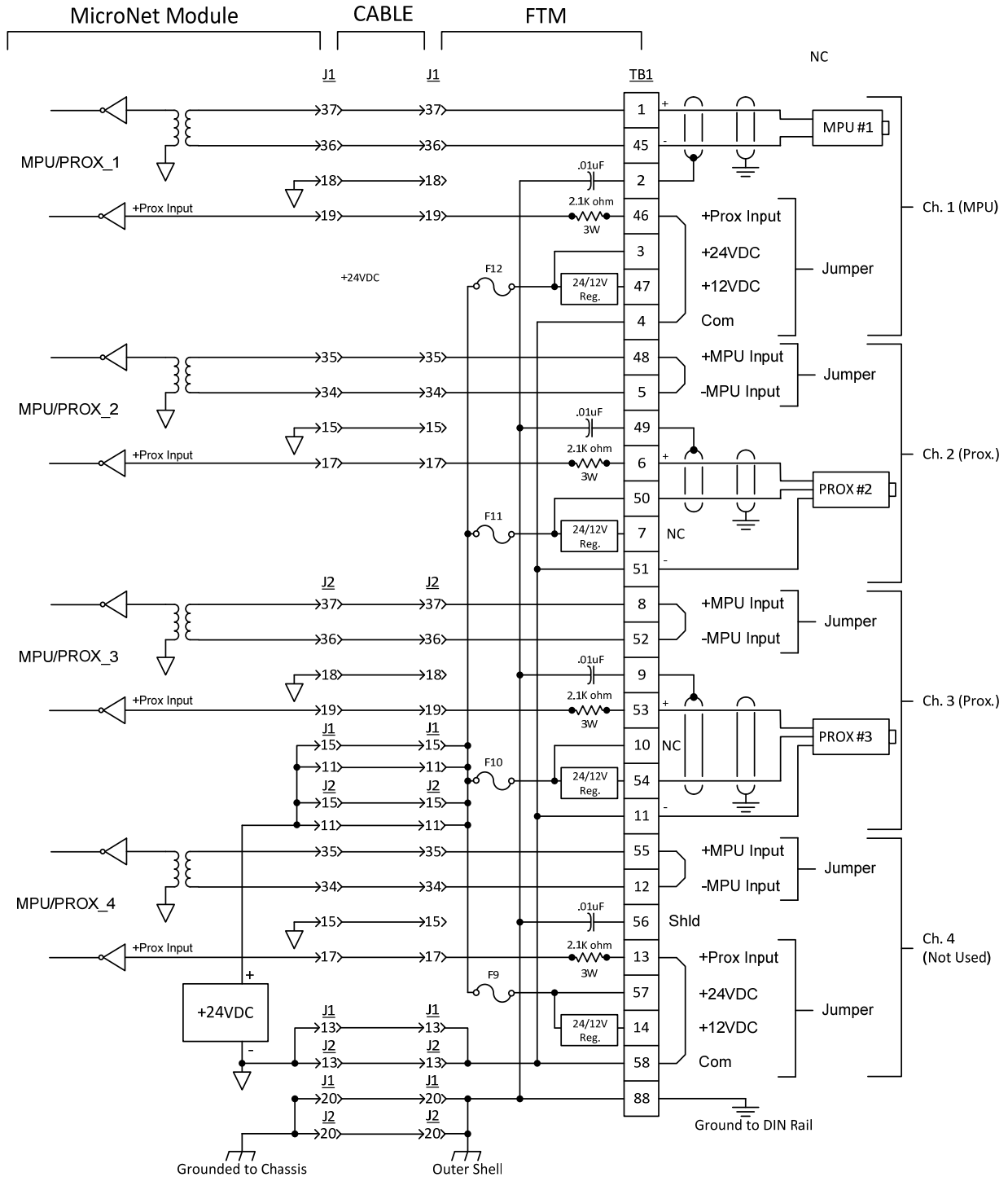


Figure 9-16—MPU/Proximity Interface Wiring to the Analog Combo FTM



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 9-16 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  $\pm 10\%$  regulation. Power connections can be made through terminals located on the FTMs. Refer to Figure 9-17 for 4-20 mA Current Input wiring.

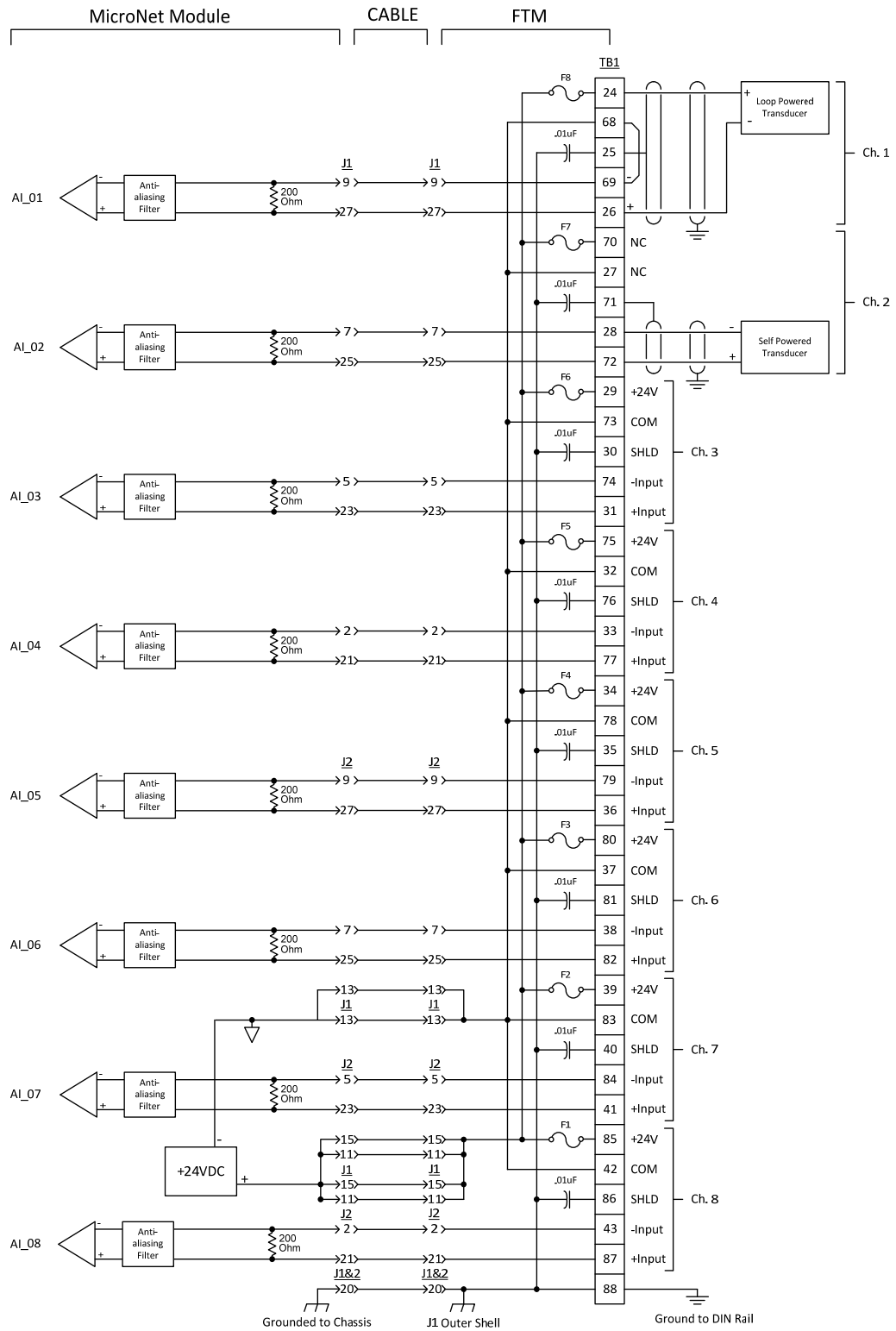


Figure 9-17—Current Input Wiring for an Analog Combo Module FTM

Only self-powered voltage transducers should be used on voltage input channels. The full scale range must not exceed 5 volts. Refer to Figure 9-18 for 0-5 Vdc voltage transducer input wiring.

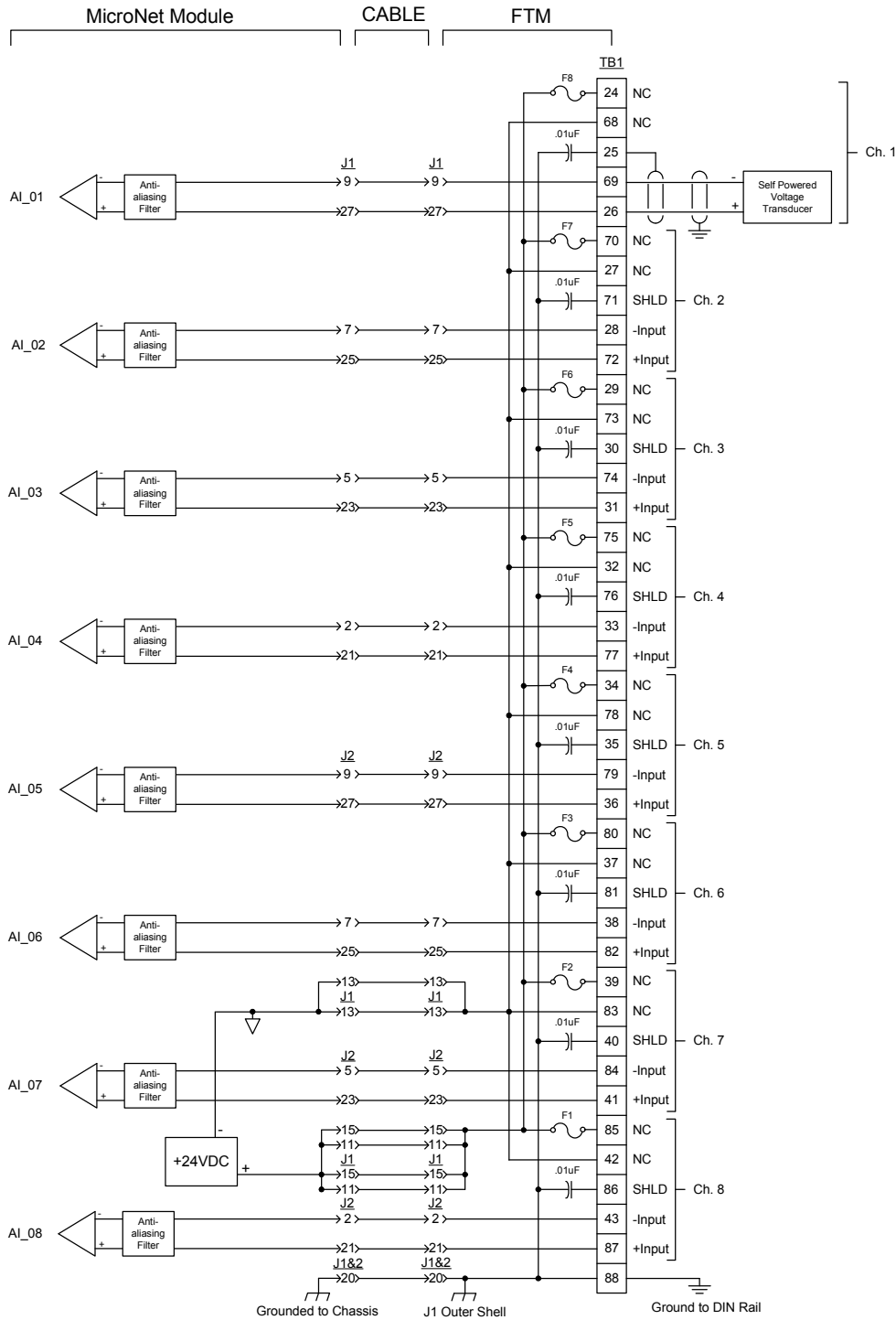


Figure 9-18—Voltage Input Wiring for an Analog Combo Module FTM

### 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 9-19 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 9-19 for an example of actuator wiring.

## **IMPORTANT**

**For a dual coil actuator in a simplex system, 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.

### 9.5.4—FTM Reference

See Chapter 13 for complete Analog Combo FTM field wiring information. See Appendix A for proper Module, FTM, and cable part numbers.

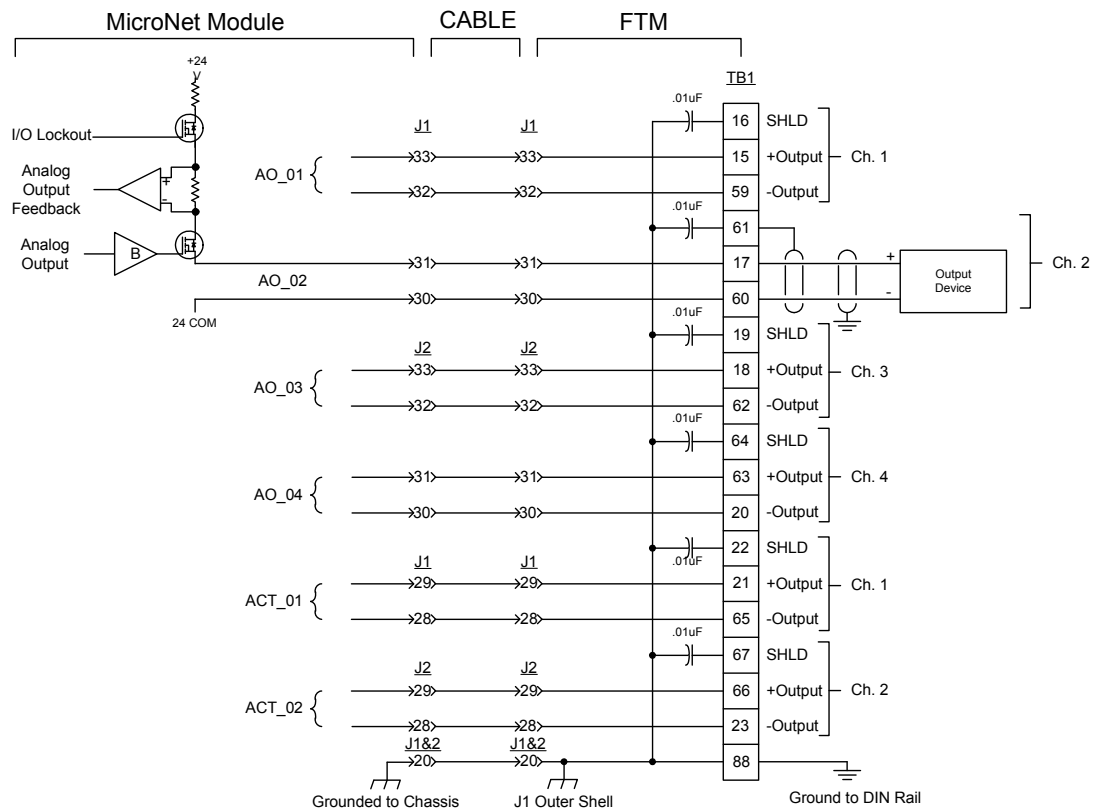


Figure 9-19—Analog Output and Actuator Wiring for an Analog Combo FTM

### 9.5.5—Troubleshooting

#### 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 9-4—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

## 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 set point to detect input faults.

Speed Sensor Input Faults. The application software may set a high and low latch set point to detect input faults. The low latch set point 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 shut down 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, insure that it is installed in the correct slot. If it is, then replace that Analog Combo module. See instructions for replacement in Chapter 15, Installation. 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 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 100 Hz - 25 kHz.
6. Verify that any unused MPU/Prox inputs are jumpered per Figure 9-16.
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, Installation. 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 15, Installation.
2. Measure the input voltage on the terminal block. It should be in the range of 3.5 – 32 V<sub>peak</sub>.
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 9-16.
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, Installation. 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 15, Installation.
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, 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.
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, Installation. 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, Installation. 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 15, 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 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, Installation. 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, Installation. 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 15, Installation.
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, Installation. 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, Installation. The FTM does not contain any active components on the MPU inputs, so replacing it should be the last option.

Replacing a Fuse on the Field Terminal Module (FTM)

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



### **WARNING**

**If power has not been removed from the control system, power will be active at the module and also 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.

## 9.6—34Ch High Density Versatile Input Module (HDVIM)

### 9.6.1—Module Description

This board includes no potentiometers and requires no calibration. A Configurable 34Ch HDVIM module may be replaced with another board of the same part number without any adjustment. Each Configurable 34Ch HDVIM Module contains circuitry for 34 Analog inputs and two cold junction inputs. 24 of the Analog inputs may be 4–20 mA inputs or thermocouple inputs, and the remaining ten Analog inputs may be 4–20 mA inputs or RTD inputs. The Configurable 34Ch HDVIM Module connects to the CPU board through the VME bus.

The first 12 Thermocouple/4–20 mA inputs are isolated as a group, from the other inputs, and from control common. The second 12 Thermocouple/4–20 mA inputs are isolated as a group, from the other inputs, and from control common. The first 4 RTD/4–20 mA inputs are isolated as a group, from the other inputs, and from control common. The second 6 RTD/4–20 mA inputs are isolated as a group, from the other inputs, and from control common.



Figure 9-20—34 Channel HDVIM Module

## 9.6.2—Module Specifications

### Thermocouple/4-20 mA Analog Inputs

Number of channels:	24
Current range:	0-24 mA (if configured for 4–20 mA)
Voltage range:	±72.8 mV (if configured for thermocouple)
Input impedance:	103 ohms (±1%) for 4-20 mA inputs

### Thermocouple Type and Range

(Type E, J, K, N, R, S, and T thermocouples must conform to the common commercial specifications published in the Annual Book of ASTM Standards with voltage predictions in line with N.I.S.T. Monograph 175 or ITS-90.)

Type E: -9.83 mV (-267.68°C/-449.82°F) to 72.8 mV  
(952.60°C/1746.68°F)

Type J: -8.09 mV (-209.72°C/-345.50°F) to 69.55 mV  
(1199.94°C/2191.89°F)

Type K: -6.45 mV (-263.95°C/-443.11°F) to 54.88 mV  
(1371.81°C/2501.26°F)

Type N: -4.34 mV (-263.14°C/-441.65°F) to 47.51 mV  
(1299.92°C/2371.86°F)

Type R: -0.22 mV (-48.27°C/-54.89°F) to 21.10 mV  
(1767.88°C/3214.18°F)

Type S: -0.23 mV (-48.60°C/-55.48°F) to 18.69 mV  
(1767.76°C/3213.97°F)

Type T: -6.25 mV (-265.71°C/-446.28°F) to 20.87 mV  
(399.97°C/751.95°F)

Common Mode Rejection	-80 dB minimum for Analog inputs
	-96 dB typical for Analog inputs
	-110 dB minimum for thermocouple inputs
	-120 dB typical for thermocouple inputs

Operational Input common mode voltage range:	±11 V minimum
Maximum Non-operational common mode voltage range:	±40 V minimum
Anti-aliasing filter:	2 poles at 10 ms (channel 11 has 2 poles at 5 ms)
Resolution:	15 bits
4-20 mA Input Accuracy:	1.1% FS (4-20 mA)

<b>IMPORTANT</b>	<p>The overall accuracy of the 4-20 mA input measurement is dependent on the ambient temperature of the board. The accuracy is based on a board temperature between 0 and 55 °C. The accuracy is in percent of full scale range.</p>
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### Thermocouple Accuracy

The overall accuracy of the thermocouple measurement is dependent on the ambient temperature of the board. The following accuracies are based on a board temperature between 0 and 55°C. All accuracies are in percent of full scale range for the type of thermocouple and the range specified.

Type E (<25°C):	1.15%
Type E (>25°C):	1.08%
Type J (<25°C):	1.09%
Type J (>25°C):	1.07%
Type K (<25°C):	1.14%
Type K (>25°C):	1.08%
Type N (<25°C):	1.21%
Type N (>25°C):	1.09%
Type R (<300°C):	1.16%
Type R (>300°C):	1.09%
Type S (<300°C):	1.16%
Type S (>300°C):	1.09%
Type T (<25°C):	2.53%
Type T (>25°C):	1.27%

### IMPORTANT

Thermocouple accuracy may be reduced by RF interference in the 900 MHz to 1.4 GHz frequency range. RF interference may reduce the accuracy another 0.45% of full scale when present.

CJ Update time:	5 ms
CJ accuracy:	±3 °C
Latency	
odd numbered channels:	1 ms
even numbered channels:	3 ms
Failure detection:	Open wire detection provided for thermocouples
Isolation:	All input channels are isolated from the rest of the MicroNet platform to 500 Vdc, however they are not isolated from each other. The inputs are differential, with a high impedance between channels.

### RTD/4-20 mA Analog Inputs

Number of channels:	10
Input type:	100 or 200 ohm 3-wire
Max. input current:	24 mA, if configured for 4–20 mA
Max. input resistance:	781Ω, if configured for RTD
RTD source current:	1 mA

**RTD Range**

(Must conform to DIN (Deutsche Institut für Normung) standard for 100 or 200 ohm European curve (Alpha = .00385) or American curve 100 or 200 ohm curve (Alpha = .00392))

100Ω RTD (European Curve):	18.49 Ω (–200 °C/–328 °F) to 390.48 Ω (850 °C/1562 °F)
200Ω RTD (European Curve):	37.04 Ω (–200 °C/–328 °F) to 533.10 Ω (457 °C/854.6 °F)
100Ω RTD (American Curve):	59.57 Ω (–100 °C/–148 °F) to 269.35 Ω (457 °C/854.6 °F)
200Ω RTD (American Curve):	119.14 Ω (–100 °C/–148 °F) to 538.70 Ω (457 °C/854.6 °F)

Common mode rejection:	–80 dB minimum for analog inputs
	–96 dB typical for analog inputs
	–96 dB minimum for RTD inputs
	–115 dB typical for RTD inputs

Input common mode range: ±11 V minimum

Safe input common mode

volt: ±40 V minimum

Input impedance: 103 ohms (±1%) for 4-20 mA inputs

Anti-aliasing filter: 2 poles at 10 ms

Resolution: 15 bits

**RTD Accuracy**

The overall accuracy of the RTD measurement is dependent on the ambient temperature of the board. The following accuracies are based on a board temperature between 0 and 55°C. All accuracy are in percent of full scale range for the type of RTD specified.

100Ω RTD (European Curve):	1.28% FS
200Ω RTD (European Curve):	1.28% FS
100Ω RTD (American Curve):	1.28% FS
200Ω RTD (American Curve):	1.28% FS

Update time: 5 ms

I/O Latency: 1 ms

Isolation: All input channels are isolated from the rest of the MicroNet platform to 500 Vdc, however inputs are not isolated from each other.

**9.6.3—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.

In a Simplex system, each 34Ch HDVIM module is connected through two high density 62 conductor analog cables to two 34Ch HDVIM FTMs. All inputs 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 9-21 for an example.

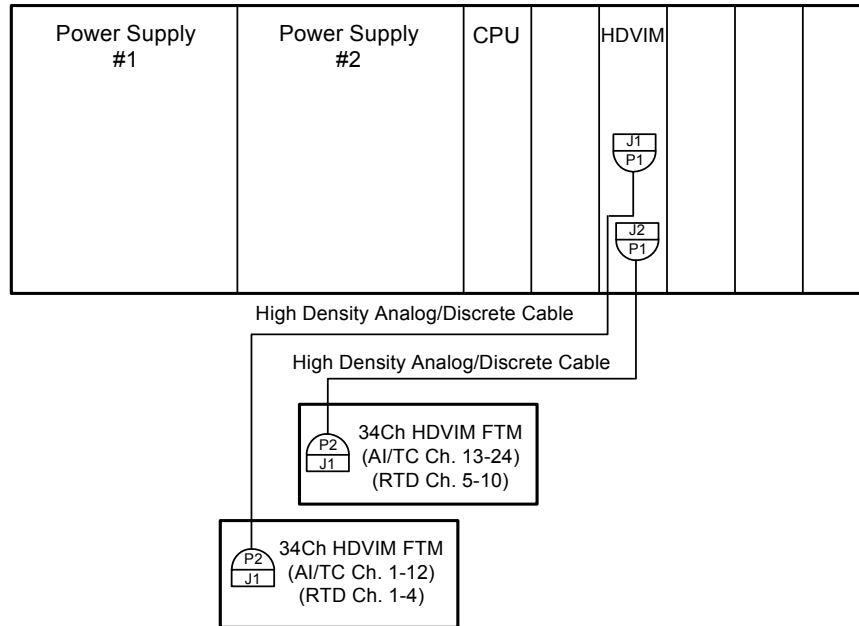


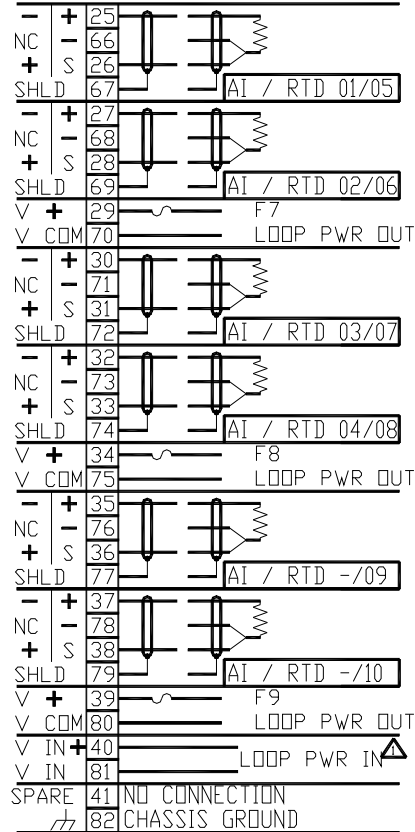
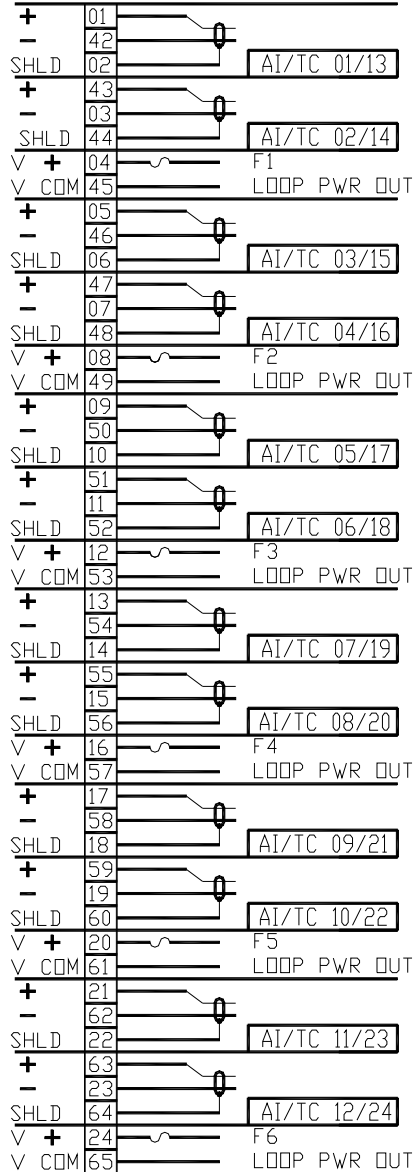
Figure 9-21—Simplex System Configuration Example

Loop power for the Analog inputs must be supplied by an external supply, if needed. This supply should be wired to terminals 40 and 81 on each FTM. The FTM will fuse and distribute the power to 9 sets of terminals on the FTM. The 4–20 mA, thermocouple, or RTD configurable inputs are selected in the GAP block software, for each input. The GAP block configuration sets input gain via software. The maximum wire size that the FTM can accept is one 16 AWG or two 20 AWG wires.

### 34Ch HDVIM Module Operation

All 34 inputs can be configured as 4–20 mA analog inputs. The first 24 channels can be configured as 4–20 mA inputs or thermocouples inputs and the last 10 can be configured as 4–20 mA inputs or RTD inputs. The application software must be configured to match the input type used, i.e. 4–20 mA, 100 ohm RTD, K type thermocouple, etc. This allows the 34Ch HDVIM module to use the applicable hardware calibration values, and to configure the appropriate hardware gains. The first thermocouple inputs must be configured in pairs, i.e. channels 1 and 2 must both be thermocouples or must both be 4–20 mA inputs. The RTD channels may be configured individually. Any 'un-used' channel of a pair, Channels 1 - 24, must have its input shorted to prevent measurement errors on the 'in-use' channel of the pair.

AIs ARE 4-20mA  
 FUSES 100mA (5X20mm)



$\Delta$  LOOP PWR SUPPLY  
 18-32VDC 5A MAX.

855-754  
 00-10-12 kdw

Figure 9-22—Wiring Diagram for 34Ch HDVIM FTM

<b>IMPORTANT</b>	<p>For MicroNet controls using this module to be CE compliant, the power supply used for the FTM "LOOP POWER" must be isolated, protected, and CE marked to EN61000-6-2 and EN61000-6-4 EMC standards. In addition, chassis ground must be connected at two points on the FTM. Pin 82 with a 16 AWG wire of the shortest length possible, no longer than 4 inches (10 cm). TB2 with a 1/2 inch (13 mm) wide flat hollow braid, no longer than 6 inches (15 cm).</p>
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### 4-20 mA Inputs

For a 4–20 mA input signal, the 34Ch HDVIM module uses a 100 ohm resistor across the input. All 4–20 mA inputs may be used with two-wire ungrounded (loop powered) transducers or isolated (self-powered) transducers. All Analog inputs have 11 Vdc of common mode rejection. If interfacing to a non-isolated device, which may have the potential of reaching over 11 Vdc with respect to the control's common, the use of a loop isolator is recommended to break any return current paths, which could produce erroneous readings. 0-5 V inputs are not supported by this module. No loop power is provided by the MicroNet module. An external supply must be connected to the FTM for powering loop powered inputs.

### RTD Inputs

RTD inputs must be configured to use either the European or American curve in software. Only 100 and 200 ohm platinum RTDs are supported. 200 ohm RTDs are limited to the maximum temperature on the American curve, even when the European curve is used. The RTD source current is 2 mA, and the RTD sense input should be tied to the negative side of the RTD, at the RTD.

### Thermocouple Inputs

See Module Specifications for supported thermocouple types. A cold junction sensor is provided on the 34Ch HDVIM FTM. If the actual cold junction in the field wiring occurs elsewhere, the temperature of that junction must be brought into the control as a thermocouple, RTD, or 4–20 mA input, and the application software must be configured to use the appropriate cold junction temperature. The thermocouple and cold junction input units (°C or °F) should be consistent in the application software.

The first 12 Analog inputs on each FTM are isolated as a group from control common, earth ground, and the rest of the Analog inputs. The next 4 or 6 Analog inputs on the FTM are also isolated as a group from control common, earth ground, and the rest of the Analog inputs. This results in 4 isolated groups of inputs on each module.

#### **IMPORTANT**

If 4–20 mA inputs are configured for the first twelve channels on a FTM, and thermocouple inputs are also used on that FTM, then the 4–20 mA inputs should use an isolated power supply. Similarly, if 4–20 mA inputs are configured for the last 4-6 channels on a FTM, and RTD inputs are also used on that FTM, the 4–20 mA inputs should use an isolated power supply. This prevents 4–20 mA inputs from introducing noise on temperature inputs, when they share the same isolated input ground on the module.

#### **IMPORTANT**

The FTM cold junction, has some limited immunity to RF fields. It requires the Loop power to be as noted above. It also requires that the FTM be installed into a metal cabinet as dictated by the application: standard cabinet for CE Mark and an EMC cabinet for marine installations as dictated in the system installation chapter.

### 9.6.4—FTM Reference

See Chapter 13 for complete 34Ch HDVIM FTM field wiring information. See Appendix A for proper Module, FTM, and cable part numbers.



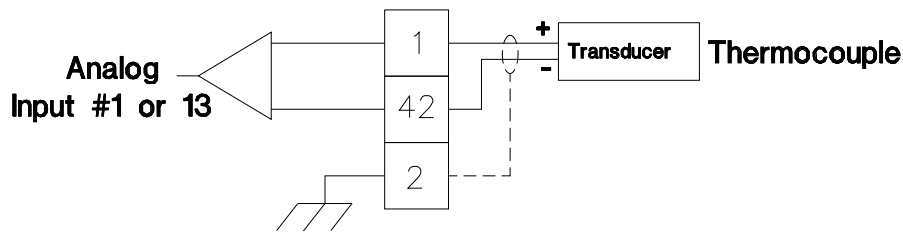


Figure 9-23—Analog Input Interface Wiring to the 34Ch HDVIM Module for Thermocouple Inputs

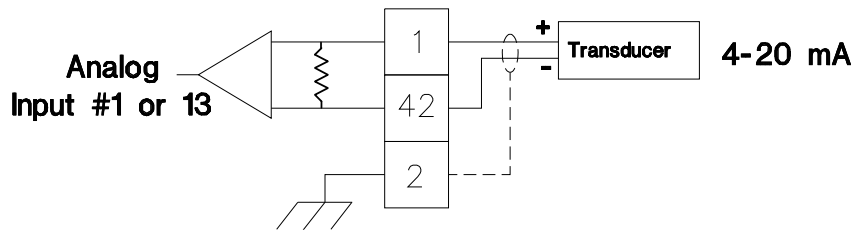


Figure 9-24—Analog Input Interface Wiring to the 34Ch HDVIM Module for 4-20 mA Inputs

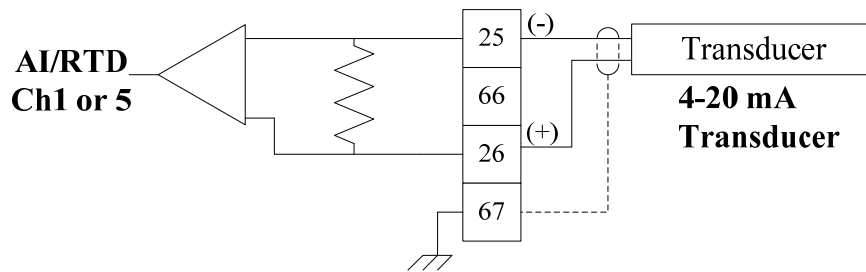


Figure 9-25—4-20 mA Input Interface Wiring to the 34Ch HDVIM Module for 4-20 mA on 4/20 mA/RTD Inputs

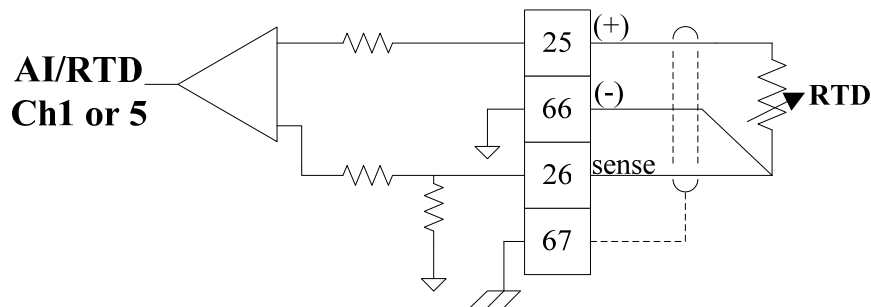


Figure 9-26—RTD Input Interface Wiring to the 34Ch HDVIM Module for RTDs on 4-20 mA/RTD Inputs

### 9.6.5—Troubleshooting

Each 34Ch HDVIM module has a red fault LED that is turned on when the system is reset. During initialization of a board, which occurs after every CPU reset, the CPU turns the Fault LED on. The CPU then tests the board 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 board is illuminated after the diagnostics and initialization have been completed, the 34Ch HDVIM module may be faulty.

Table 9-5—LED Indications of Failure

Number of LED Flashes	Failure
1	Micro-Processor failure
2	Bus, Address, any unexpected exception error
3	Internal RAM failure
4	Internal Watchdog failure
5	EEPROM failure
7	Kernel software Watchdog count error
13	Dual port RAM error

### Fault Detection (I/O)

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

**Analog Input Faults.** The application software may set a high and low latch set point to detect input faults. For thermocouple inputs, open wire detection is provided.

**Micro-controller 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 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.
2. Measure the input voltage on the terminal block. It should be in the range of 0–5 V for 4–20 mA inputs. RTD inputs have a 2 mA current source. Thermocouple inputs should have the appropriate millivolt signal.
3. Verify that there are no or minimal AC components to the Analog Input signal. AC components can be caused by improper shielding. Thermocouple inputs are extremely sensitive to signal fluctuations.
4. Check the wiring. For a 4–20 mA input if the input is reading 0 or the engineering units that correspond to 0 mA, look for a loose connection at the terminal blocks and disconnected or misconnected cables.
5. For RTD inputs, check for proper connection of the sense line.
6. For thermocouple inputs, check for proper cold junction location.
7. If the input is reading high, check that the power is not connected across the input directly.
8. Check the software configuration to ensure that the input is configured properly. Ensure that the proper RTD or thermocouple type is selected, if applicable.
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 34Ch HDVIM module.
10. If the readings are incorrect on several channels of the 34Ch HDVIM module, corresponding to both cables, replace the 34Ch HDVIM module.
11. If replacing the module does not fix the problem, replace the FTM. See the instructions in Chapter 15, Installation, for replacing the FTM. The FTM contains only traces and a few discrete components, so failure is extremely unlikely.

## 9.7—Current Input Modules

There are three different 8Ch Current Input modules available from Woodward. These consist of the 8Ch Current Input (4-20 mA) module, Non-Standard 8Ch Current Input (4-20 mA) module, and the 8Ch Current/Voltage Input Module. The 8Ch Current/Voltage Input module was created for a special program and is not a standard Woodward product.

### 9.8—8Ch Current Input (4-20 mA) Module

#### 9.8.1—Module Description

Each 8Ch Current Input (4-20 mA) Module contains circuitry for eight fully isolated double-ended current inputs. The module is connected through one Low Density Analog cable to one Analog Input FTM for field wiring connections. All analog inputs may be used with two-wire ungrounded (loop powered) transducers or isolated (self-powered) transducers. The Input signal range is between 0 and 25 mA. The module has a built-in precision voltage source. The readings from the precision-voltage reference are used for on-line temperature compensation and automatic calibration for the 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.



Figure 9-27—8 Channel Current Input (4-20 mA) Module

#### 9.8.2—Specification

Number of Channels:	8
Input Range:	0-25 mA
Accuracy:	0.5% of full scale
Temperature Coefficient:	12 ppm/degrees C
Anti-aliasing filter:	2 poles at 12 ms (Channels 1-8)
Module interface:	VMEbus

Resolution:	16 bit converter
Isolation:	1500 Vac continuous (channel input to control common)
CMRR:	-90 db
Input Impedance:	249 ohms
Status Indication:	RED LED - channel fault or board fault

### 9.8.3—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.

In a simplex system, each 8Ch Current Input (4-20 mA) module is connected through one Low Density Analog cable to one Analog Input FTM. All of the I/O are accessible on the FTM. See Figure 9-28 for configuration.

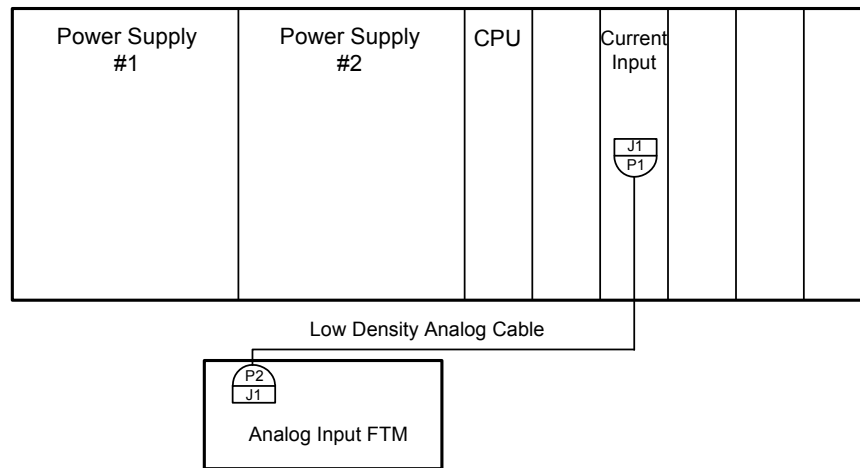


Figure 9-28—8Ch Current Input (4-20 mA) Module Configuration

### Field Wiring

See Chapter 13 for detail wiring connections for the Analog Input FTM. See Figure 9-29 for transducer wiring.

All analog inputs may be used with two-wire ungrounded (loop powered) transducers or isolated (self-powered) transducers. Loop powered or self-powered 4–20 mA transducers may be connected to the current input modules via the Analog Input FTM shown in Figure 9-29.

### 9.8.4—FTM Reference

See Chapter 13 for complete Analog Input FTM field wiring. See Appendix A for proper Module, FTM, and cable part numbers.

### 9.8.5—Troubleshooting

The input MUX (multiplexer) permits the module to read either the value of the precision-voltage reference for this channel, or the sensed input for this channel. The MUX receives the current input and, under the control of the microcontroller, passes the value through the Gain amplifier to the Isolation Amplifier. The output of the Isolation Amplifier goes to one input of the channel-selecting MUX.

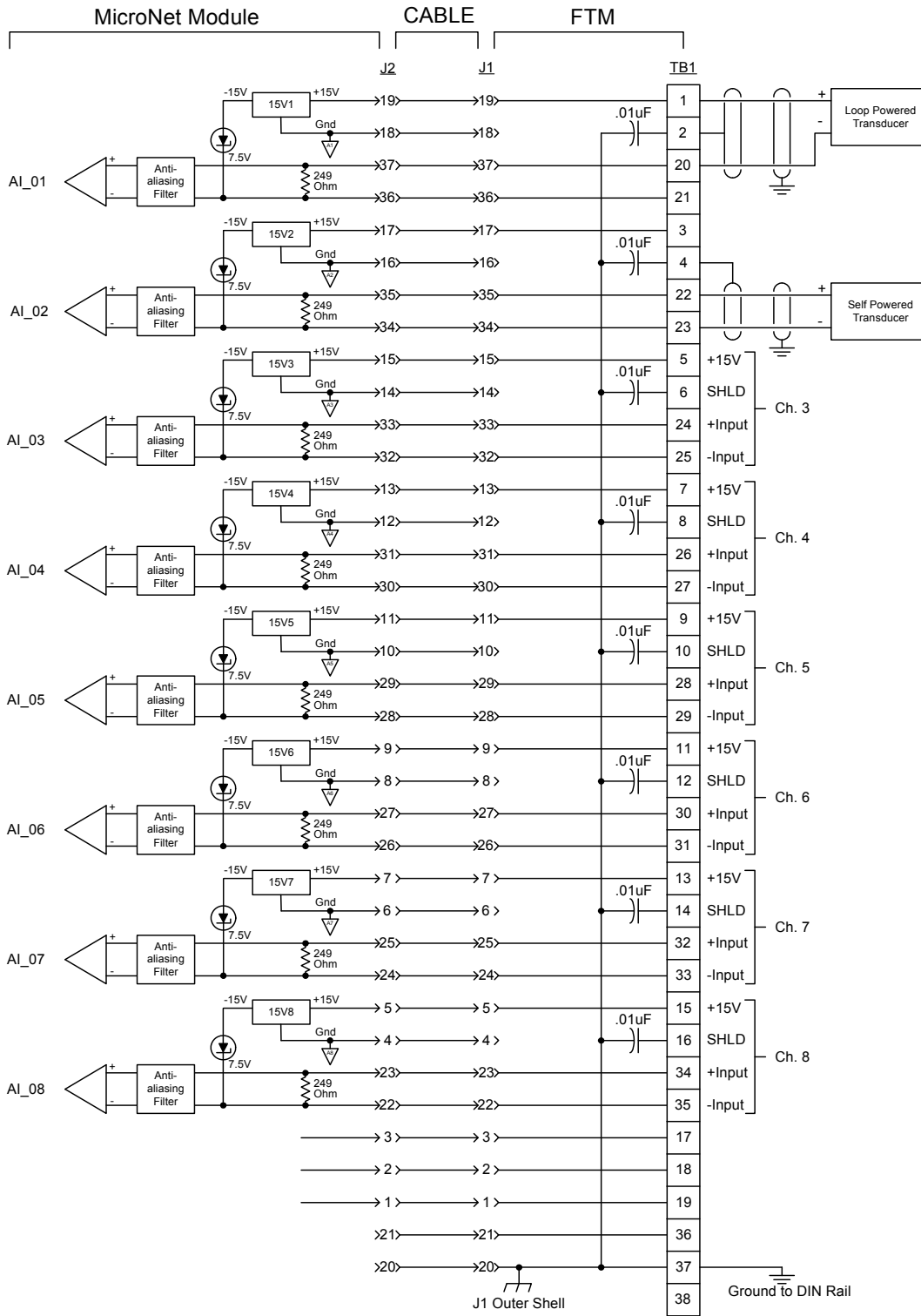


Figure 9-29—Analog Input Wiring for an 8Ch Current Input (0–25 mA) Module



Limits have been set for the expected readings when the on-board microcontroller reads each voltage reference. If the reading obtained is outside these limits, the system determines that the input channel, A/D converter, or the channel's precision-voltage reference is not functioning properly. If this happens, the micro-controller flags that channel as having a fault condition. The CPU will then take whatever action the application engineer has provided for in the application program.

The readings from the precision-voltage reference are also used for on-line temperature compensation and automatic calibration for the module. The readings of the precision-voltage reference, obtained from the A/D converter, are used by the microcontroller to determine software scaling- and offset-constants for each channel. These scaling-and offset-constants are respectively multiplied by and added to each channel reading to provide corrected channel readings. The module therefore includes no potentiometers and needs no calibration.

Each I/O module has a fuse on it; this fuse is visible and can be changed through a cutout in the plastic cover of the module. If this fuse is blown, replace it with a fuse of the same type and size.

### Troubleshooting Guide

If a current 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 across the + and – inputs 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, look for a loose connection on the terminal blocks, disconnected or misconnected cables.
5. Check the software configuration to ensure that the input is configured properly.
6. If the other channels on the module are not working either, check the fuse on the 8Ch Current Input (0–25 mA) module. 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.
7. If the problem remains, swap out the 8Ch Current Input (0–25 mA) module with another module of the same part number. If the problem remains, replace the cable.
8. If the problem remains, 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.

## 9.9—Non-Standard 8Ch Current Input (4-20 mA) Module

### 9.9.1—Module Description

Each Non-Standard 8Ch Current Input (4-20 mA) Module utilizes the same circuitry that the 8Ch Current Input (4-20 mA) module uses. Seven of the eight double-ended channels of this module are fully isolated. Through the use of a special FTM and cable, the derivative of the signal from channel 7 is generated on the FTM and then fed to channel 8 on the analog Input module. This derivative signal can be used for monitoring a rate of change in the channel 7 input transducer. The first seven channels may be connected to current transducers. Channels 1 through 6 are standard 0–25 mA inputs with standard frequency response. Channel 7 has been altered to allow for higher frequency response. The module has a built-in precision voltage source. The readings from the precision-voltage reference are used for on-line temperature compensation and automatic calibration for the 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.



Figure 9-31—Non-standard 8 Channel Current Input (4–20 mA) Module



### 9.9.2—Specification

Number of Channels:	8
Input Range:	0-25 mA
Accuracy:	0.5% of full scale
Temperature Coefficient:	12 ppm/degrees C
Anti-aliasing filter	2 poles at 12 ms (Channels 1-6)
Anti-aliasing filter	2 poles at 5 ms (Channels 7-8) (Channel 8 is the derivative of channel 7.)
Module interface:	VMEbus
Resolution:	16 bit converter
Isolation:	1500 Vac continuous (channel input to control common)
CMRR:	-90 db
Input Impedance:	249 Ohms
Status Indication:	RED LED - channel fault or board fault

### 9.9.3—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 8Ch Current Input module is connected through one analog cable to one FTM. All of the I/O are accessible on the FTM.

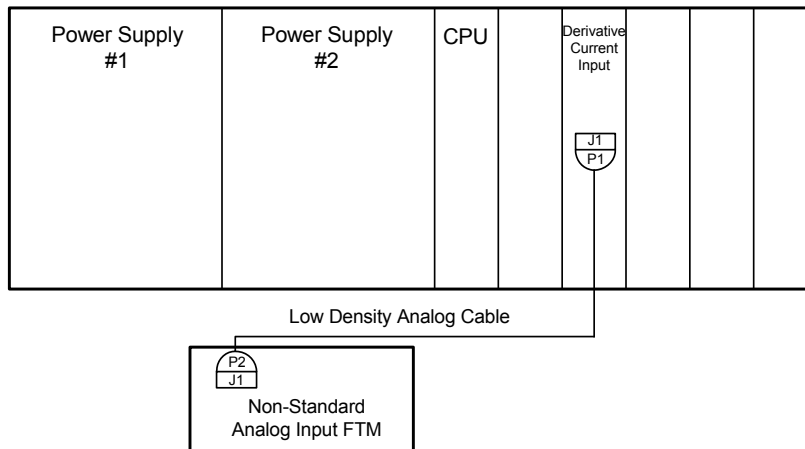


Figure 9-32—Non-Standard 8Ch Current Input (4–20 mA) Module Configuration

### Field Wiring

See Chapter 13 for detail wiring connections for the Non-standard Analog Input FTM. See Figure 9-33 for transducer wiring.

The first six analog inputs may be used with two-wire ungrounded (loop powered) transducers or isolated (self-powered) transducers. The seventh channel can be used with a self-powered transducer only. Channel eight should not be connected to any field wiring. Loop powered or self-powered 4–20 mA transducers may be connected to the current input modules via the Non-Standard Analog Input FTM shown in Figure 9-33.

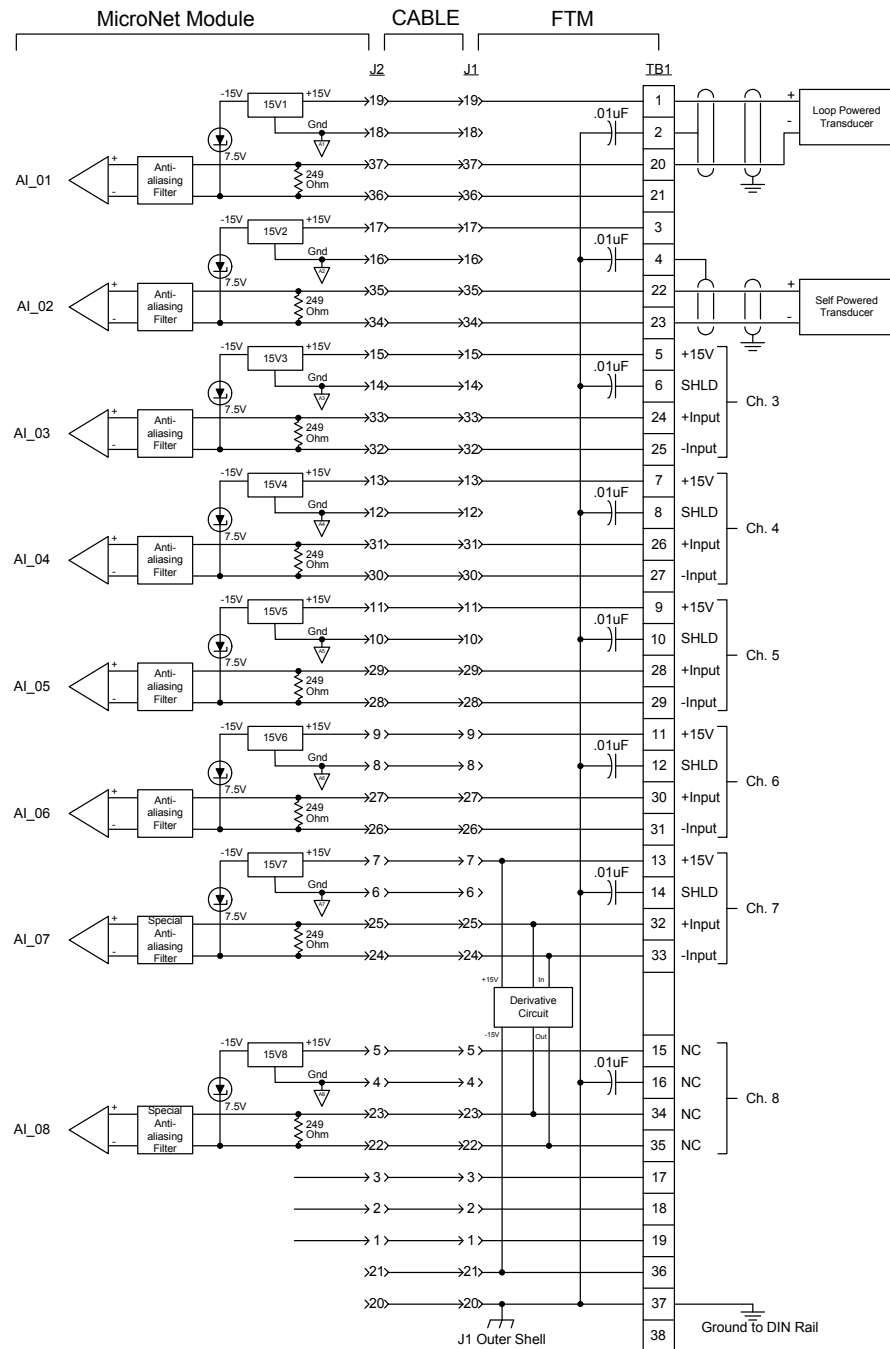


Figure 9-33—Analog Input Wiring for a Non-Standard 8Ch Current Input (0–25 mA) Module

### 9.9.4—FTM Reference

The output from channel seven is split and fed to channel seven on the Non-Standard Current Input (4-20 mA) Module and also fed through a derivative circuit on the FTM to channel eight on the Non-Standard Current Input (4-20 mA) Module. See Chapter 13 for complete field wiring information for the Non-Standard Analog Input FTM. See Appendix A for proper Module, FTM, and cable part numbers.

## 9.9.5—Troubleshooting

The input MUX (multiplexer) permits the module to read either the value of the precision-voltage reference for this channel, or the sensed input for this channel. The MUX receives the current input and, under the control of the microcontroller, passes the value through the Gain amplifier to the Isolation Amplifier. The output of the Isolation Amplifier goes to one input of the channel-selecting MUX.

This MUX, under control of the microprocessor, selects the channel to be read. The analog output of this MUX is converted to a digital value by the A/D converter, and passed to the microcontroller. The microcontroller makes any necessary corrections to this value and stores the result in the Dual-Port RAM. The CPU can then access the values stored in Dual-Port RAM through the VME interface and bus. See Figure 9-30 for block diagram of module.

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 is successful, the LED goes off.

During initialization of the module, the module's micro-controller turns the LED off after power-on self-tests have passed and the CPU has initialized the module.

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.

This module also has on-card on-line fault detection and automatic calibration/compensation. Each input channel has its own precision voltage reference. Once per minute, while not reading inputs, the on-board microcontroller reads this reference. The microcontroller then uses this data read from the voltage reference for both fault detection and automatic temperature compensation/calibration.

Limits have been set for the expected readings when the on-board microcontroller reads each voltage reference. If the reading obtained is outside these limits, the system determines that the input channel, A/D converter, or the channel's precision-voltage reference is not functioning properly. If this happens, the micro-controller flags that channel as having a fault condition. The CPU will then take whatever action the application engineer has provided for in the application program.

The readings from the precision-voltage reference are also used for on-line temperature compensation and automatic calibration for the module. The readings of the precision-voltage reference, obtained from the A/D converter, are used by the microcontroller to determine software scaling- and offset-constants for each channel. These scaling-and offset-constants are respectively multiplied by and added to each channel reading to provide corrected channel readings. The module therefore includes no potentiometers and needs no calibration.

Each I/O module has a fuse on it; this fuse is visible and can be changed through a cutout in the plastic cover of the module. If this fuse is blown, replace it with a fuse of the same type and size.

## Troubleshooting Guide

If a current 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 across the + and – inputs 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, look for a loose connection on the terminal blocks, disconnected or misconnected cables.
5. Check the software configuration to ensure that the input is configured properly.
6. If the other channels on the module are not working either, check the fuse on the Non-Standard 8Ch Current Input (0–25 mA) module. 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.
7. If the problem remains, swap out the Non-Standard 8Ch Current Input (0–25 mA) module with another module of the same part number. If the problem remains, replace the cable.
8. If the problem remains, 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.

## 9.10—Voltage Input Module

### 9.11—8 Channel Voltage Input (0-10 Vdc) Module

#### 9.11.1—Module Description

Each 8Ch Voltage Input (0-10 Vdc) Module has eight channels for 0-10 Vdc transducers. All eight channels are fully isolated double-ended voltage inputs. The module is connected through one Low Density Analog cable to one Analog Input FTM for field wiring connections. The module has a built-in precision voltage source. The readings from the precision-voltage reference are used for on-line temperature compensation and automatic calibration for the 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.



Figure 9-34—8 Channel Voltage Input (0-10 Vdc) Module

#### 9.11.2—Specification

Number of Channels:	8
Input Range:	0-10 Volts
Accuracy:	0.5% of full scale
Temperature Coefficient:	12 ppm/degrees C
Anti-aliasing filter:	2 poles at 12 ms (Channels 1-8)
Module interface:	VMEbus
Resolution:	16 bit converter
Isolation:	1500 Vac continuous (channel input to control common)
CMRR:	-90 db
Input Impedance:	$\geq 2 \text{ M}\Omega$
Status Indication:	RED LED - channel fault or board fault

### 9.11.3—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 8Ch Voltage Input module is connected through one analog cable to one FTM. All of the I/O are accessible on the FTM.

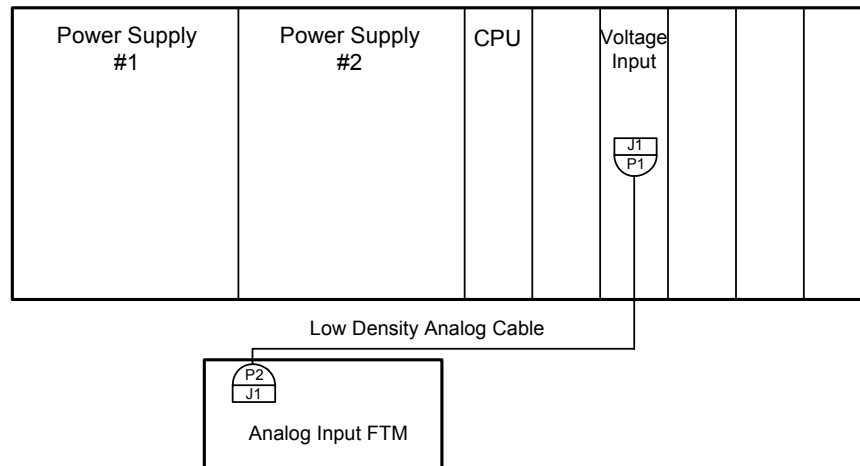


Figure 9-35—8Ch Voltage Input (0–10 Vdc) Module Configuration

### Field Wiring

See Chapter 13 for detail wiring connections for the Analog Input FTM. See Figure 9-36 for transducer wiring.

### 9.11.4—FTM Reference

See Chapter 13 for complete field wiring information for the Voltage Input (0–10 Vdc) FTM. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

### 9.11.5—Troubleshooting

The input MUX (multiplexer) permits the module to read either the value of the precision-voltage reference for this channel, or the sensed input for this channel. The MUX receives the voltage input and, under the control of the microcontroller, passes the value through the Gain amplifier to the Isolation Amplifier. The output of the Isolation Amplifier goes to one input of the channel-selecting MUX.

This MUX, under control of the microprocessor, selects the channel to be read. The analog output of this MUX is converted to a digital value by the A/D converter, and passed to the microcontroller. The microcontroller makes any necessary corrections to this value and stores the result in the Dual-Port RAM. The CPU can then access the values stored in Dual-Port RAM through the VME interface and bus. See Figure 9-37 for block diagram of module.

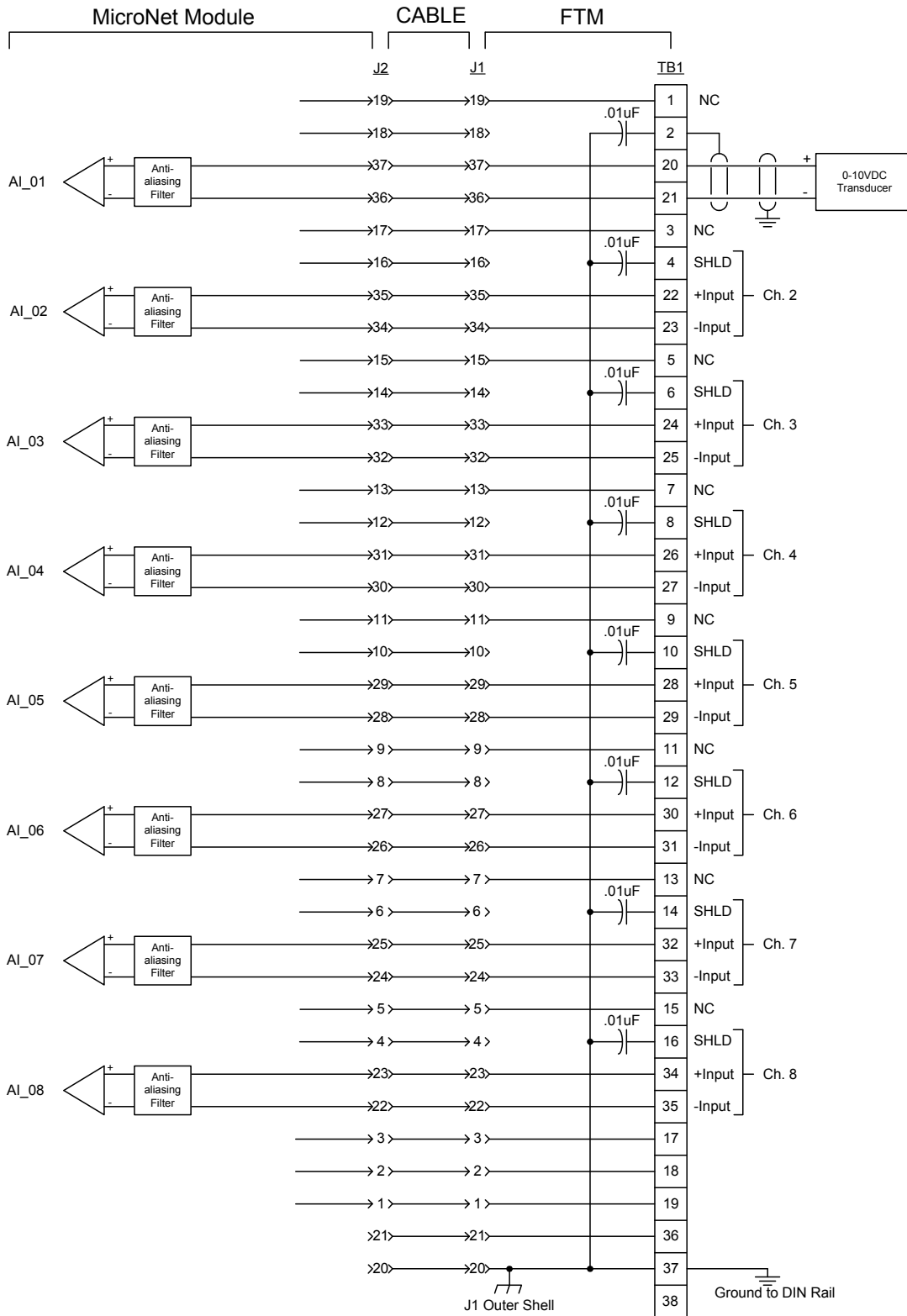


Figure 9-36—Voltage Input Wiring for an 8Ch Voltage Input (0–10 Vdc) Module

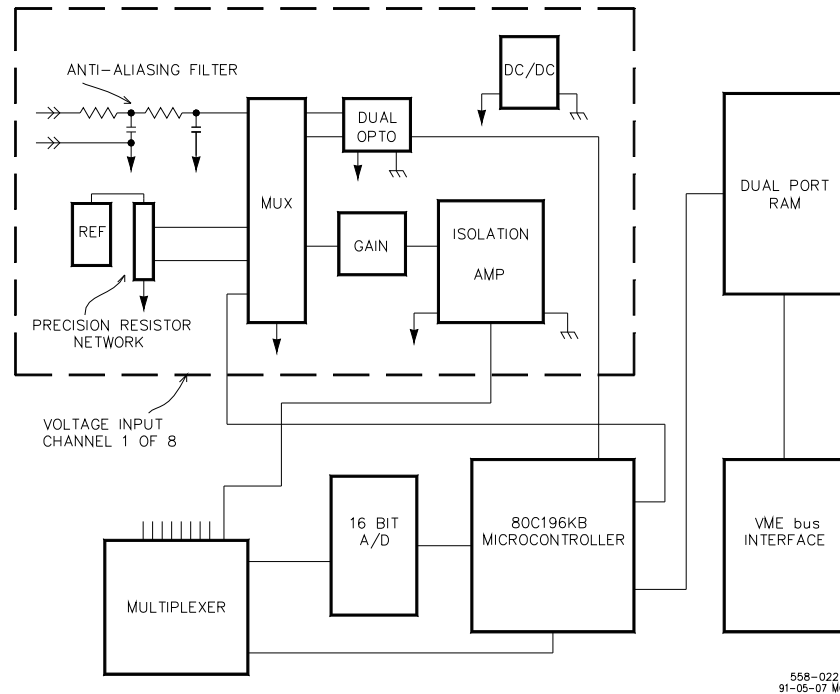


Figure 9-37—8Ch Voltage Input (0-10 Vdc) Module Block Diagram

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 is successful, the LED goes off.

During initialization of the module, the module's micro-controller turns the LED off after power-on self-tests have passed and the CPU has initialized the module.

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.

This module also has on-card on-line fault detection and automatic calibration/compensation. Each input channel has its own precision voltage reference. Once per minute, while not reading inputs, the on-board microcontroller reads this reference. The microcontroller then uses this data read from the voltage reference for both fault detection and automatic temperature compensation/calibration.

Limits have been set for the expected readings when the on-board microcontroller reads each voltage reference. If the reading obtained is outside these limits, the system determines that the input channel, A/D converter, or the channel's precision-voltage reference is not functioning properly. If this happens, the micro-controller flags that channel as having a fault condition. The CPU will then take whatever action the application engineer has provided for in the application program.



The readings from the precision-voltage reference are also used for on-line temperature compensation and automatic calibration for the module. The readings of the precision-voltage reference, obtained from the A/D converter, are used by the microcontroller to determine software scaling- and offset-constants for each channel. These scaling-and offset-constants are respectively multiplied by and added to each channel reading to provide corrected channel readings. The module therefore includes no potentiometers and needs no calibration.

Each I/O module has a fuse on it; this fuse is visible and can be changed through a cutout in the plastic cover of the module. If this fuse is blown, replace it with a fuse of the same type and size.

### Troubleshooting Guide

If a voltage 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 across the + and – inputs 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 V, look for a loose connection on the terminal blocks, disconnected or misconnected cables.
5. Check the software configuration to ensure that the input is configured properly.
6. If the other channels on the module are not working either, check the fuse on the 8Ch Voltage Input (0-10 Vdc) module. 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.
7. If the problem remains, swap out the 8Ch Voltage Input (0-10 Vdc) module with another module of the same part number. If the problem remains, replace the cable.
8. If the problem remains, 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.

## 9.12—Current Output Modules

There are two Current Output modules.

## 9.13—8Ch Current Output (4-20 mA) Module

### 9.13.1—Module Description

Each 8Ch Current Output (4-20 mA) Module has eight channels for outputting 0–25 mA. The module is connected through one Low Density Analog cable to one Analog Input FTM for field wiring connections.

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.



Figure 9-38—8 Channel Current Output (4-20 mA) Module

### 9.13.2—Specification

Number of Channels:	8
Current range:	0–25 mA
Maximum load resistance:	600 ohms max.
Analog Channel bandwidth:	500 Hz min.
Module interface:	VMEbus
Output update time:	1 ms
Resolution:	12 bit
Accuracy:	0.1% of full scale @25 degrees C
Maximum Drift:	50 ppm/degrees C
Status Indication:	RED LED - channel fault or board fault
Channel faults:	Output current monitored
Microcontroller faults:	System monitors a software watchdog
System faults:	All outputs are set to zero if MFT is lost.
Operating Temp:	0 to 70 °C
Isolation:	None

### 9.13.3—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 8Ch Current Output module is connected through one analog cable to one FTM. All of the I/O are accessible on the FTM.

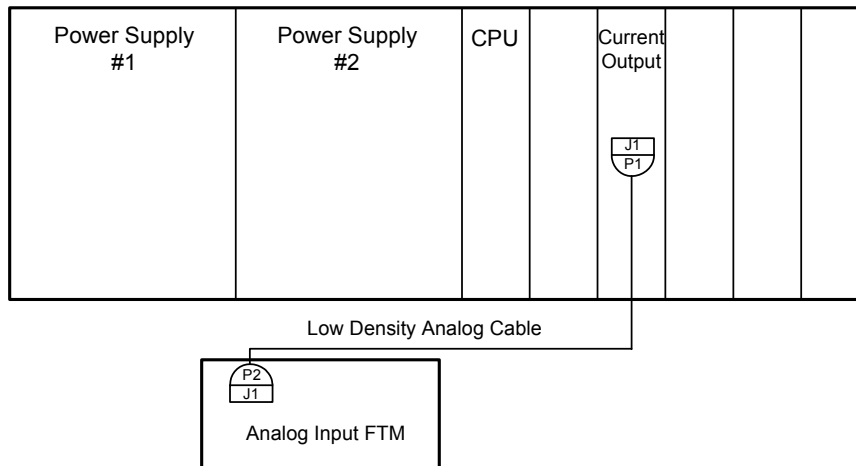


Figure 9-39—8Ch Current Output (4-20 mA) Module Configuration

There are 8 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 9-40 for analog output connection. 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 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.

### 9.13.4—FTM Reference

See Chapter 13 for complete field wiring information for the 8Ch Current Output (4–20 mA) FTM. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

### 9.13.5—Troubleshooting

The system writes output values to the Dual-Port RAM through the VME bus and interface. The microcontroller scales the data using calibration constants stored in EEPROM, and schedules outputs to occur at the proper time.

The microcontroller monitors the output current of each channel and alerts the system if a fault is detected. The current-output drivers can be disabled by the system. If a fault, which prevents the entire card from operating is detected by either the microcontroller or the system, the FAULT LED will illuminate. See Figure 9-41 for module block diagram.

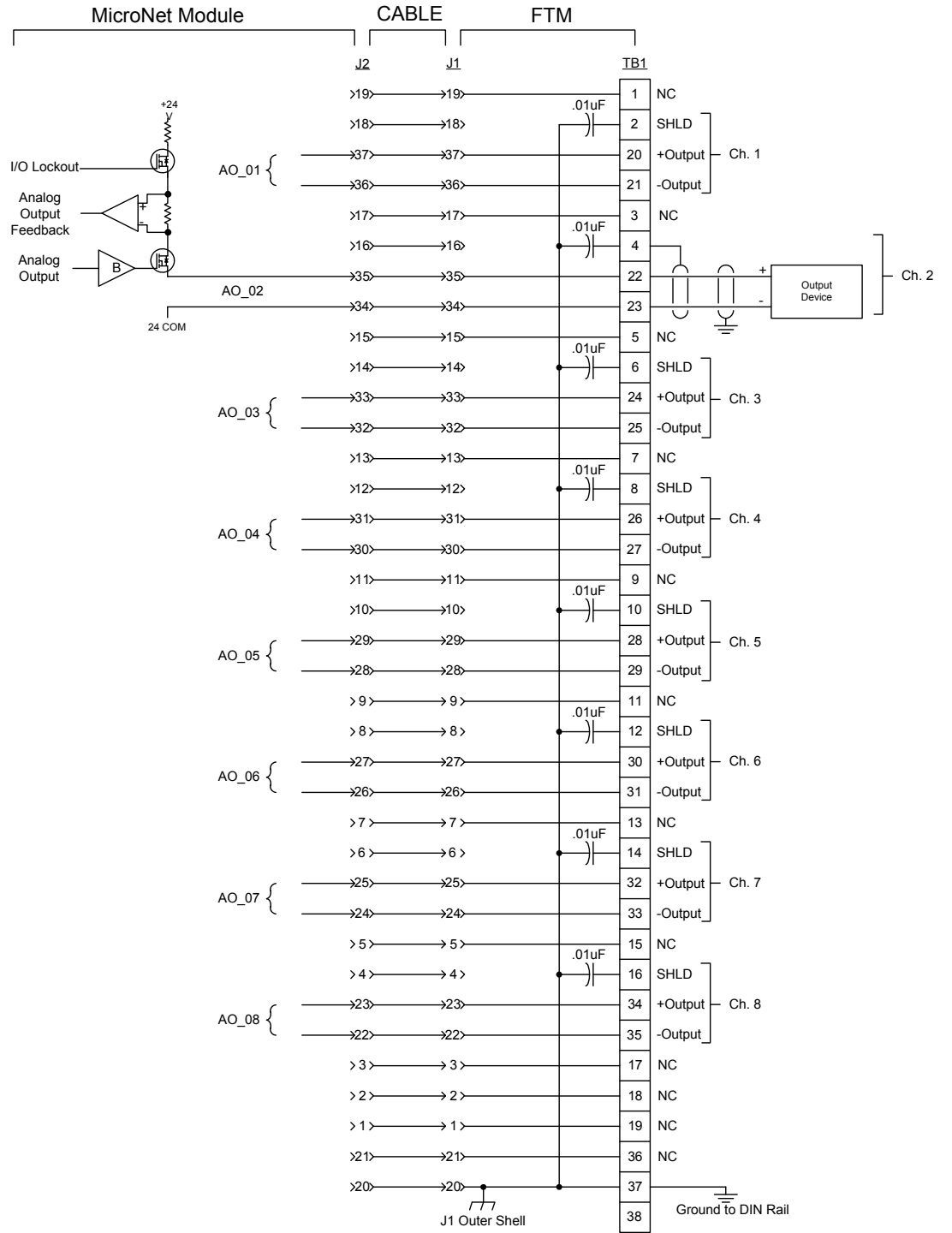


Figure 9-40—Analog Output Wiring for an 8Ch Current Output (4–20 mA) Module

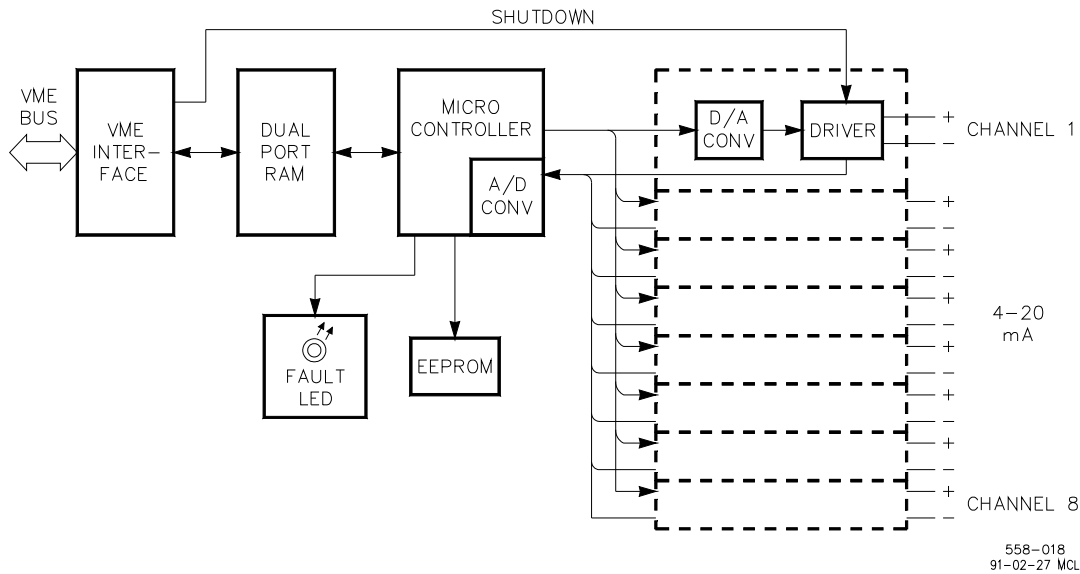


Figure 9-41—Current Output (4–20 mA) Module Block Diagram

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.
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 8Ch Current Output ( 4–20 mA) Module are also not working, check the fuse on the 8Ch Current Output ( 4–20 mA) Module. See instructions for module replacement in Chapter 15, Installation. 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, replace the 8Ch Current Output (4–20 mA) 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.

## 9.14—8Ch Current Output (0–1 mA) Module

### 9.14.1—Module Description

Each 8Ch Current Output (0-1 mA) Module has eight channels for outputting 0–1 mA. The module is connected through one Low Density Analog cable to one Analog Input FTM for field wiring connections. This module utilizes the same circuits that the 8Ch Current Output (0-20 mA) Module uses.

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.



Figure 9-42—8 Channel Current Output (0–1 mA) Module

### 9.14.2—Specification

Number of Channels:	8
Current range:	0–1.25 mA
Maximum load resistance:	10 k $\Omega$ max.
Analog Channel bandwidth:	500 Hz min.
Module interface:	VMEbus
Output update time:	1 ms
Resolution:	12 bit
Accuracy:	0.1% of full scale @25 °C
Maximum Drift:	50 ppm/degrees C
Status Indication:	RED LED - channel fault or board fault
Channel faults:	Output current monitored
Microcontroller faults:	System monitors a software watchdog
System faults:	All outputs are set to zero if MFT is lost.
Operating Temp:	0 to 70 °C
Isolation:	None

### **9.14.3—Installation**

See 8Ch Current Output (4-20 mA) Module.

### **9.14.4—FTM Reference**

See Chapter 13 for complete field wiring information for the 8Ch Current Output (0–1 mA) FTM. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

### **9.14.5—Troubleshooting**

See 8Ch Current Output (4-20 mA) Module.

## 9.15—Voltage Output Modules

There are two Current Output modules.

### 9.16—8Ch Voltage Output (0-5 Vdc ) Module

#### 9.16.1—Module Description

Each 8Ch Voltage Output (0-5 Vdc) Module has eight channels for outputting 0-5 Vdc. The module is connected through one Low Density Analog cable to one Analog Input FTM for field wiring connections.

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.

#### 9.16.2—Specification

Number of Channels:	8
Current range:	0 – 6.25 V
Minimum load resistance:	500 ohms
Analog Channel bandwidth:	500 Hz min.
Module interface:	VMEbus
Output update time:	1 ms
Resolution:	12 bit
Accuracy:	0.1% of full scale @25 °C
Maximum Drift:	50 ppm/degrees C
Status Indication:	RED LED - channel fault or board fault
Channel faults:	Output current monitored
Microcontroller faults:	System monitors a software watchdog
System faults:	All outputs are set to zero if MFT is lost.
Operating Temp:	0 to 70 °C
Isolation:	None





Figure 9-43—8 Channel Voltage Output (0-5 Vdc) Module

### 9.16.3—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 8Ch Voltage Output module is connected through one analog cable to one FTM. All of the I/O are accessible on the FTM.

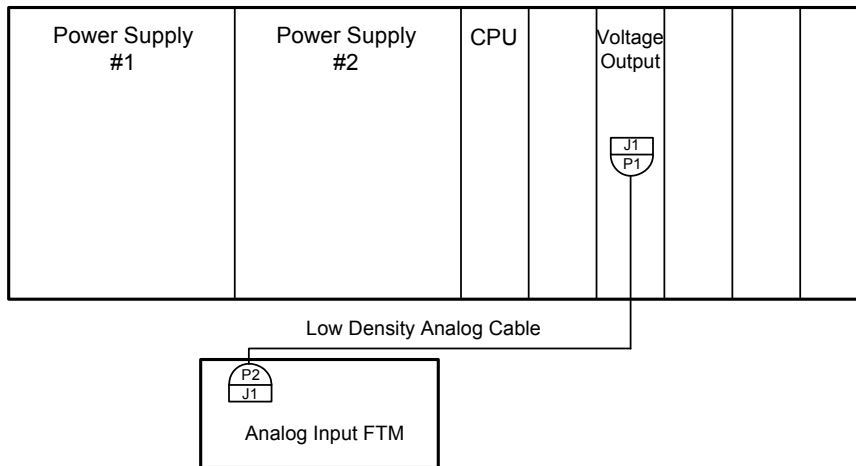


Figure 9-44—8Ch Voltage Output (0–5 Vdc) Module Configuration

There are 8 analog output channels of 0-5 Vdc with a full scale range of 0-6.25 Vdc. All Analog Outputs can drive a minimum load of 500 ohms (load + wire resistance). See Figure 9-45 for analog output connection. Each output monitors the output source voltage 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.

#### 9.16.4—FTM Reference

See Chapter 13 for complete field wiring information for the 8Ch Voltage Output (0–5 Vdc) FTM. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

#### 9.16.5—Troubleshooting

Figure 9-46 is a block diagram of the Voltage Output Module with eight 0-5 Vdc outputs.

The system writes output values to the Dual-Port RAM through the VME bus and interface. The microcontroller scales the data using calibration constants stored in EEPROM, and schedules outputs to occur at the proper time.

The microcontroller monitors the output voltage of each channel and alerts the system if a fault is detected. If a fault, which prevents the entire card from operating is detected by either the microcontroller or the system, the FAULT LED will illuminate.

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.
2. Check the load resistance to ensure that it is not less than 500 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 check that the output is correct across the FTM terminals. If the output is correct, there is a problem with the field wiring.
6. If the other output channels on the 8Ch Voltage Output (0-5 Vdc) Module are also not working, check the fuse on the 8Ch Voltage Output (0-5 Vdc) Module. See instructions for module replacement in Chapter 15, Installation. 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, replace the 8Ch Voltage Output (0-5 Vdc) 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.

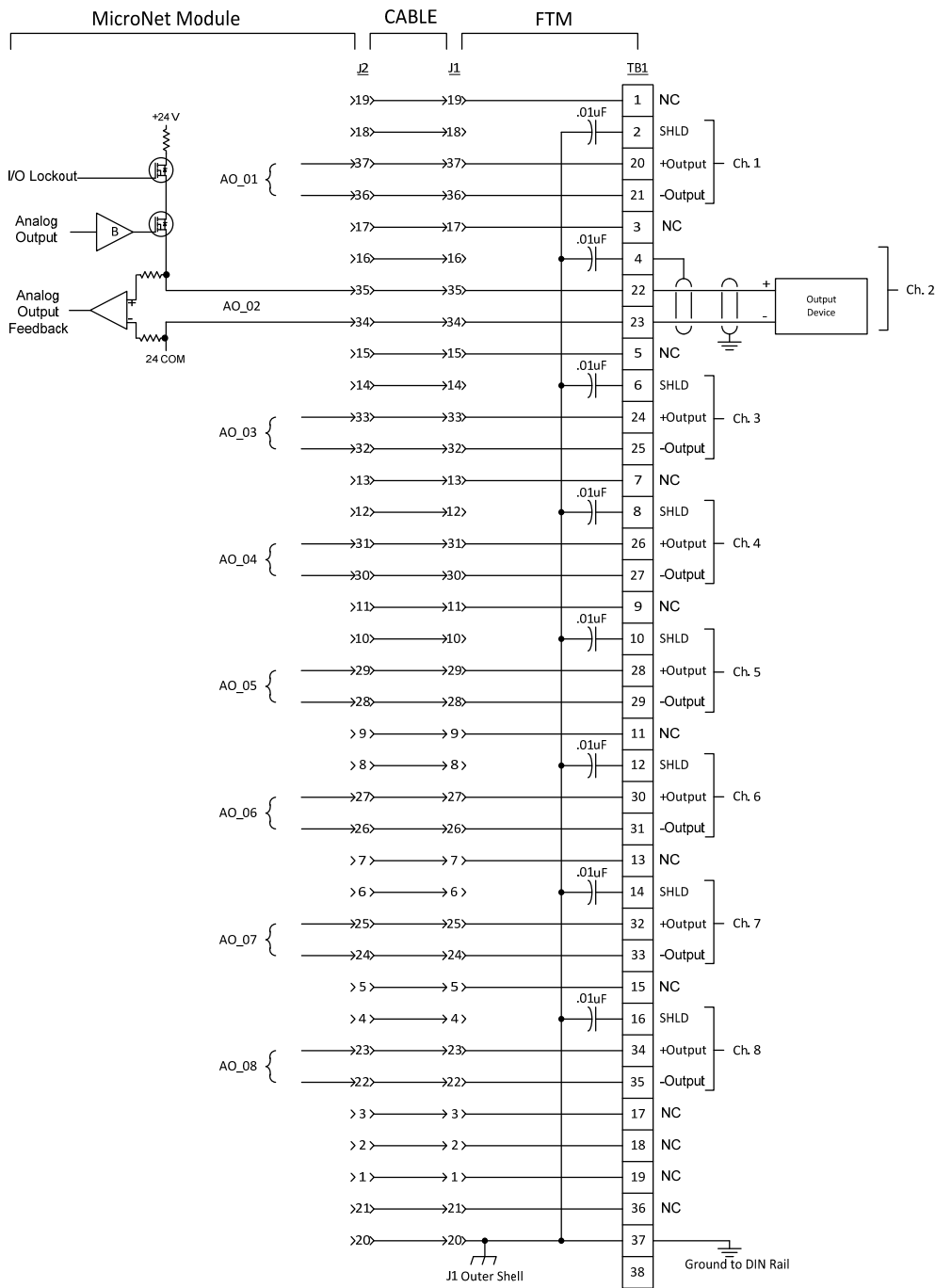


Figure 9-45—Analog Output Wiring for an 8Ch Voltage Output (0–5 Vdc) Module



### 9.17.2—Specification

Number of Channels:	8
Current range:	0 – 12.5 V
Maximum load resistance:	500 ohms min.
Analog Channel bandwidth:	500 Hz min.
Module interface:	VMEbus
Output update time:	1 ms
Resolution:	12 bit
Accuracy:	0.1% of full scale @25 °C
Maximum Drift:	50 ppm/degrees C
Status Indication:	RED LED - channel fault or board fault
Channel faults:	Output current monitored
Microcontroller faults:	system monitors a software watchdog
System faults:	All outputs are set to zero if MFT is lost.
Operating Temp:	0 to 70 °C
Isolation:	None

### 9.17.3—Installation

See 8Ch Voltage Output (0-5 Vdc) Module.

### 9.17.4—FTM Reference

See Chapter 13 for complete field wiring information for the 8Ch Voltage Output (0–10 Vdc) FTM. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

### 9.17.5—Troubleshooting

See 8Ch Voltage Output (0-5 Vdc) Module.

## 9.18—Thermocouple Input Modules

There are two Thermocouple Input modules.

### 9.19—8Ch TC (Fail Low) Module

#### 9.19.1—Module Description

There are eight fully isolated thermocouple channels on this module. Each channel receives a signal from a thermocouple. These signals can be from an E, J, K, R, S, or T type thermocouple. The same module can read all types of thermocouples. The GAP application configuration determines the type of thermocouple each channel reads. If an open thermocouple wire is detected by the module, the output of the channel will ramp down to its minimum value. There is a 9<sup>th</sup> Channel used to measure the reference junction temperature of the junction between the thermocouple and the copper traces on the FTM. This measurement is used to calculate the thermocouple measurement temperature through the GAP application. This cold junction measurement is located on the FTM and utilizes an AD590 temperature sensor. If the actual cold junction in the field wiring occurs elsewhere, the temperature of that junction must be brought into the control as a thermocouple, RTD, or 4–20 mA input, and the application software must be configured to use the appropriate cold junction temperature. The thermocouple and cold junction input units (°C or °F) should be consistent in the application software.

The board performs on-line temperature compensation and hardware diagnostics. 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.



Figure 9-48—8 Channel TC (Fail Low) Module

### 9.19.2—Specification

Number Channels: 8 double ended, fully isolated, thermocouple input channels  
1 cold junction channel.

(Type E, J, K, R, S, and T thermocouples must conform to the common commercial specification published in the Annual Book of ASTM Standards with voltage predictions in line with N.I.S.T. Monograph 175 or ITS-90.)

Table 9-6-Thermocouple Types and ranges:

T/C TYPE	LOW END °C (°F)	HIGH END °C (°F)
J	-40°C (-40°F)	1050°C (1922°F)
K	-40°C (-40°F)	1600°C (29125°F)
E	-40°C (-40°F)	800°C (1472°F)
R	-40°C (-40°F)	1750°C (3182°F)
S	-40°C (-40°F)	1750°C (3182°F)
T	-40°C (-40°F)	1050°C (1922°F)
CJ	-40°C (-40°F)	150°C (302°F)

Module interface: VMEbus  
 Open thermocouple detection: Fail Low  
 Output: Linearized temperatures in °C  
 Resolution: 16 bit converter  
 Accuracy: 0.5% of full scale over the entire temperature range  
 Temperature Coefficient: 12 ppm/degree C  
 Isolation: 1500 Vac continuous (channel input to control common)  
 Input Impedance: 2 MΩ

CMRR:	-90 db
Status Indication:	RED LED - channel fault or board fault
Cold Junction Comp:	AD590L IC sensor 1% accuracy (Located on FTM)

### 9.19.3—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 8Ch TC (Fail Low) module is connected through one low Density analog cable to one TC Input FTM. All of the I/O are accessible on the FTM.

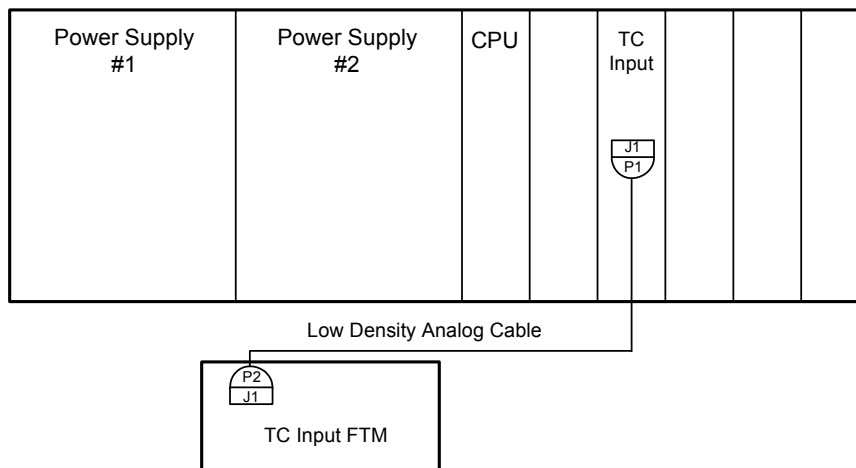


Figure 9-49—8Ch TC (Fail Low) Module Configuration

See Figure 9-50 for Thermocouple field wiring connections.

### 9.19.4—FTM Reference

See Chapter 13 for TC Input FTM information. See Appendix A for proper Module, FTM, and cable part numbers.

### 9.19.5—Troubleshooting

The board performs on-line temperature compensation and hardware diagnostics. To do this, once per minute, it reads two known voltages for each channel. These values are checked against certain limits to determine if a hardware fault has occurred. These values are also used to determine software scaling constants used for temperature compensation. The MUX receives the thermocouple input and, under the control of the microcontroller, passes the value through the gain amplifier to the isolation amplifier. The output of the isolation amplifier goes to one input of the channel-selecting MUX.

This MUX, under control of the microprocessor, selects the channel to be read. The analog output of this MUX is converted to a digital value by the A/D converter, and passed to the microcontroller. The microcontroller uses a lookup table to linearize the thermocouple readings and stores the result in the Dual-Port RAM. The CPU can then access the values stored in Dual-Port RAM through the VME interface and bus. Upon detection of an open wire on

the input, the channel will indicate a minimum scale reading. See Figure 9-51 for module block diagram.

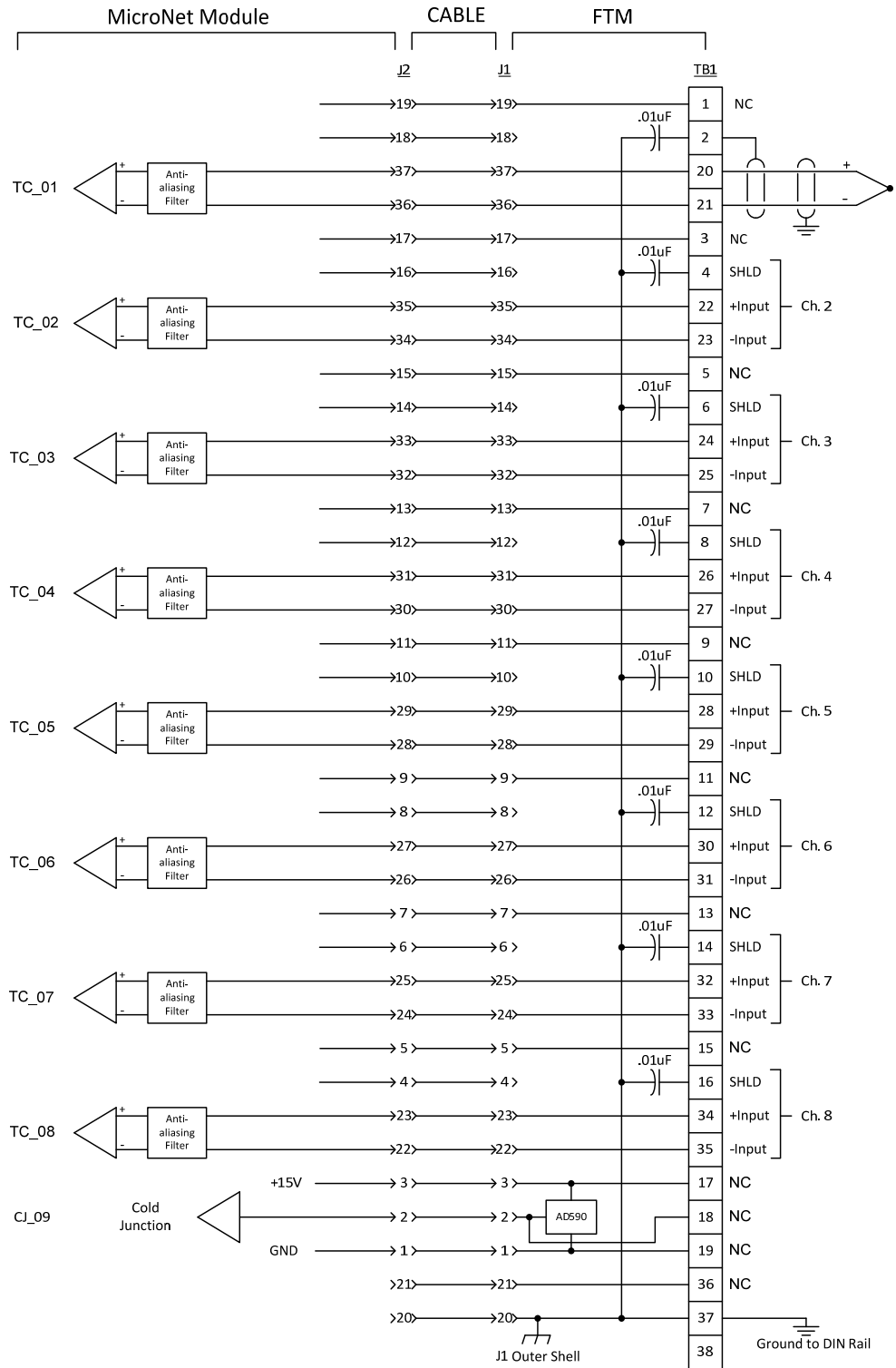


Figure 9-50—8Ch TC Input (Fail Low) Module Field Wiring



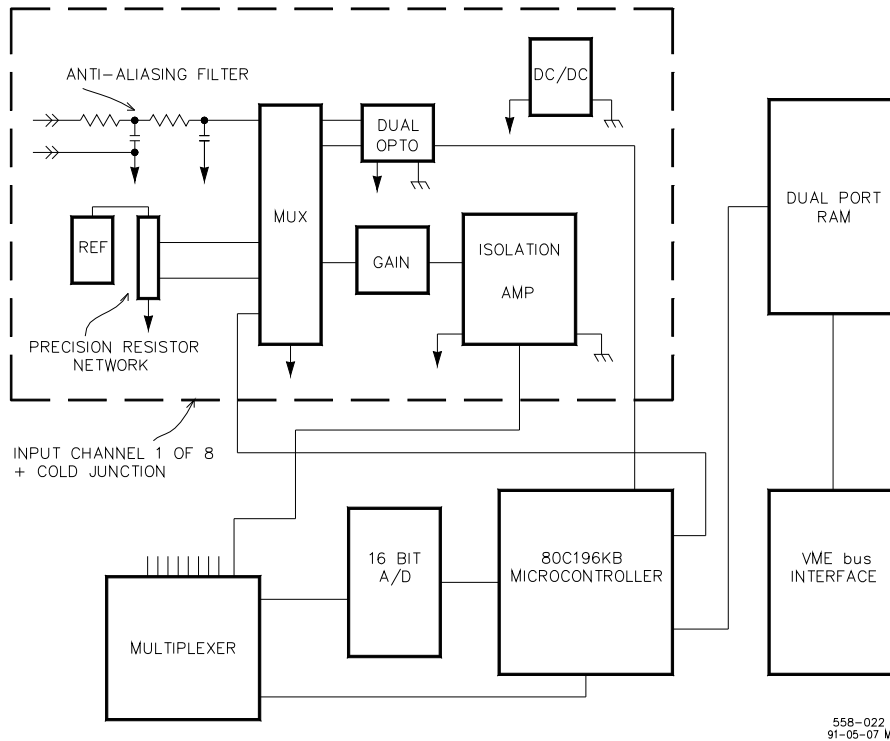


Figure 9-51—Thermocouple Input Block Diagram

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 is successful, the LED goes off.

During initialization of the module, the module's micro-controller turns the LED off after power-on self-tests have passed and the CPU has initialized the module.

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.

This module also has on-card on-line fault detection and automatic calibration/compensation. Each input channel has its own precision voltage reference. Once per minute, while not reading inputs, the on-board microcontroller reads this reference. The microcontroller then uses this data read from the voltage reference for both fault detection and automatic temperature compensation/calibration.

Limits have been set for the expected readings when the on-board microcontroller reads each voltage reference. If the reading obtained is outside these limits, the system determines that the input channel, A/D converter, or the channel's precision-voltage reference is not functioning properly. If this happens, the micro-controller flags that channel as having a fault condition. The CPU will then take whatever action the application engineer has provided for in the application program.

The readings from the precision-voltage reference are also used for on-line temperature compensation and automatic calibration for the module. The readings of the precision-voltage reference, obtained from the A/D converter, are used by the microcontroller to determine software scaling- and offset-constants for each channel. These scaling- and offset-constants are respectively multiplied by and added to each channel reading to provide corrected channel readings. The module therefore includes no potentiometers and needs no calibration.

Each I/O module has a fuse on it; this fuse is visible and can be changed through a cutout in the plastic cover of the module. If this fuse is blown, replace it with a fuse of the same type and size.

#### **Troubleshooting Guide**

If a Thermocouple 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 appropriate millivolt signal.
3. Verify that there are no or minimal AC components to the Analog Input signal. AC components can be caused by improper shielding. Thermocouple inputs are extremely sensitive to signal fluctuations.
4. If the input is reading minimum range, look for a loose connection at the terminal blocks and disconnected or misconnected cables.
5. If all the temperature measurements are offset by a fixed amount, check for proper cold junction location. Replace the FTM.
6. Check the software configuration to ensure that the input is configured properly. Ensure that the proper thermocouple type is selected.
7. After verifying all of the above, replace the 8Ch TC module.

## 9.20—8Ch TC (Fail High) Module

### 9.20.1—Module Description

There are two types of the Thermocouple (Fail High) modules. The standard module is the same as the 8Ch TC (Fail Low) Module except when a failure is detected, the signal will indicate a full scale value. The Non-standard 8Ch TC (Fail High) module has replaced the type “E” table with a type “N” table and also fails high when a failure is detected.

### 9.20.2—Specification

Number Channels: 8 double ended, fully isolated, thermocouple input channels  
1 cold junction channel.

(Type E, J, K, N, R, S, and T thermocouples must conform to the common commercial specification published in the Annual Book of ASTM Standards with voltage predictions in line with N.I.S.T. Monograph 175 or ITS-90.)



Figure 9-52—8 Channel TC (Fail High) Module

Table 9-7-Thermocouple Types and ranges:

T/C TYPE	LOW END °C (°F)	HIGH END °C (°F)
J	-40°C (-40°F)	1050°C (1922°F)
K	-40°C (-40°F)	1600°C (29125°F)
E	-40°C (-40°F)	800°C (1472°F)
R	-40°C (-40°F)	1750°C (3182°F)
S	-40°C (-40°F)	1750°C (3182°F)
T	-40°C (-40°F)	1050°C (1922°F)
N	-40°C (-40°F)	1051°C (1925°F)
CJ	-40°C (-40°F)	150°C (302°F)

Module interface:	VMEbus
Open thermocouple detection:	Fail Low
Output:	Linearized temperatures in °C
Resolution:	16 bit converter
Accuracy:	0.5% of full scale over the entire temperature range
Temperature Coefficient:	12 ppm/degree C
Isolation:	1500 Vac continuous (channel input to control common)
Input Impedance:	2 MΩ
CMRR:	-90 db
Status Indication:	RED LED - channel fault or board fault
Cold Junction Comp:	AD590L IC sensor 1% accuracy

### 9.20.3—Installation

See 8Ch TC (Fail Low) Module.

### 9.20.4—FTM Reference

See Chapter 13 for complete field wiring information for the 8Ch TC (Fail High) FTM. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

### 9.20.5—Troubleshooting

See 8Ch TC (Fail Low) Module.

## 9.21—RTD Input Modules

There are four RTD (Resistance Temperature Device) Input modules.

### 9.22—8Ch RTD Input (10 ohm)

#### 9.22.1—Module Description

The eight channels of this module are semi-isolated. The channels are isolated from the control common but not from each other. Each channel receives a signal from an RTD. This signal must be from a 10Ω Copper RTD with the following temperature to Resistance relationship:

$$T=(R*25.95)-(234.5)$$

Where R= resistance of copper RTD (ohms)  
T= °C

The board performs on-line temperature compensation and hardware diagnostics. 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.



Figure 9-53—8 Channel RTD Input Module (10 ohm)

### 9.22.2—Specification

Number of Channels:	8 semi-isolated, RTD channels
Input Type:	3 wire
(Must conform to 10 ohm copper RTD temperature/resistance relationship (Alpha = .00427))	
Temperature range:	−40 to +300 °C
Module interface:	VMEbus
Output:	Linearized temperatures in °C
Resolution:	14 bit converter
Accuracy:	0.5% of full scale over the entire temperature range
Temperature Coefficient:	12 ppm/degrees C
Isolation:	1500 Vac continuous (input channels to control common, not channel to channel)
Input Impedance:	2.2 MΩ
CMRR:	-90 db
Status Indication:	RED LED - channel fault or board fault
Excitation:	4 mA

### 9.22.3—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 8Ch RDT Input Module is connected through one low Density analog cable to one Analog Input FTM. All of the I/O are accessible on the FTM.

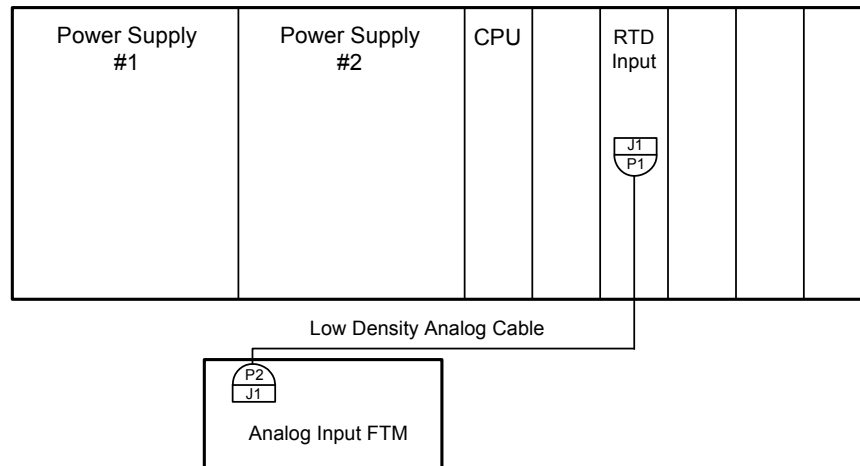


Figure 9-54—8Ch RTD Module Configuration

See Figure 9-55 for RTD field wiring connections.

### 9.22.4—FTM Reference

See Chapter 13 for complete field wiring information for the 8Ch RTD Input (10 ohm) FTM. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

### 9.22.5—Troubleshooting

The board performs on-line temperature compensation and hardware diagnostics. To do this, once per minute, it reads two known voltages for each channel. These values are checked against certain limits to determine if a hardware fault has occurred. These values are also used to determine software scaling constants used for temperature compensation. The MUX receives the RTD input and, under the control of the microcontroller, passes the value through the gain amplifier to the isolation Amplifier. The gain amplifier introduces the proper gain for the type of RTD used. The output of the isolation amplifier goes to one input of the channel-selecting MUX.

This MUX, under control of the microprocessor, selects the channel to be read. The analog output of this MUX is converted to a digital value by the A/D converter, and passed to the microcontroller. The microcontroller uses a lookup table to linearize the RTD reading and stores the result in the Dual-Port RAM. The CPU can then access the values stored in Dual-Port RAM through the VME interface and bus. See Figure 9-56 for module block diagram.

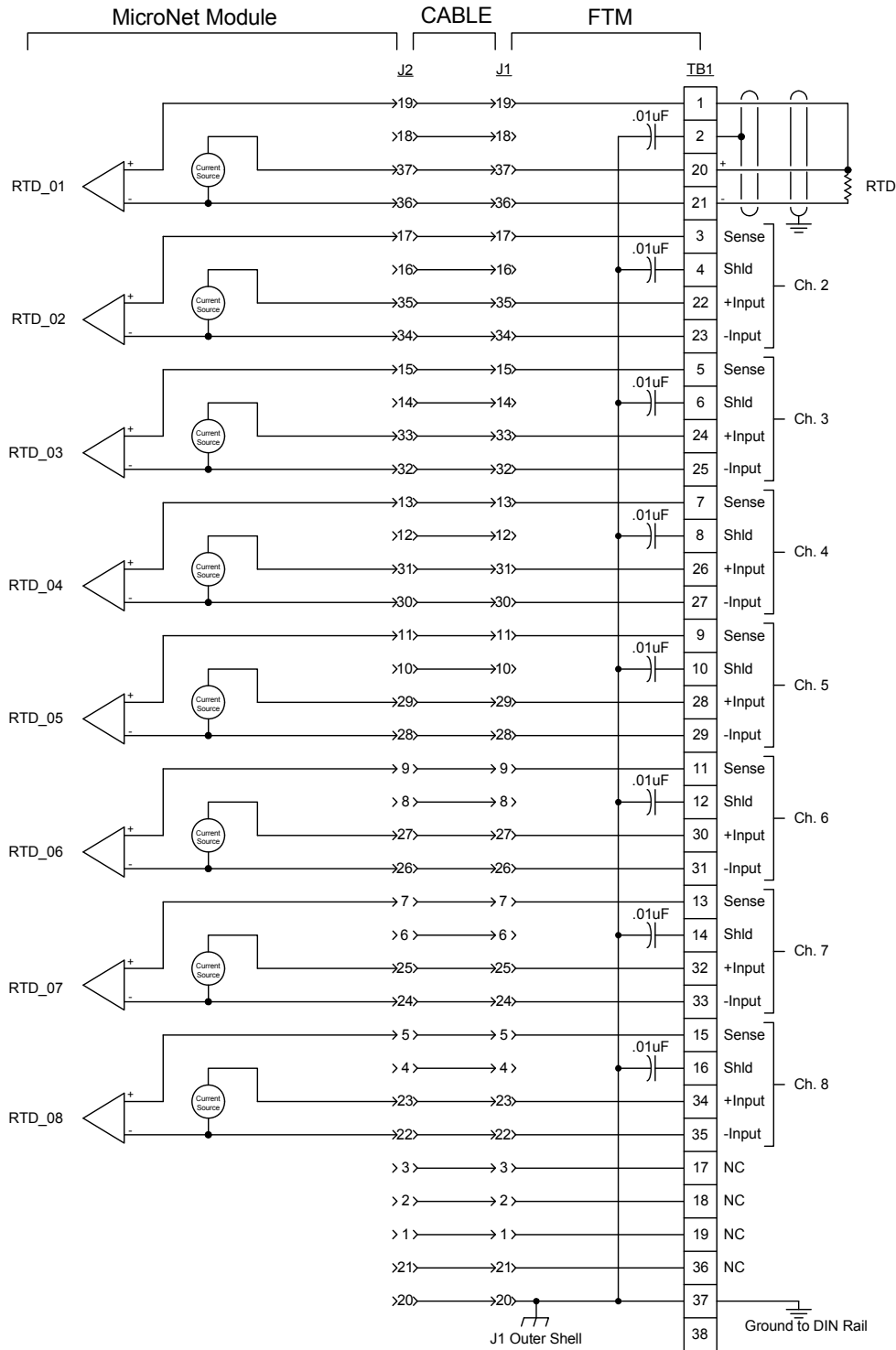


Figure 9-55—8Ch RTD Input Module Field Wiring

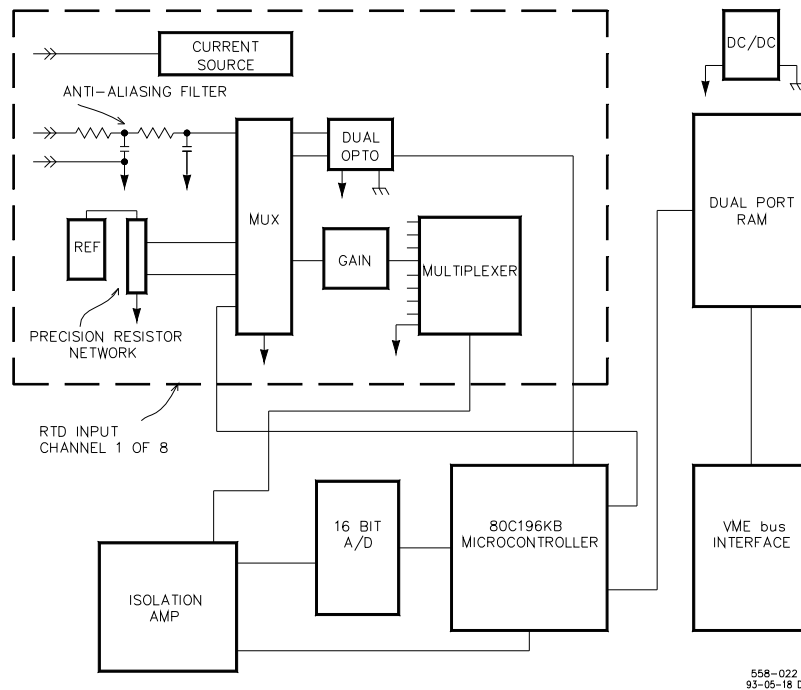


Figure 9-56—RTD Input Block Diagram

558-022 E  
93-05-18 DAR

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 is successful, the LED goes off.

During initialization of the module, the module's micro-controller turns the LED off after power-on self-tests have passed and the CPU has initialized the module.

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.

This module also has on-card on-line fault detection and automatic calibration/compensation. Each input channel has its own precision voltage reference. Once per minute, while not reading inputs, the on-board microcontroller reads this reference. The microcontroller then uses this data read from the voltage reference for both fault detection and automatic temperature compensation/calibration.

Limits have been set for the expected readings when the on-board microcontroller reads each voltage reference. If the reading obtained is outside these limits, the system determines that the input channel, A/D converter, or the channel's precision-voltage reference is not functioning properly. If this happens, the micro-controller flags that channel as having a fault condition. The CPU will then take whatever action the application engineer has provided for in the application program.



The readings from the precision-voltage reference are also used for on-line temperature compensation and automatic calibration for the module. The readings of the precision-voltage reference, obtained from the A/D converter, are used by the microcontroller to determine software scaling- and offset-constants for each channel. These scaling-and offset-constants are respectively multiplied by and added to each channel reading to provide corrected channel readings. The module therefore includes no potentiometers and needs no calibration.

Each I/O module has a fuse on it; this fuse is visible and can be changed through a cutout in the plastic cover of the module. If this fuse is blown, replace it with a fuse of the same type and size.

### Troubleshooting Guide

If an RTD 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 (Sense to – input). It should be in the range generated by a 4 mA current source across the RTD.
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 for proper connection of the sense line.
5. Check the software configuration to ensure that the input is configured properly. Ensure that the proper RTD is selected. Ensure that the Lag input Tau is set to at least 0.200.
6. If replacing the module does not fix the problem, replace the FTM. See the instructions in Chapter 15, Installation, for replacing the FTM. The FTM contains only traces and a few discrete components, so failure is extremely unlikely.

## 9.23—8Ch RTD Input (100 ohm)

### 9.23.1—Module Description

The eight channels of this module are semi-isolated. The channels are isolated from the control common but not from each other. Each channel receives a signal from an RTD. This signal must be from a 100 $\Omega$  Platinum RTD (European or American curve). There are two types of 100 ohm modules. The standard module has the same temperature ranges for the American and European curves (–40 to +450 °C). The high temperature module has a temperature range of –40 to +450 °C for the American curve and –40 to +645 °C for the European curve.



Figure 9-57—8 Channel RTD Input Module (100 ohm)

### 9.23.2—Specification

Number of Channels: 8 semi-isolated, RTD channels  
 Input Type: 3 wire

(Must conform to (Deutsche Institut für Normung) DIN standard for 100 ohm European curve (Alpha = .00385) or American curve 100 ohm curve (Alpha = .00392))

#### Temperature ranges

Standard module: –40 to +450 °C (100 ohm platinum, American, European)

High Temp Module: –40 to +645 °C (100 ohm platinum, European)  
 –40 to +450 °C (100 ohm platinum, American)

Excitation: 2 mA

Module interface: VMEbus

Output: Linearized temperatures in °C

Resolution:	14 bit converter
Accuracy:	0.5% of full scale over the entire temperature range
Temperature Coefficient:	12 ppm/degree C
Isolation:	1500 Vac continuous (input channels to control common, not channel to channel)
Input Impedance:	2.2 M $\Omega$
CMRR:	-90 db
Status Indication:	RED LED - channel fault or board fault

### 9.23.3—Installation

See 8Ch RTD Input (10 ohm) Module.

### 9.23.4—FTM Reference

See Chapter 13 for complete field wiring information for the 8Ch RTD Input (100 ohm) FTM. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

### 9.23.5—Troubleshooting

See 8Ch RTD Input (10 ohm) Module.

## 9.24—8Ch RTD Input (200 ohm)

### 9.24.1—Module Description

The eight channels of this module are semi-isolated. The channels are isolated from the control common but not from each other. Each channel receives a signal from an RTD. This signal must be from a 200 $\Omega$  Platinum RTD (European or American curve).



Figure 9-58—8 Channel RTD Input Module (200 ohm)

**9.24.2—Specification**

Number of Channels: 8 semi-isolated, RTD channels  
 Input Type: 3 wire

(Must conform to (Deutsche Institut für Normung) DIN standard for 200 ohm European curve (Alpha = .00385) or American curve 200 ohm curve (Alpha = .00392))

Temperature ranges	-40 to +450 °C (200 ohm platinum, American, European)
Excitation:	1 mA
Module interface:	VMEbus
Output:	Linearized temperatures in °C
Resolution:	14 bit converter
Accuracy:	0.5% of full scale over the entire temperature range
Temperature Coefficient:	12 ppm/degree C
Isolation:	1500 Vac continuous (input channels to control common, not channel to channel)
Input Impedance:	2.2 MΩ
CMRR:	-90 db
Status Indication:	RED LED - channel fault or board fault

**9.24.3—Installation**

See 8Ch RTD Input (10 ohm) Module.

**9.24.4—FTM Reference**

See Chapter 13 for complete field wiring information for the 8Ch RTD Input (200 ohm) FTM. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

**9.24.5—Troubleshooting**

See 8Ch RTD Input (10 ohm) Module.

## 9.25—8Ch RTD Input (500 ohm)

### 9.25.1—Module Description

The eight channels of this module are semi-isolated. The channels are isolated from the control common but not from each other. Each channel receives a signal from an RTD. This signal must be from a 500 $\Omega$  Platinum RTD (European or American curve).



Figure 9-59—8 Channel RTD Input Module (500 ohm)

### 9.25.2—Specification

Number of Channels: 8 semi-isolated, RTD channels  
Input Type: 3 wire

(Must conform to (Deutsche Institut für Normung) DIN standard for 500 ohm European curve (Alpha = .00385) or American curve 500 ohm curve (Alpha = .00392))

Temperature ranges	–40 to +450 °C (500 ohm platinum, American, European)
Excitation:	400 a
Module interface:	VMEbus
Output:	Linearized temperatures in °C
Resolution:	14 bit converter
Accuracy:	0.5% of full scale over the entire temperature range
Temperature Coefficient:	12 ppm/degree C
Isolation:	1500 Vac continuous (input channels to control common, not channel to channel)
Input Impedance:	2.2 M $\Omega$
CMRR:	-90 db
Status Indication:	RED LED - channel fault or board fault

**9.25.3—Installation**

See 8Ch RTD Input (10 ohm) Module.

**9.25.4—FTM Reference**

See Chapter 13 for complete field wiring information for the 8Ch RTD Input (500 ohm) FTM. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

**9.25.5—Troubleshooting**

See 8Ch RTD Input (10 ohm) Module.

## 9.26—4Ch MPU/Proximity Module

There are many configurations of the MPU/Proximity Module. See Appendix A for the various part numbers.

### 9.26.1—Module Description

This module has four speed inputs that can be configured as either transformer isolated MPU inputs or non-isolated proximity inputs. The configuration of MPU and proximity inputs is dependent on the part 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.

#### **IMPORTANT**

For compatibility with the CPU5200 (Cyber-Security), the minimum required revisions of the 4Ch MPU/Proximity modules are shown in the chart below:

Table 9-8-Minimum Required Revisions of the 4Ch MPU/Proximity Modules

Woodward Item Number	Revision required for use with CPU5200 (Cyber-Security)
5463-787	Revision P and later
5464-015	Revision M and later
5464-414	Revision H and later
5464-658	Revision K and later
5464-659	Revision H and later
5464-834	Revision K and later
5464-844	Revision G and later
5464-850	Revision G and later
5466-404	Revision D and later
5466-405	Revision C and later



### 9.26.2—Specification

Number Channels:	4
Input Type:	MPU/Proximity Detector (factory selected by part number)
Input Frequency Range:	MPU: 50 Hz to 25 KHz Prox: 0.04 Hz to 2 KHz
Input Amplitude:	MPU: 1 Vrms min, 25 Vrms max, Freq > 20 Hz Prox: 10 mA
Input Impedance:	MPU: 2000 $\Omega$ Prox: 2000 $\Omega$
Isolation Voltage:	MPU: 500 Vrms Prox: None
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 +55 °C



Figure 9-60—4 Channel MPU/Proximity Module

### 9.26.3—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.

Any of the module's four speed channels accept passive magnetic pickup units (MPUs) or proximity probes. The number of MPU and proximity inputs per module is determined by the position of jumpers internal to the module. These jumpers are factor set. The part number of the module will determine the ratio of MPU to Proximity inputs. Each speed input channel can only accept one MPU or one proximity probe. See Appendix A for desired part number of modules.

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. See Figure 7-62 for MPU and proximity probe wiring examples.

<b>IMPORTANT</b>	<p>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.</p>
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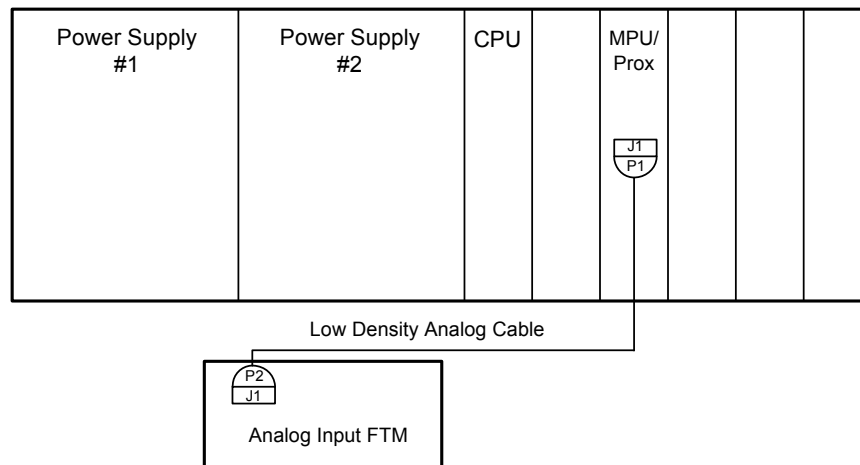


Figure 9-61—4Ch MPU/Proximity Module

### 9.26.4—FTM Reference

See Figure 9-62 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.

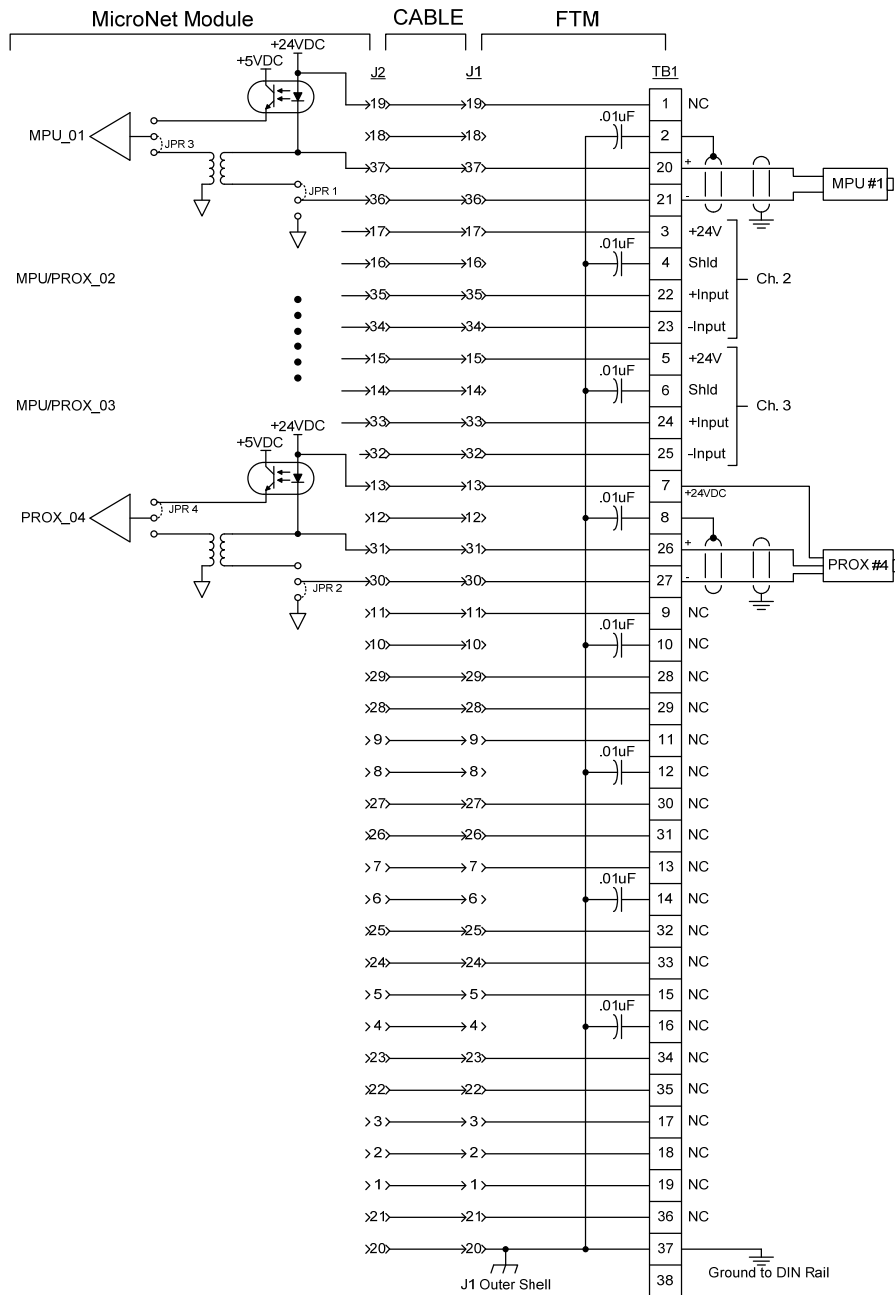


Figure 9-62—MPU and Proximity Probe Interface Wiring

## 9.26.5—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.

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 is successful, the LED goes off.

During initialization of the module, the module's micro-controller turns the LED off after power-on self-tests have passed and the CPU has initialized the module.

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.

Each I/O module has a fuse on it; this fuse is visible and can be changed through a cutout in the plastic cover of the module. If this fuse is blown, replace it with a fuse of the same type and size.

### 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.

**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 15, Installation.
2. Measure the input voltage on the terminal block. It should be in the range of 3.5 - 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 0.5 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.

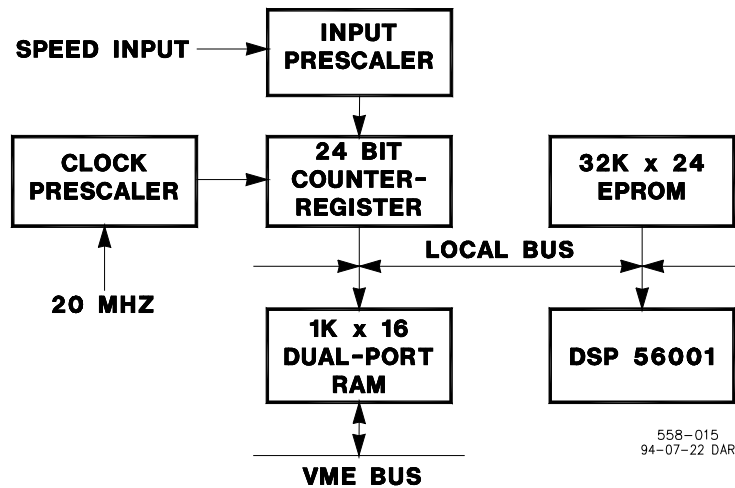


Figure 9-63—Digital Speed Sensor Module Block Diagram

## 9.27—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.

### 9.27.1—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.

### 9.27.2—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 $\Omega$ Eddy: 2000 $\Omega$
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 9-64— Speed Sensor Smart-Plus Module

### 9.27.3—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.

A Eddy probe may be used to sense very low speeds. With a Eddy probe, speed can be sensed down to 1 Hz. See Figure 9-66 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.

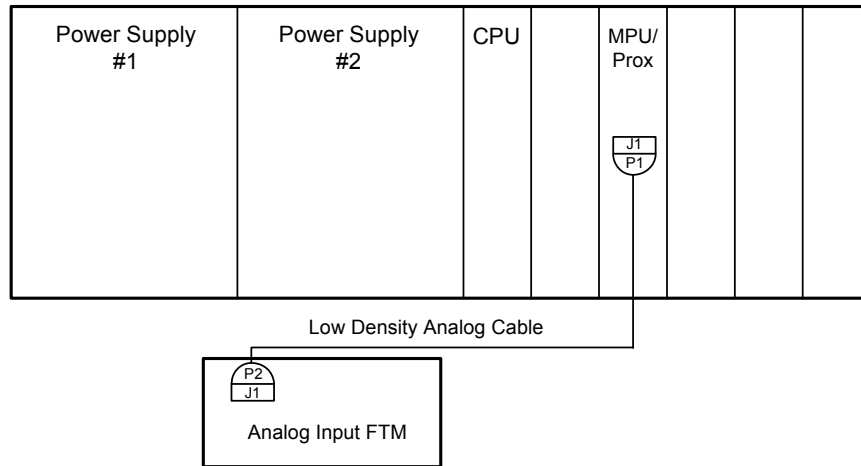


Figure 9-65—4Ch MPU/Eddy Module

**9.27.4—FTM Reference**

See Figure 9-66 below for complete field wiring information for the 4Ch MPU/Eddy FTM. Note the ground connection on pin 37 of the FTM.

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

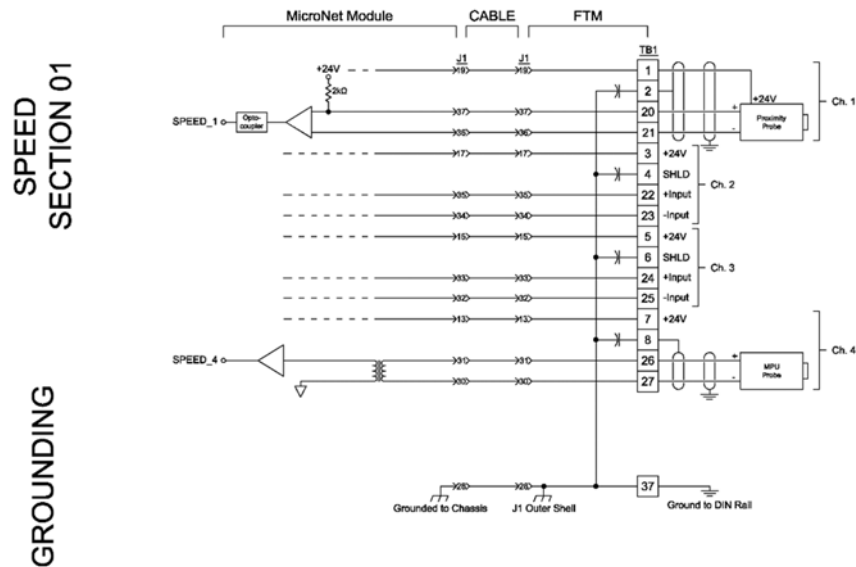


Figure 9-66—MPU and Eddy Probe Interface Wiring



### 9.27.5—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.

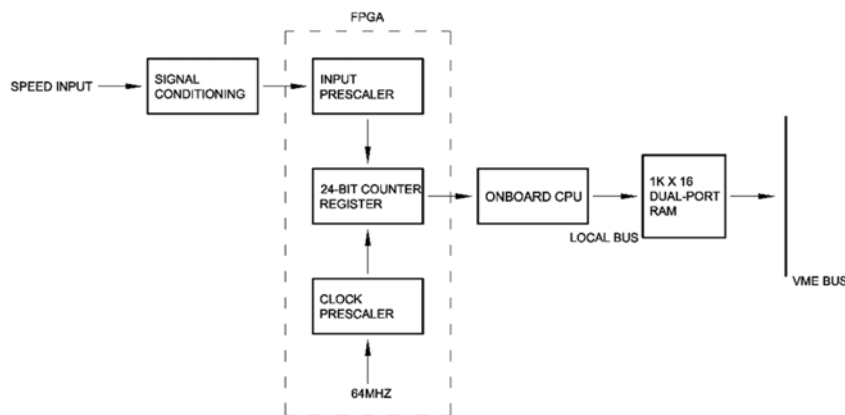


Figure 9-67—Digital Speed Sensor Module Block Diagram

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 9-9—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:

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.

## 9.28—24/8 Analog Smart Plus Module

### 9.28.1—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 8 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).
2. 24 channels of 4-20 mA inputs with 8 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 8 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 9-68—24/8 Analog Smart Plus Module

### 9.28.2—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
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:	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 voltage rejection
Read backResolution:	
Source:	12 bits
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 (pending release in Q2 2016) must be used with Coder Version 5.08 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.

**9.28.3—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.

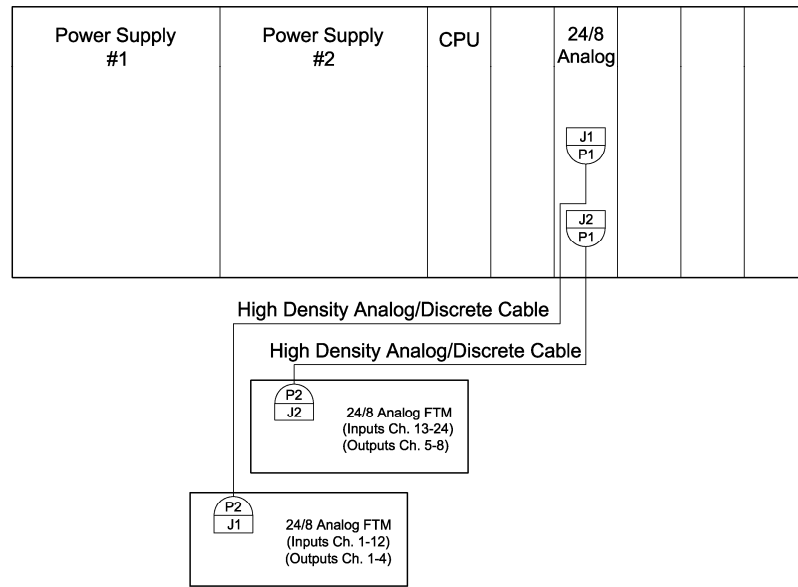


Figure 9-69—Simplex System Configuration Example

### 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  $\pm 10\%$  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**

Input type configuration is factory set for backward compatible part numbers.

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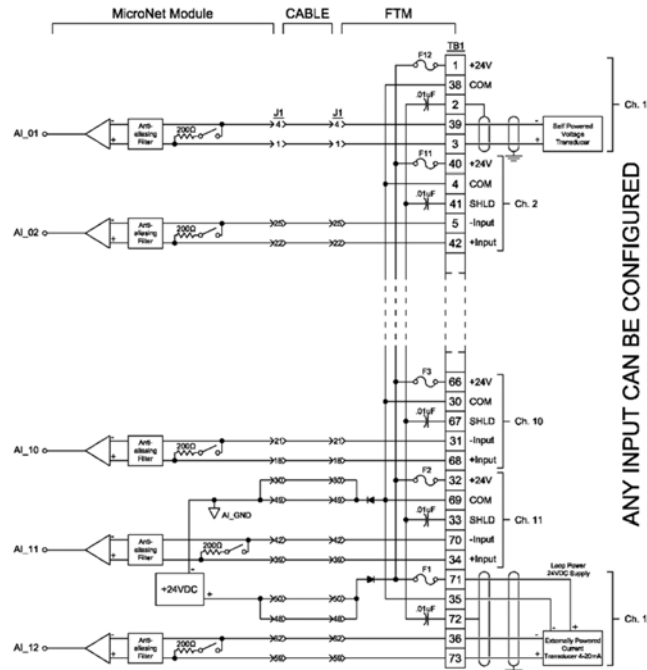


Figure 9-70—Analog Input Wiring for a 24/8 Analog FTM

**Analog Outputs**

There are 8 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.

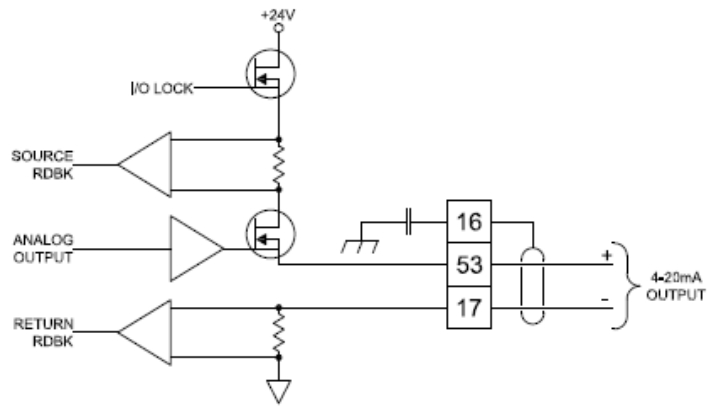


Figure 9-71—Analog Output Wiring for a 24/8 Analog FTM



### 9.28.4—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.

### 9.28.5—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 9-10—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.

## 9.29—Speed/Analog IO Combo Smart-Plus Module

**Note:** This module is pending release in Q2 of 2016.

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.

### 9.29.1—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.

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.

### 9.29.2—Specification

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 $\Omega$ or 6000 $\Omega$ over 80 to 2000Hz

#### Prox ratings

Input Frequency Range:	0.04 Hz to 25 KHz
Input Amplitude:	0-24Vpk,
Input Impedance:	2000 $\Omega$ 12mA short circuit current

#### Eddy ratings

Input Frequency Range:	1 Hz to 25 KHz
Input Amplitude:	0-24Vpk,
Input Impedance:	2000 $\Omega$ 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/N5466-1105	0.01% over temperature range
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 voltage rejection
Read backResolution:	
Source:	12 bits
Return:	8 bits
Read back accuracy:	0.5% of 0-25 mA full scale
Read back temp drift:	400 ppm/C, maximum

Two versions 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 9-72— Speed/Analog IO Combo Smart-Plus Module

### 9.29.3—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.

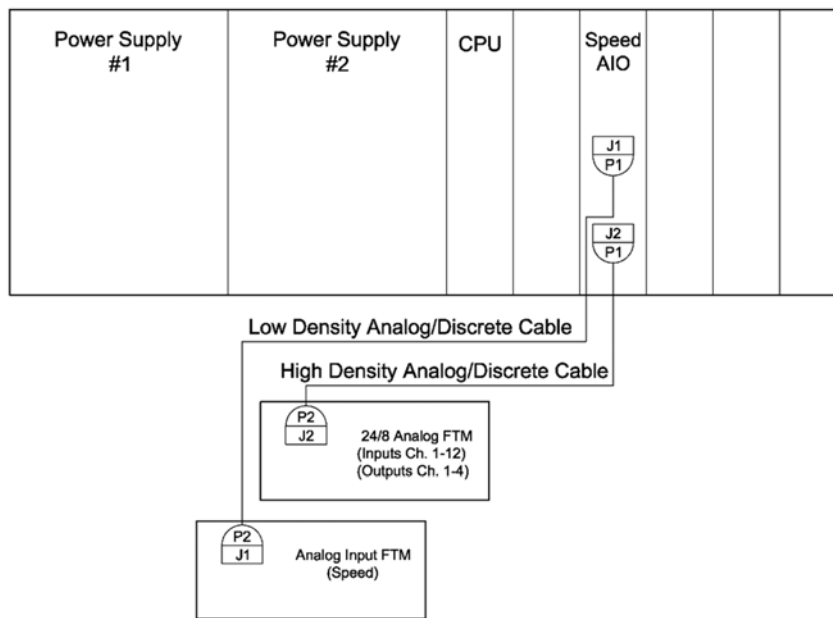


Figure 9-73— Simplex System Configuration Example.

### 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**

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 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.

### 9.29.4—FTM Reference

See Figure 9-74 below for complete field wiring information for the 4Ch MPU/Eddy FTM. Note the ground connection on pin 37 of the FTM.

See Appendix A for part number Cross Reference for modules, FTM's, and cables.

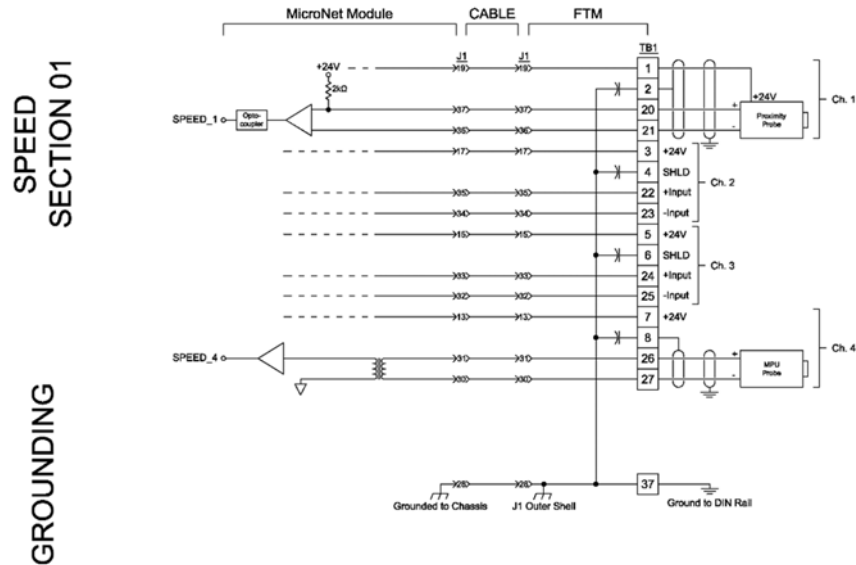


Figure 9-74—MPU and Prox Probe Interface Wiring

#### 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  $\pm 10\%$  regulation. Power connections can be made through terminals located on the 24/8 Analog FTM's. 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.

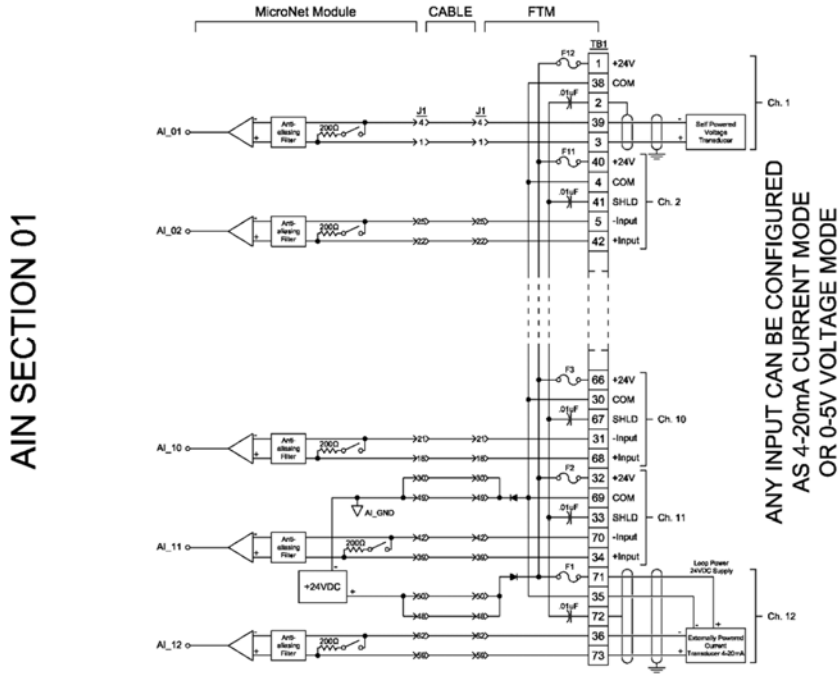


Figure 9-75—Analog Input Wiring for a 24/8 Analog FTM

**Analog Outputs**

There are 4 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.

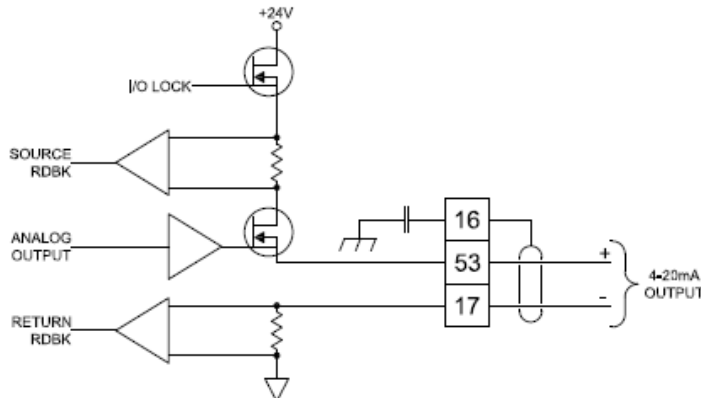


Figure 9-76—Analog Output Wiring for a 24/8 Analog FTM

### 9.29.5—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.

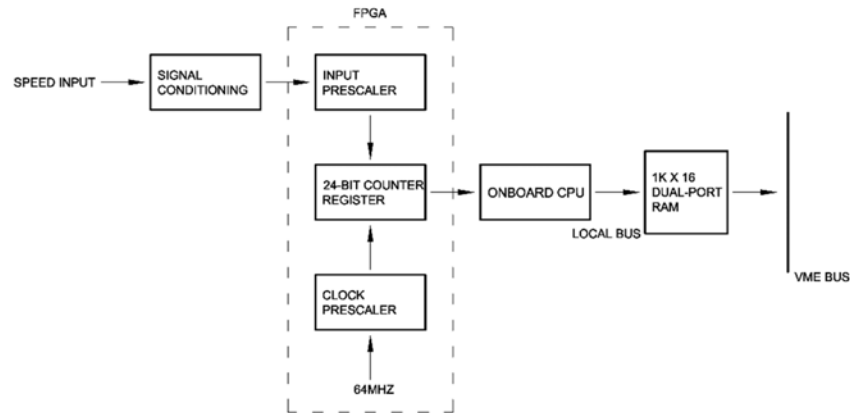


Figure 9-77—Digital Speed Sensor Module Block Diagram

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 9-11—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 Readback ADC Error
19	Speed Error
20	AI ADC Timeout
21	AO Readback 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 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. 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.

## 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. 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.

### 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. 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.

### 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 24/8 Analog module, corresponding to both cables, 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, corresponding to both cables, 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 N—

- Replaced Proximity Sensor with Eddy Sensor in Chapter 9
- Updated Appendix A
- Removed Appendix F and created note in Regulatory and Compliance section regarding SIL Certification information.

### Changes in Revision M—

- Updated front panel indicator tables and related information as marked with change bars.
- Significant updates to Section 9.27 with changes marked by change bars.
- Significant updates to Section 9.28 with changes marked by change bars.
- Four new modules specifications 5466-5000, 5466-5001, 5466-5026, and 5466-5027 added to the table in Appendix A.

### Changes in Revision L—

- Updated compliance and technical information.

Chapters 10–16 and the appendixes are contained in volume 2.

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PO Box 1519, Fort Collins CO 80522-1519, USA  
1000 East Drake Road, Fort Collins CO 80525, USA  
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

Email and Website—[www.woodward.com](http://www.woodward.com)

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