WOODWARD

Product Manual 26166V1
(Revision U, 6/2019)
Original Instructions

MicroNet™ Simplex Digital Control
MicroNet™ Plus Digital Control

Manual 26166 consists of 3 volumes (26166V1, 26166V2, & 26166V3).

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.

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:
www.woodward.com/publications

The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.

Proper Use

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

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. Be sure to check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

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

Contents

This manual is divided into three volumes:

- Volume 1 contains chapters 1–8 (manual 26166V1).
- Volume 2 contains chapters 9–15 and the appendixes (manual 26166V2).
- Volume 3 contains obsolete sections from Volume1 and Volume 2.

Illustrations and Tables

Warnings and Notices

Important Definitions

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

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

⚠WARNING

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.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

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

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

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

Follow these precautions when working with or near the control.

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

IMPORTANT

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

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:

Restriction of Hazardous Substances 2011/65/EU
Woodward Turbomachinery Systems products are intended exclusively for sale and use only as a part of Large Scale Fixed Installations per the meaning of Art.2.4(e) of directive 2011/65/EU. This fulfills the requirements stated in Art.2.4(c) and as such the product is excluded from the scope of RoHS2.

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

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

ATEX – Potentially Explosive Atmospheres Directive: Directive 2014/34/EU on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres
Zone 2, Category 3, Group II G, Ex nA [nL] IIC T3 X

IMPORTANT **EMC Compliance**	**The MicroNet Digital Control must be installed inside a metal enclosure or cabinet to meet the EMC Directive requirements. Reference Section 15 of manual 26166V2 for considerations regarding the installation location and specific cabinet construction requirements.**

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

EAC Customs Union: Certified for use in Ordinary Locations only to Technical Regulation CU 004/2011 On the Safety of Low Voltage Equipment and CU 020/2011 On the Electromagnetic Compatibility of Technical Equipment Declaration of Conformity Registration No: RU C-US .АЛ32.B.02262.

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 per certifcate 2314167.

Marine

American Bureau of Shipping:	Rules for Condition of Classification, Part 1 2015 Steel Vessels Rules 1-1-4/7.7, 1-1-A3, 1-1-A4, which covers the following: Steel Vessel (2015): 4-2-1/7.5.1, 4-2-1/7.3, 4-9-8/13, 4-9-6/23, 4-9-5/17; Steel Vessels Under 90 Meters (295 Feet) in Length (2015): 4-7-4/3.9 Offshore Support Vessels (2015): 4-2-1/7.5.1, 4-2-1/7.3, 4-9-8/13, 4-9-6/23, 4-9-5/17
DNV/GL:	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

IMPORTANT
EMC Compliance

The MicroNet Digital Control must be installed inside an EMC rated cabinet or enclosure for Marine Applications. Reference Section 15 of manual 26166V2 for considerations regarding the installation location and specific cabinet construction requirements.

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

WARNING

The 24/12 and 16-Channel Relay Interface Modules are suitable for ordinary or non-hazardous locations only.

The MicroNet Control shall not be installed in areas exceeding Pollution Degree 2 as defined in IEC 60664-1 and is rated to Overvoltage Category II.

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. Verify the PE Terminal has been connected prior to applying power to the MicroNet Control.

Grounding is required using 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 is clearly marked as the disconnecting device for the equipment. The switch or circuit breaker shall not interrupt the protective earth conductor.

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.

Safety Symbols

	Direct Current
	Alternating Current
	Both Alternating and Direct Current
	Caution, risk of electrical shock
	Caution, refer to accompanying documents
	Protective conductor terminal
	Frame or chassis terminal

Chapter 1.
General Information

1.1. Introduction

The MicroNet Plus and MicroNet Simplex controls are 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 five milliseconds. Less critical code is typically assigned to slower rate groups. The rate group structure prevents the possibility of changing system dynamics by adding additional code. Control is always deterministic and predictable.

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.

1.3. Non-Preferred and Obsolete Modules

For information on all non-preferred or obsolete modules see Volume 3 of this manual.

Details on all Active Preferred modules are contained in Volumes 1 and 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

	Main and Expansion rack configurations		
System Config	**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 P1020
- Simplex or Redundant I/O modules
- Simplex or Redundant Power
- Redundant smart fans

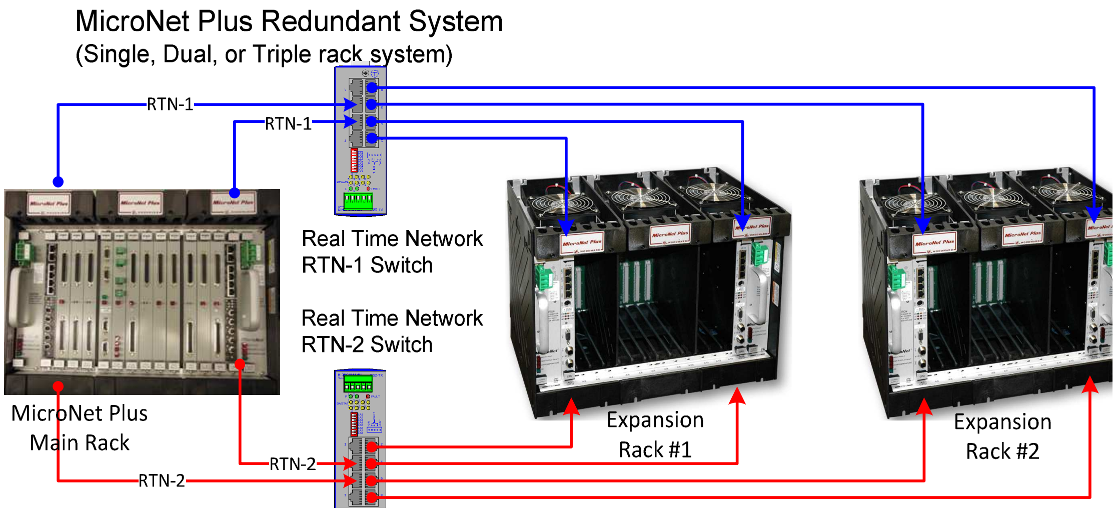


Figure 2-1. MicroNet Plus Redundant System

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, and supporting internal circuitry.
- 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.

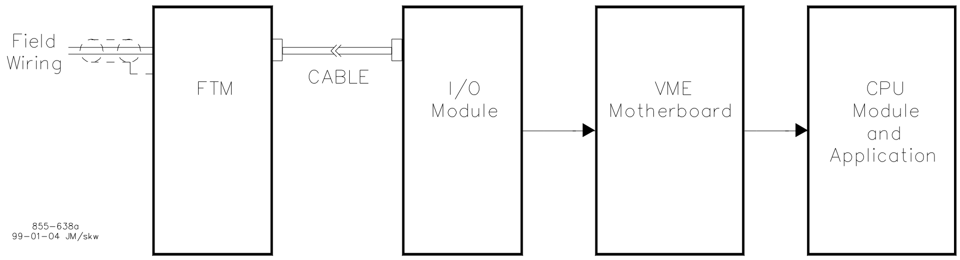


Figure 2-2. Input Flow

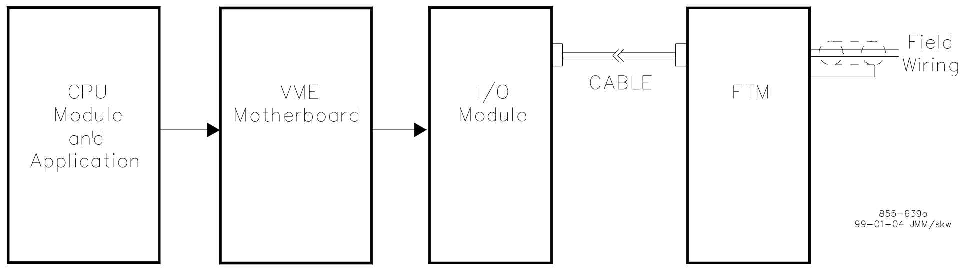


Figure 2-3. Output Flow

2.1.5. 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

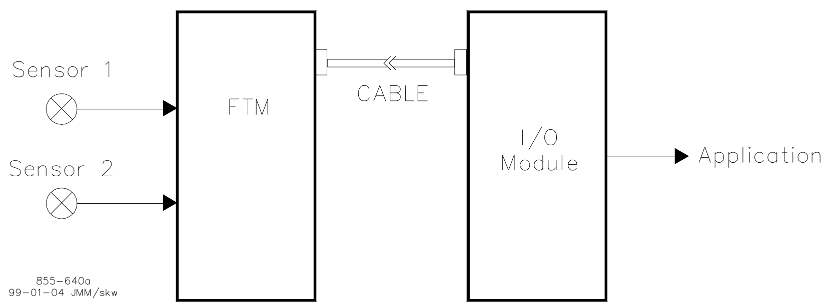


Figure 2-4. Redundant Sensors

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.

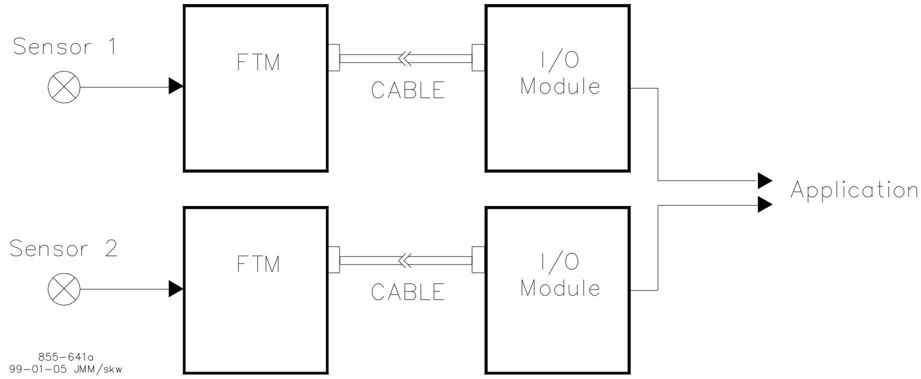


Figure 2-5. Redundant Inputs

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.

2.1.6. 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
- Simplex or Redundant I/O modules
- Simplex or Redundant Power
- Redundant smart fans

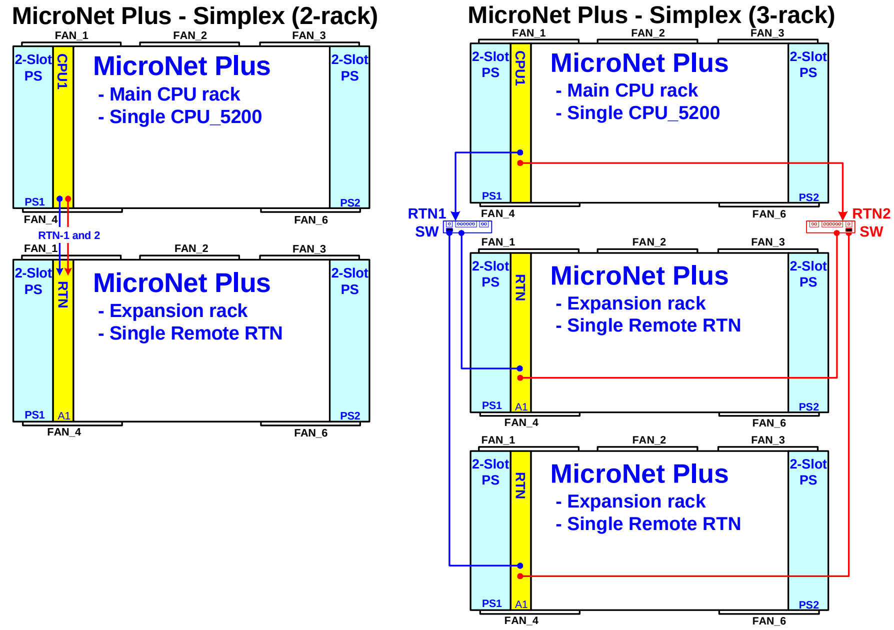


Figure 2-6. MicroNet Plus Simplex System Diagrams

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 CPU module that must be located in slot A1 of the main chassis. No other options are available.

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.

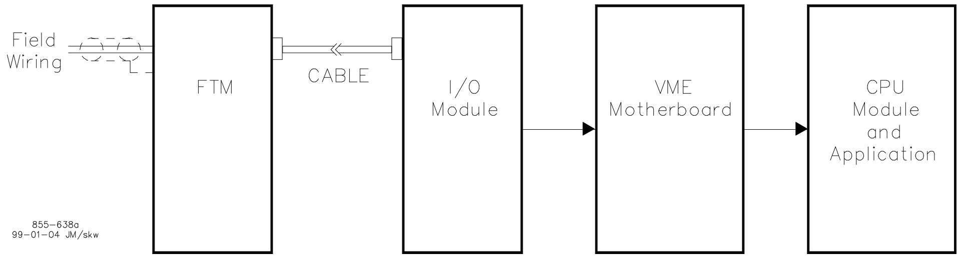


Figure 2-7. Input Flow

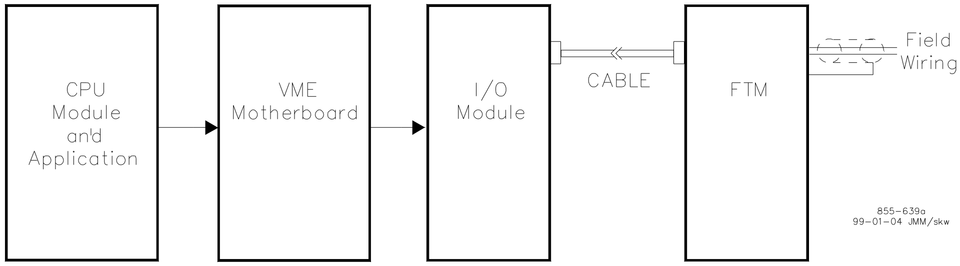


Figure 2-8. Output Flow

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

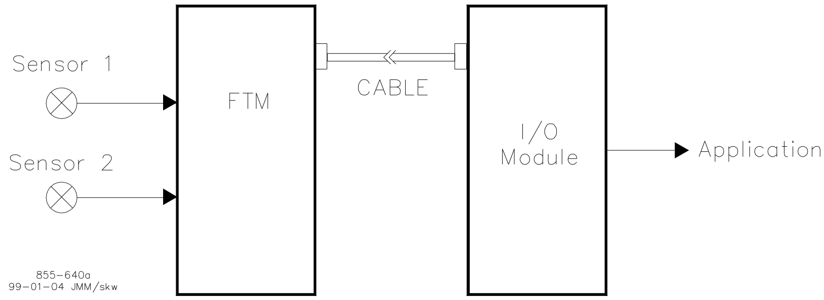


Figure 2-9. Redundant Sensors

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.

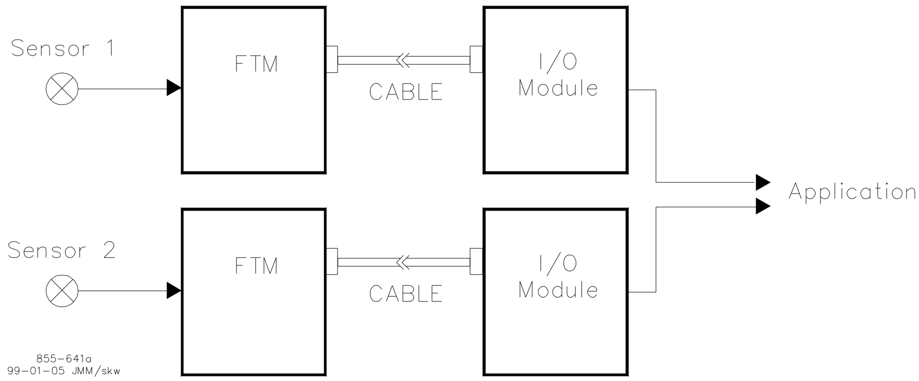


Figure 2-10. Redundant Inputs

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 P1020.
- 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:** MicroNet Plus based systems require that the expansion chassis use the Remote RTN module in slot A1. The CPU 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 RESET MODULE BEFORE REMOVAL	**Live insertion and removal of the CPU5200, CPU P1020, 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.

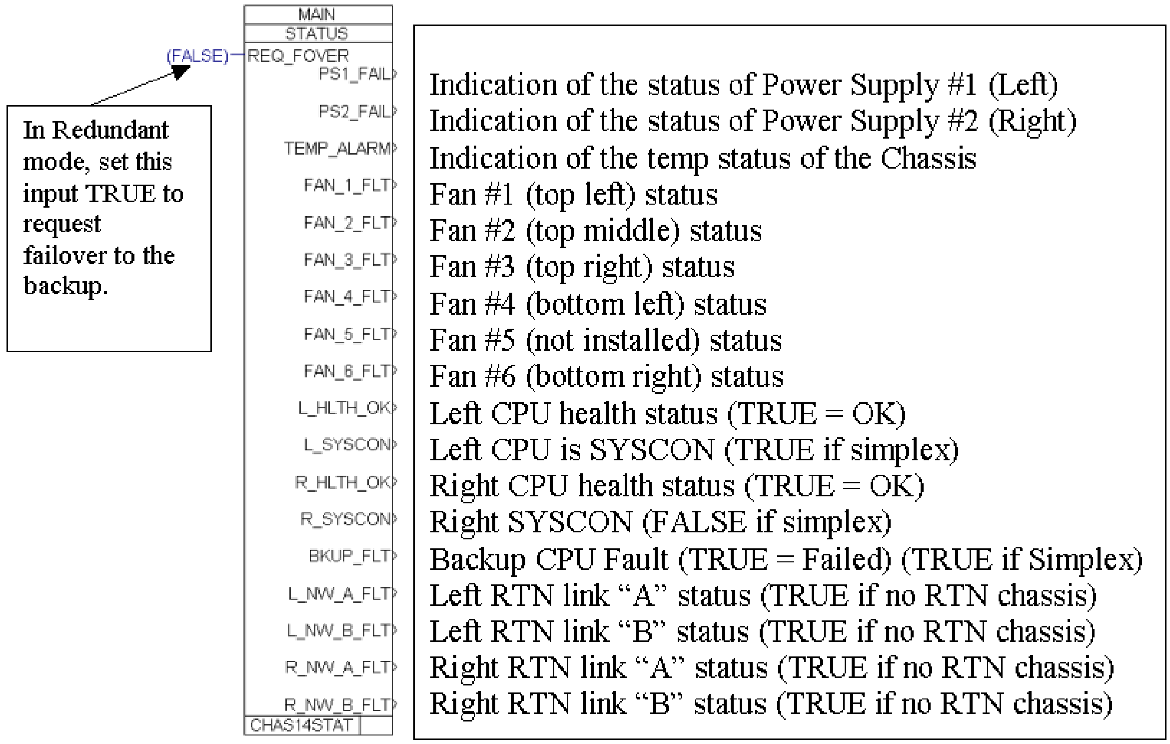


Figure 2-11. CHAS_STAT Block

Chapter 3.
Chassis Configurations

3.1. MicroNet Plus 14-Slot Chassis

Figure 3-1. 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

3.1.1. 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 3-1. 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.

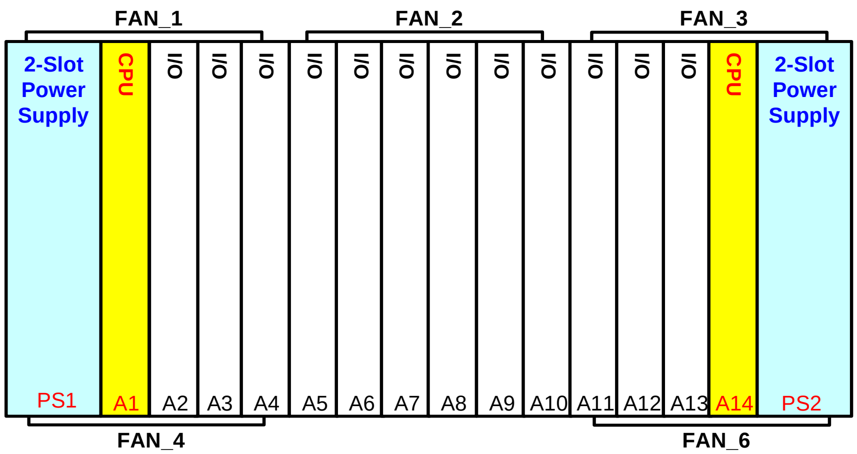


Figure 3-2. MicroNet Plus 14-Slot Chassis

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°C ± 3°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.

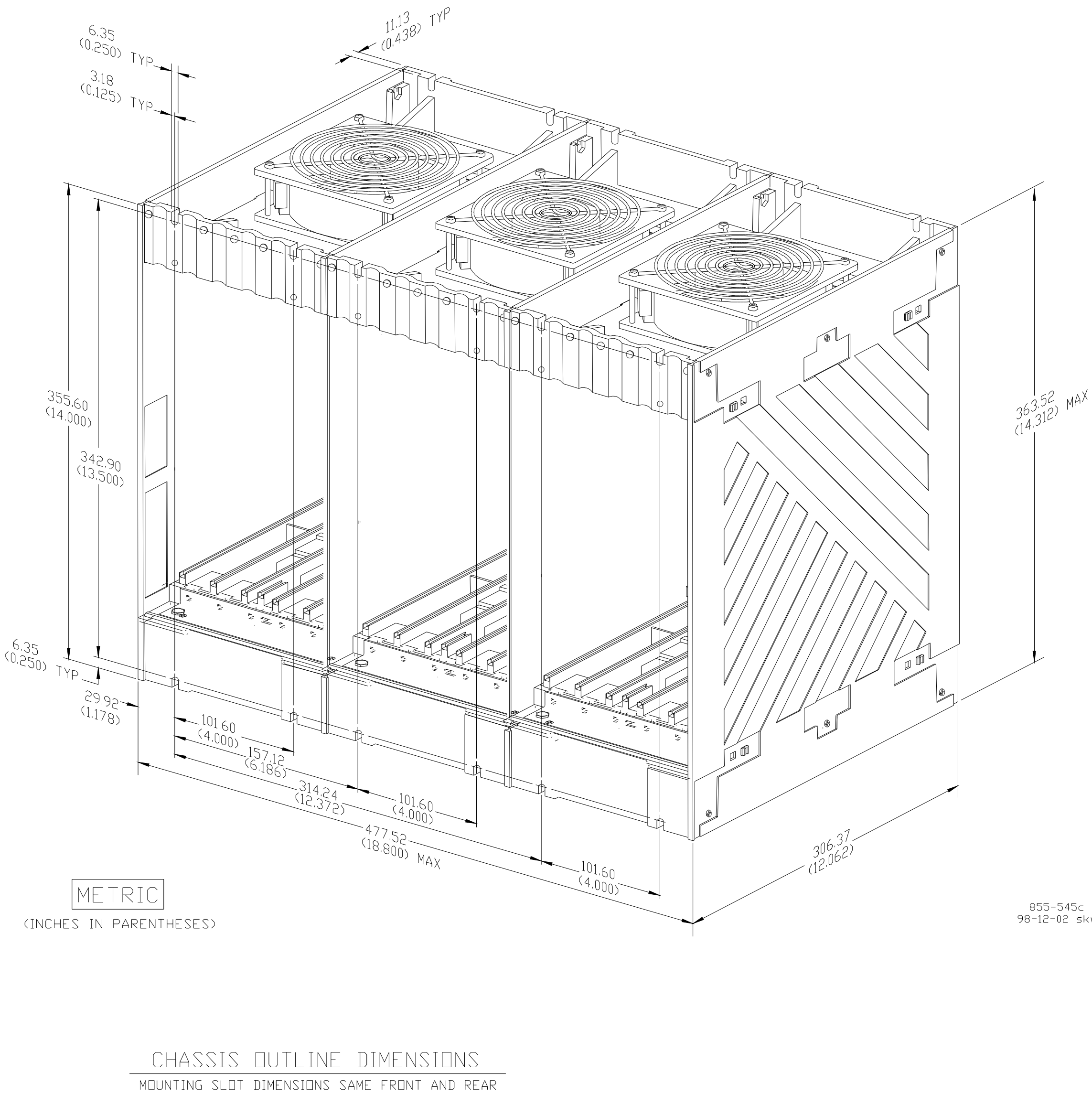


Figure 3-3. Outline Drawing of MicroNet Plus Chassis

3.1.2. Installation

Figure 3-4 shows the mounting template and fasteners to bulkhead mount the chassis. Rack mounting is not recommended.

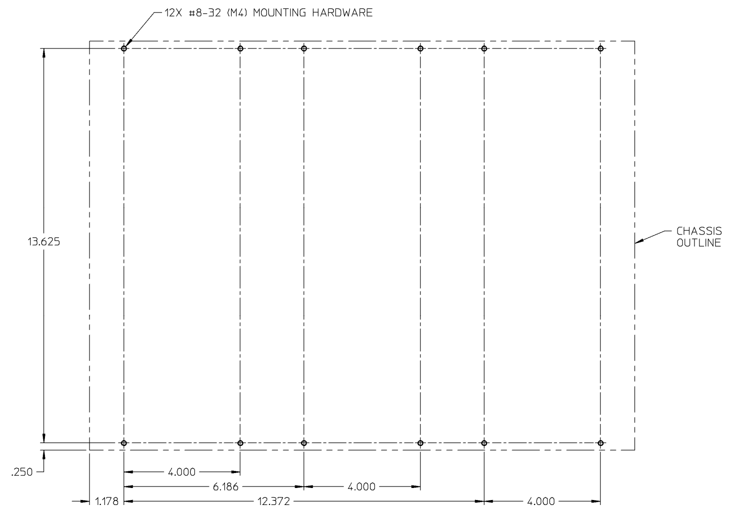


Figure 3-4. Mounting Template of MicroNet Plus 14-Slot I/O Chassis

3.2. MicroNet Plus 8-Slot Chassis

Figure 3-5. 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

3.2.1. 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 3-6. 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.

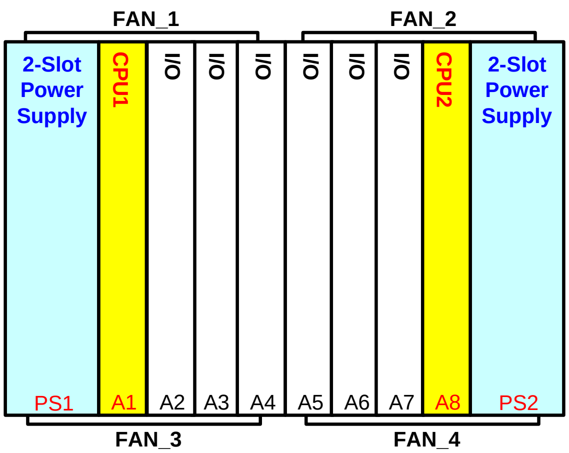


Figure 3-6. MicroNet Plus 8-Slot Chassis

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°C ± 3°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.

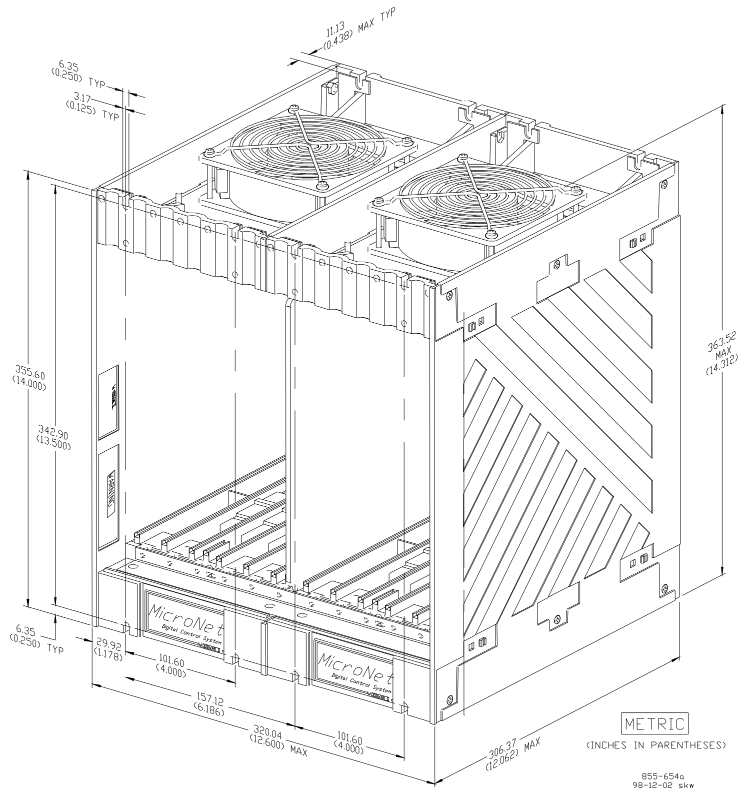


Figure 3-7. Outline Drawing of MicroNet Plus 8-Slot Chassis

3.2.2. Installation

Figure 3-8 shows the mounting template and fasteners to bulkhead mount the chassis. Rack mounting is not recommended.

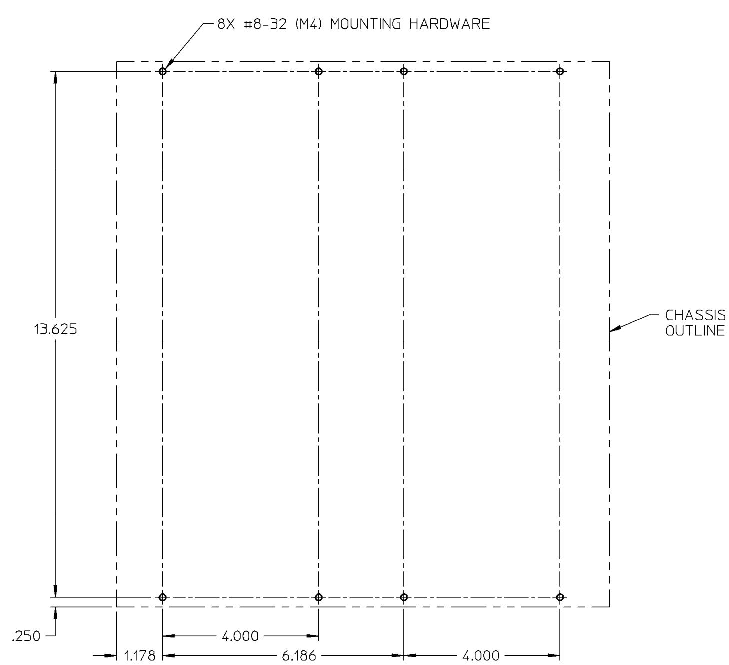


Figure 3-8. Mounting Template of MicroNet Plus 8-Slot I/O Chassis

Chapter 4.
Power Supplies

4.1. MicroNet Plus Chassis Power Supplies

4.1.1. 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 ±10% for the 24 V bus, +/-5% for the 5 V bus, and +/-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 on supply needs to be replaced, the recommended method for changing Power Modules is with the power off (to the module being removed and the module being inserted). The system will tolerate this “cold swap” method without failure.

Each main power supply has four LEDs to indicate power supply health (OK, Input Fault, Overtemperature, and Power Supply Fault). See MicroNet Plus Power Supply Troubleshooting (Section 4.5) 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 4-1. Power Supply Module

4.1.2. 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.**

Table 4-1. 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

Table 4-2. Main PS (110 Vac/dc Input)

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

Table 4-3. Main PS (220 Vac Input)

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

Input Power Wiring

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

IMPORTANT

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

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

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

Power requirements depend on the number and type of modules supplied for each system. For a system with a single I/O chassis, size the input power source according to the rating of the MicroNet Plus power supply to which the source is connected. Do not size the supply mains for the sum of the MicroNet Plus power supply ratings when redundant supplies are used. MicroNet Plus supplies are redundant when installed in the same chassis. Redundant supplies share the load between them equally, but each must provide for full load in the event that one of the units is disabled. Table 4-1 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 4-1, and the power source must be sized for the sum of the branches.

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

Table 4-1 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 4-1. MicroNet Plus Power Supply Requirements

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

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

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

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

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.

4.1.3. 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?

4.2. Installation

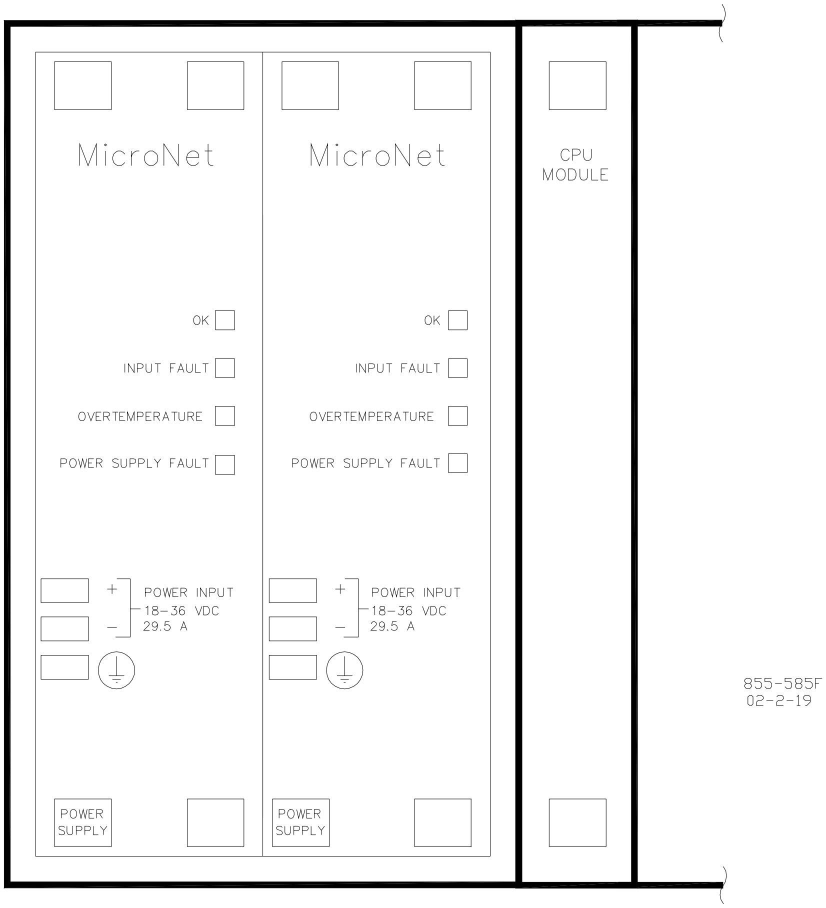


Figure 4-2. MicroNet Power Supply

4.2.1. Input Power Wiring

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

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

Branch circuit fuses, circuit breakers, and wiring must meet appropriate codes and authorities having jurisdiction for the specific country (CE, UL, etc.). See Table 4-2 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 4-6 which meet local code requirements. Time delay fuses or circuit breakers must be used to prevent nuisance trips.

Power requirements depend on the number and type of modules supplied for each system. For a system with a single I/O chassis, size the input power source according to the rating of the MicroNet power supply to which the source is connected. Do not size the supply mains for the sum of the MicroNet power supply ratings when redundant supplies are used. MicroNet supplies are redundant when installed in the same chassis. Redundant supplies share the load between them equally, but each must provide for full load in the event that one of the units is disabled. Table 4-2 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 4-2, 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 4-2 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 4-2. MicroNet Simplex Power Supply Requirements

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

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

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

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

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

4.2.2. 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.

4.3. 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 and the supply's output disabled. If necessary, use the power supply's front panel LEDs to assist in diagnosing any related problems. If all supply LEDs are off (not illuminated), it is probable that input power is not present, and verification should be made.

4.3.1. Power Supply LED Descriptions

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

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

OVERTEMPERATURE LED—This red LED gives an early warning of a thermal shutdown. The LED turns on to indicate that the internal power supply temperature has exceeded approximately 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.

4.3.2. Simplex Power Supply Checks

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

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

Chapter 5.
CPUs

5.1. Network Topologies

The information that follows pertains to both CPU P1020 and CPU5200.

5.1.1. Network Topology:

As a rule, the MicroNet CPU should not be directly connected to a workstation with a Teamed network setup. A Teamed network, directly connected to MicroNet CPU appears to enhance communication instability with some common industrial protocols. The following discusses a simple Teamed NIC setup and offers an alternative topology.

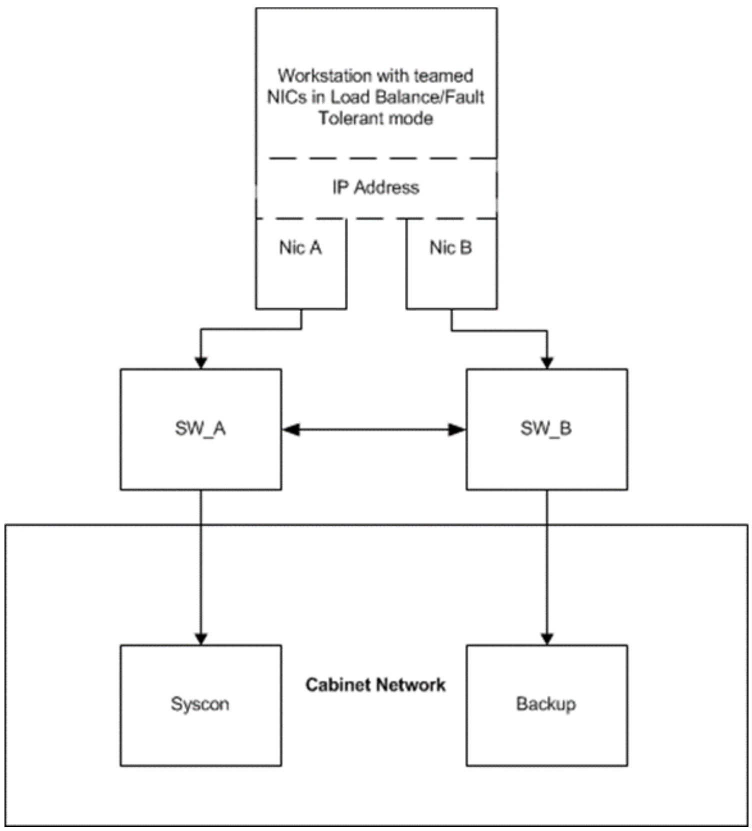


Figure 5-1. Simple Teamed NIC Setup

The teamed workstation has a single IP address. NIC A and NIC B are the teamed adaptors sharing a single IP address. Each NIC has a unique MAC address. There is a connection between the two networks that allows the teaming software to know that the NIC connections are alive and handle the routing.

5.1.2. Suggested Topology:

Remove the network team from the computer. A backup IP address could be a assigned to the second NIC and configured through the server interfaces (MBE server for Modbus TCP). Removing the team will remove the two MAC addresses associated with a single IP address and force an assigning of an IP address per NIC.

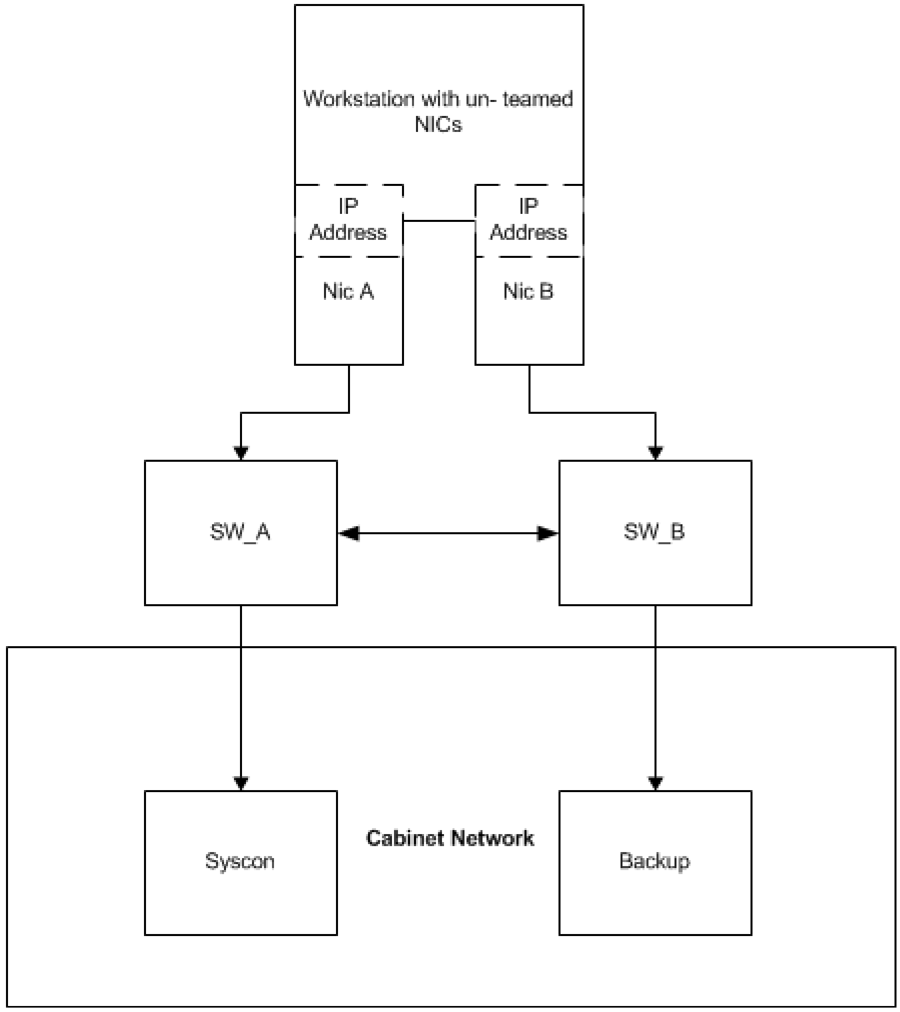


Figure 5-2. Simple Un-Teamed NIC Setup

Note: A teamed network can be a part of an industrial control system and play an important part in load balancing and failover as a complete system. However, NO DIRECT CONNECTION to a MicroNet Plus CPU by a teamed NIC IP address should be part of the network configuration. The workstation with un-teamed NIC would become the connection to the MicroNet CPU for the Modbus data as well as the OPC data. Other computers on the network can access this data through DCOM (in the case of OPC) or additional Modbus server functionality.

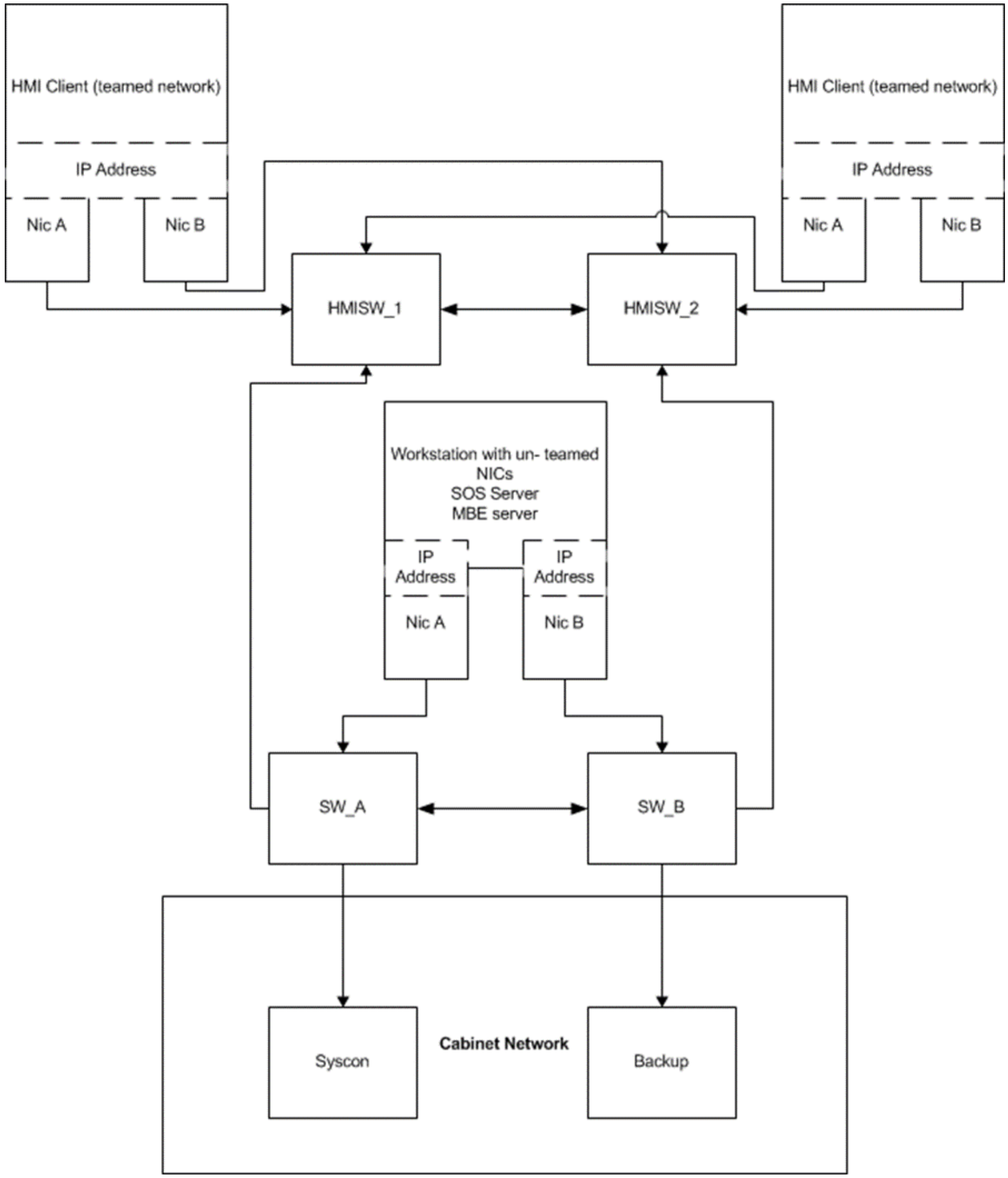


Figure 5-3. Teamed Network with No Direct Connection to MicroNet CPU

5.2. CPU P1020 Module

5.2.1. Module Description

The MicroNet CPU Module runs an 800 MHz dual core processor, 512 MB RAM, 768 MB of flash memory, a Real Time clock, and various communication peripherals. These peripherals include (4) general use Ethernet ports (2x 1000Mbps, 2x 100 Mbps), (2) Real Time Network ports, (1) one service port, and (5) CAN ports.

The CPU_P1020 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 0° to +55 °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 **RESET MODULE** **BEFORE REMOVAL**	**Live insertion and removal of this module is allowed in a MicroNet Plus chassis. This module should be reset immediately before removing it from the chassis. This notifies the module that it will be removed and provides a graceful failover to another healthy CPU module if available.**

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

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

> **Note:** Recommended storage temperature of the CPU Module is 45°C to preserve clock battery life and backup data retention.

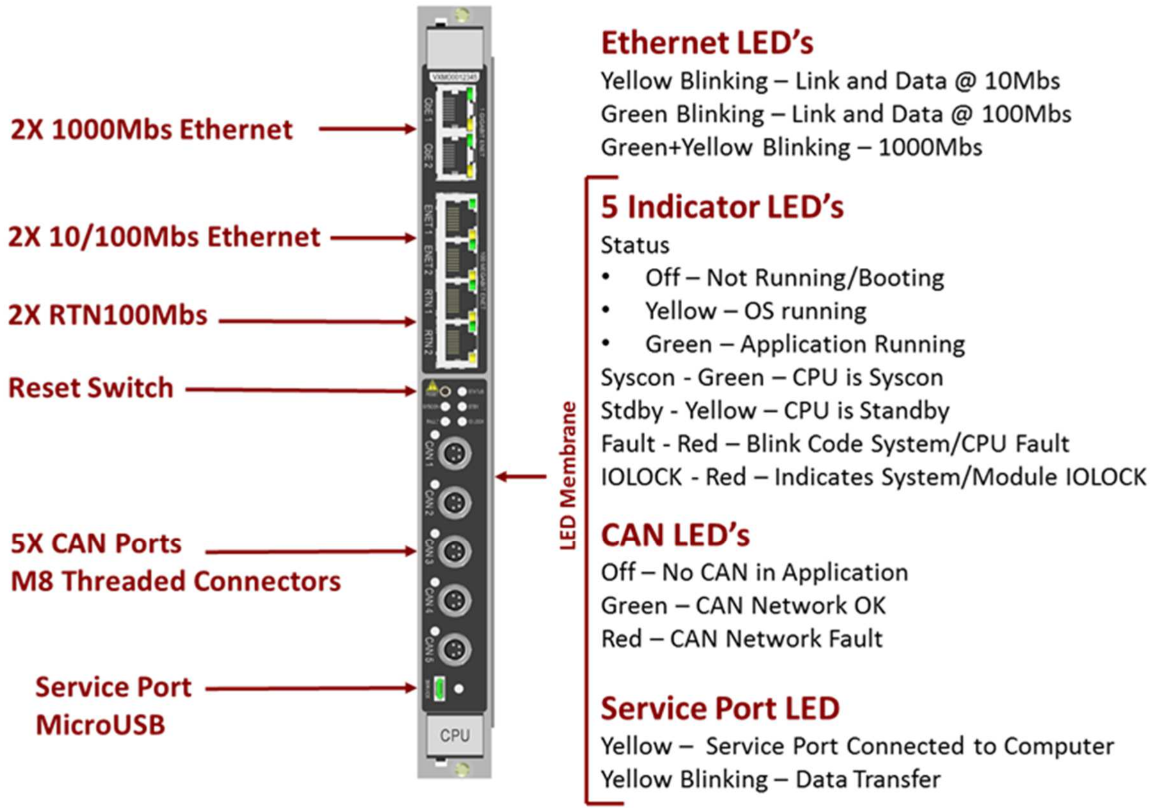


Figure 5-4. CPU Module

5.2.2. 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.

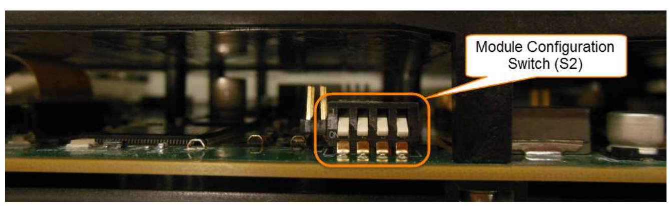


Figure 5-5. Modular Configuration Switch (S2)

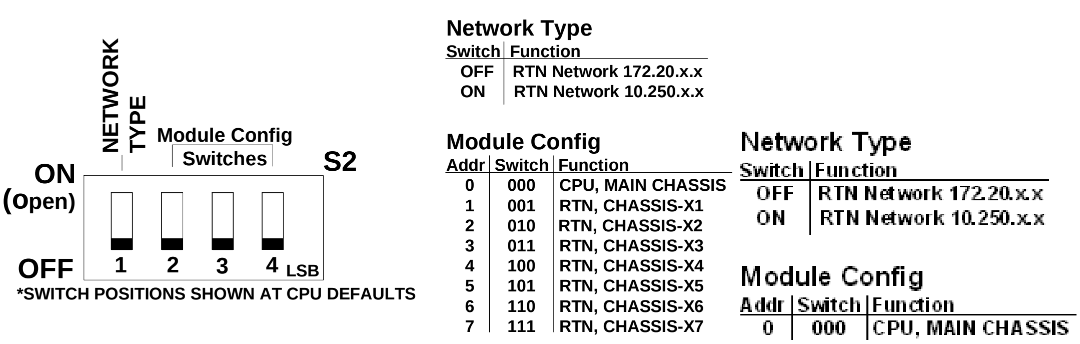


Figure 5-6. CPU_P1020 Module Hardware Configuration

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: The CPU P1020 Module cannot be configured to function as a remote RTN module.

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 GbE1, GbE2, ENET1, ENET2 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 (GbE1, GbE2, 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 GbE1, GbE2, ENET1, ENET2.

IMPORTANT	**This module has been factory configured with fixed Ethernet IP addresses of** • **Gigabit #1 (GbE1) = 172.16.100.1, Subnet Mask = 255.255.0.0** • **Gigabit #2 (GbE2) = 192.168.128.20, Subnet Mask = 255.255.255.0** • **Ethernet #1 (ENET1) = 192.168.129.20, Subnet Mask = 255.255.255.0** • **Ethernet #2 (ENET2) = 192.168.130.20, Subnet Mask = 255.255.255.0**

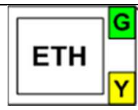
Network Configuration Utility (AppManager)

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**. A PC connection must be made to Gigabit #1 (GbE1) 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.

5.2.3. Front Panel Indicators (LEDs)

Table 5-1. CPU P1020 Module Front Panel LEDs

LED	Name	Description
	Ethernet	Blinking GREEN when link and data is transmitted or received at 100 Mbps. Blilnking YELLOW when link and data transfer is 10 Mbps Blinking GREEN and YELLOW when link and data transfer is 1000 Mbps
	STATUS	GREEN – GAP application is running YELLOW – CPU OS is running and idle.
	SYSCON	System Controller (GREEN)—Active when this CPU module is the VMEbus System Controller.
	STANDBY	Standby Ready (YELLOW)— Active in a redundant system. Indicates that the backup CPU module is in standby mode ready to take over System Controller functions in a failover event. In a redundant system, the "SYSCON" CPU module has both SYSCON and STANDBY indicators active.
	IOLOCK	IOLOCK (RED)—This LED indicates that an I/O LOCK condition exists either locally on the CPU itself ar VMEbus. **Note:** IOLOCK is a condition driven by the SYSCON where all I/O modules are placed into a failsafe condition and outputs are driven to a known state.
	FAULT	CPU FAULT (RED)—Actively flashes CPU fault codes as necessary.
	CAN #1, #2, #3, #4, #5	Active GREEN when data is transmitted or received through CAN ports. RED indicates a fault

5.2.4. Power Up LED Sequence

- IOLOCK on
- SYSCON on for 4 seconds, off for 2 seconds
- STBY on for 4 seconds, off for 2 seconds
- SYSCON on the CPU which is SYSCON (left CPU by default if it exists)
- STATUS yellow when operating system is booted up and ready to start an applicatoin(~90 seconds after powerup)
- SYSCON light will switch back and forth between redundant CPUs 6 times to determine which CPU will be Syscon when application is commanded to start
- STATUS green when application is running
- IOLOCK off when application is running without errors
- STBY yellow when application is running on redundant CPUs

5.2.5. 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:
- 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.

NOTICE

RESET MODULE BEFORE REMOVAL

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

5.2.6. 10/100/1000 BaseT Ethernet Ports
There are two 10/100 plus two 1000 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

GbE1 and GBE2 may be configured as general purpose Ethernet ports as desired
ENET1 and ENET2 are prevented (via firewall) from use with SSH enable applications – AppManager, SOS.

IMPORTANT

Max cable length is 30 meters. Double shielded, Cat 5-e cables (SSTP) are required for customer installations. Ensure that cables have strain relief and do not apply any forces to the connectors.

5.2.7. 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.**

Ensure that cables have strain relief and do not apply any forces to the connectors.

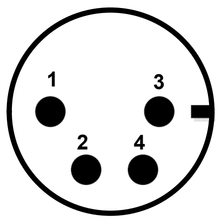
5.2.8. Service Port

An isolated micro USB service port is located on the front of the CPU module. This port creates a command-line interface to the operating system for specific troubleshooting use and cannot be configured for application software use.

The communication settings for the virtual communications port are fixed at 115200 baud, 8 data bits, no parity, 1 stop-bit, and no flow control.

5.2.9. CAN Communication Ports

Five CAN ports (M8 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.



Pin 1 – CAN Shield (AC coupled)
Pin 2 – CAN Low (blue)
Pin 3 – CAN Signal Ground (black)
Pin 4 – CAN High (white)

Figure 5-7. CAN Communication Ports (M8 male)

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

Table 5-2- CAN Network Trunk Line Specifications

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

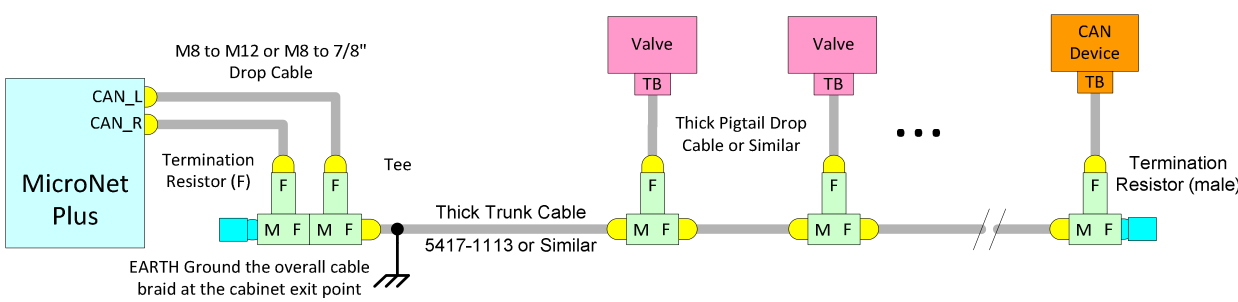
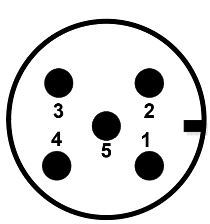


Figure 5-8. Micronet to Valve CAN Interface

Woodward supplies M8 to M12 (5 pin standard) cables.

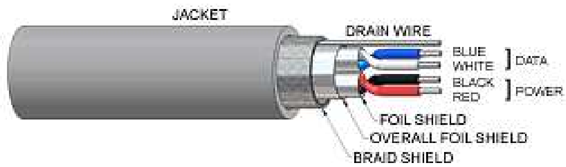


P1 – CAN Shield
P2 – not used
P3 – CAN Signal Ground (black)
P4 - CAN High (White)
P5 – CAN Low (Blue)

Figure 5-9. Example of Woodward supplied 5 Pin Standard Cable

5.2.10. CAN Cable Specification

Thick trunk cable is preferred and recommended. 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.



Impedance:	120 Ω ±10% at 1 MHz
DC resistance:	< 7 Ω per 1000 ft.
Cable capacitance:	12 pF/ft. at 1 kHz
Propagation delay	1.36 ns/ft. (maximum)
Data Pair:	19 strands, 1.0 mm² corresponds to 18 AWG, individually tinned, 3 twists/foot
Power Pair:	19 strands, 1.5 mm² corresponds to 15 AWG, individually tinned, 3 twists/foot
Drain / Shield Wire:	19 strands Tinned Copper shielding braid or shielding braid and foil
Cable type:	twisted pair cable. 2x2 lines
Bend Radius:	20x diameter during installation or 7x diameter fixed position
Signal attenuation:	0.13 dB/100 ft. @ 125 kHz (maximum) 0.25 dB/100 ft. @ 500 kHz (maximum) 0.40 dB/100 ft. @ 1000 kHz (maximum)

Figure 5-10. CAN Cable Specification

5.2.11. 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.

Note: Use only screw-on type CAN connectors

Table 5-3. Recommended Bulk Cable

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

5.2.12. Troubleshooting and Tuning

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

Table 5-4. CPU Fault LED Flash Codes

Source Code	Fault Code	Fault Message
2	1	WGInitRAMDrives Error
2	4	WGInitFlashDrives Error
2	7	CPU in WRONG Slot!!
2	9	Chassis Switch set to #, must be set to 0 to run
2	10	Error Initializing User Accounts
3	5	Chassis Switch not Valid! Main must be set to zero!
4	7	Wrong CPU type
4	9	Footprint out of date
1	1	RAM error
1	2	Data bus error
1	3	Address bus error
1	4	Memory Cell test error
1	5	Booloader error

5.3. PowerPC CPU5200 Module (Motorola)

5.3.1. 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.

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

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

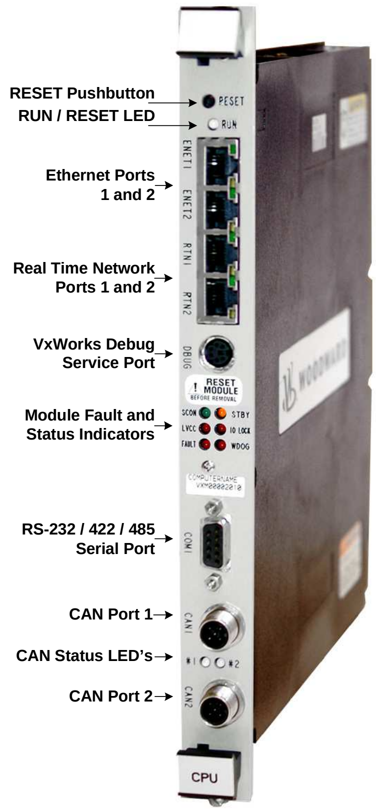


Figure 5-11. PowerPC CPU5200 Module (Motorola)

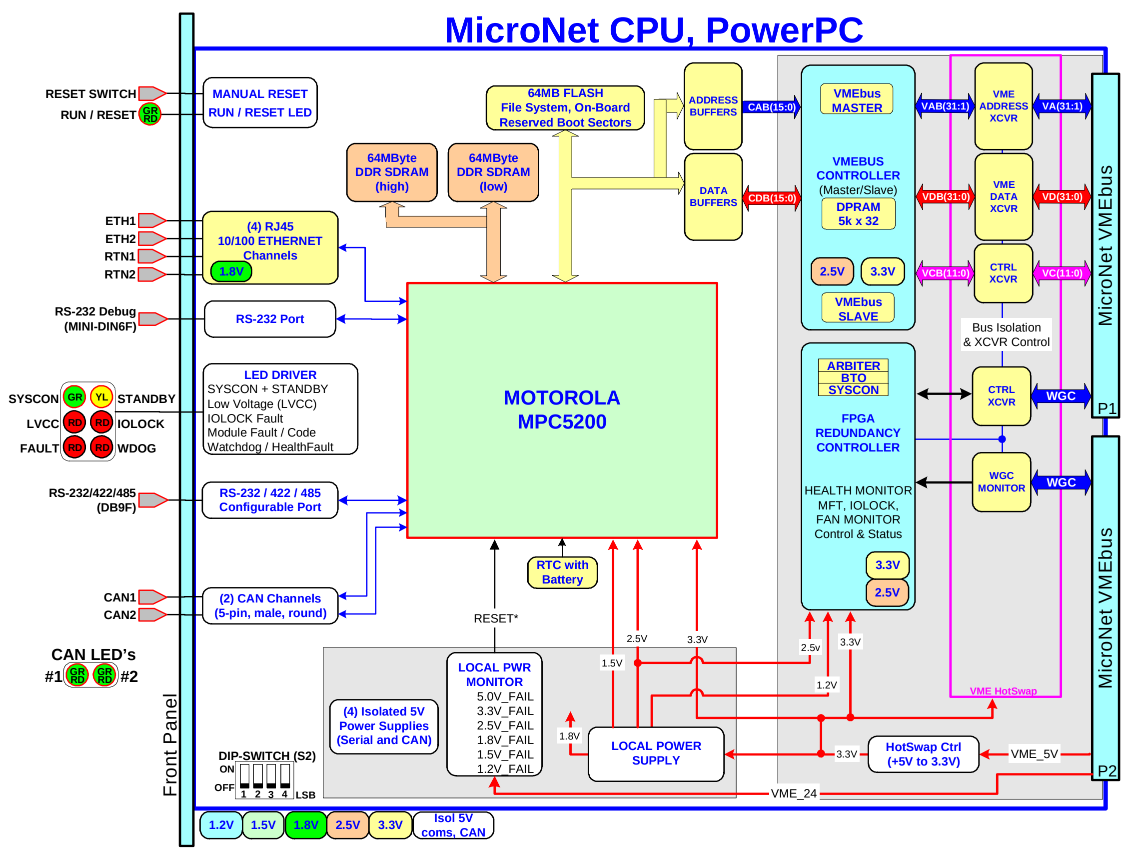
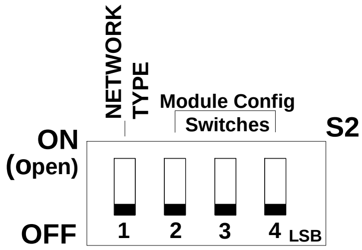


Figure 5-12. CPU Module Block Diagram

5.3.2. 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.



*SWITCH POSITIONS SHOWN AT CPU DEFAULTS

Network Type

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

Module Config

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

Figure 5-13. 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**. 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.

5.3.3. Front Panel Indicators (LEDs)

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

Table 5-5. PowerPC CPU5200 Module Front Panel LEDs

LED	Name	Description
GR/RD 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.
ETH: G TX/RX	TX/RX	<u>TX/RX (GREEN)</u>—Active GREEN when data is transmitted or received.
ETH: Y LINK	LINK	<u>LINK ACTIVE (YELLOW)</u>—A valid Ethernet connection to another device exists
SYSCON GR, YL STANDBY; LVCC RD, RD IOLOCK; FAULT RD, RD WDOG	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. **Note:** IOLOCK is a condition driven by the SYSCON where all I/O modules are placed into a failsafe condition and outputs are driven to a known state.
	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 LED's #1 GR/RD, GR/RD #2	CAN #1, #2	<u>CAN #1, #2 (GREEN/RED)</u>—Active GREEN or RED when data is transmitted or received through CAN port #1 or #2.

5.3.4. 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.

NOTICE

RESET MODULE BEFORE REMOVAL

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

5.3.5. 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.

5.3.6. 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

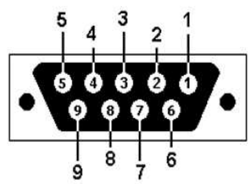
- **Double shielded, Cat 5 Ethernet cables (SSTP) are required for customer installations.**
- **Cable length between the Main rack and RTN switch is 3 m (10 ft.) max.**
- **Cable length between the RTN switch and Expansion rack is 30 m (100 ft.) max.**

5.3.7. 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 (-)

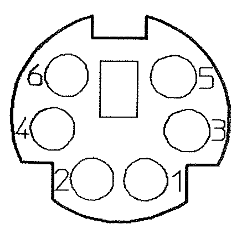
Figure 5-14. CPU Communications Port (DB9F)

5.3.8. 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.



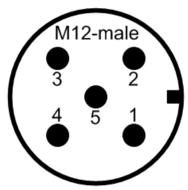
Pin 1 – RS-232 Receive
Pin 2 – RS-232 Transmit
Pin 3 – Signal Ground
Pin 4 – Not Used
Pin 5 – Signal Ground
Pin 6 – Not Used

Figure 5-15. CPU Service Port (mini-DIN6F)

5.3.9. 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 5.2.2—Module Configuration above.



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

Figure 5-16. CAN Communication Ports (M12 male)

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

Table 5-6. CAN Network Trunk Line Specifications

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

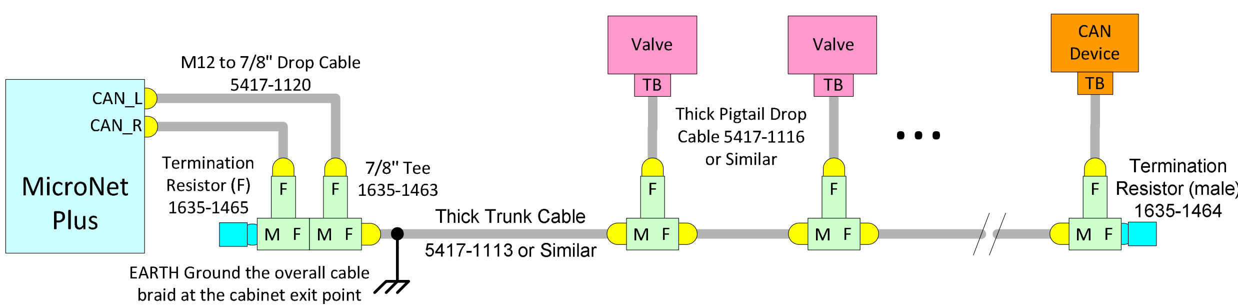
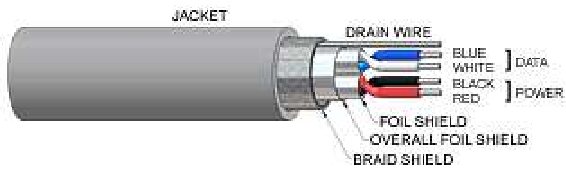


Figure 5-17. Micronet to Valve CAN Interface

5.3.10. CAN Cable Specification

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

Table 5-7. CAN Cable Specification



Impedance:	120 Ω ±10% at 1 MHz
DC resistance:	< 7 Ω per 1000 ft.
Cable capacitance:	12 pF/ft. at 1 kHz
Propagation delay	1.36 ns/ft. (maximum)
Data Pair:	19 strands, 1.0 mm² corresponds to 18 AWG, individually tinned, 3 twists/foot
Power Pair:	19 strands, 1.5 mm² corresponds to 15 AWG, individually tinned, 3 twists/foot
Drain / Shield Wire:	19 strands Tinned Copper shielding braid or shielding braid and foil
Cable type:	twisted pair cable. 2x2 lines
Bend Radius:	20x diameter during installation or 7x diameter fixed position
Signal attenuation:	0.13 dB/100 ft. @ 125 kHz (maximum) 0.25 dB/100 ft. @ 500 kHz (maximum) 0.40 dB/100 ft. @ 1000 kHz (maximum)

Recommended Bulk Cable

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

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

Table 5-8. Recommended Bulk Cable

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

5.3.11. Troubleshooting and Tuning

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

Table 5-9. 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

Chapter 6.
Communication

6.1. Remote RTN Module

6.1.1. 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

RESET MODULE BEFORE REMOVAL

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

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 6-3 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 6-1. Remote RTN Module

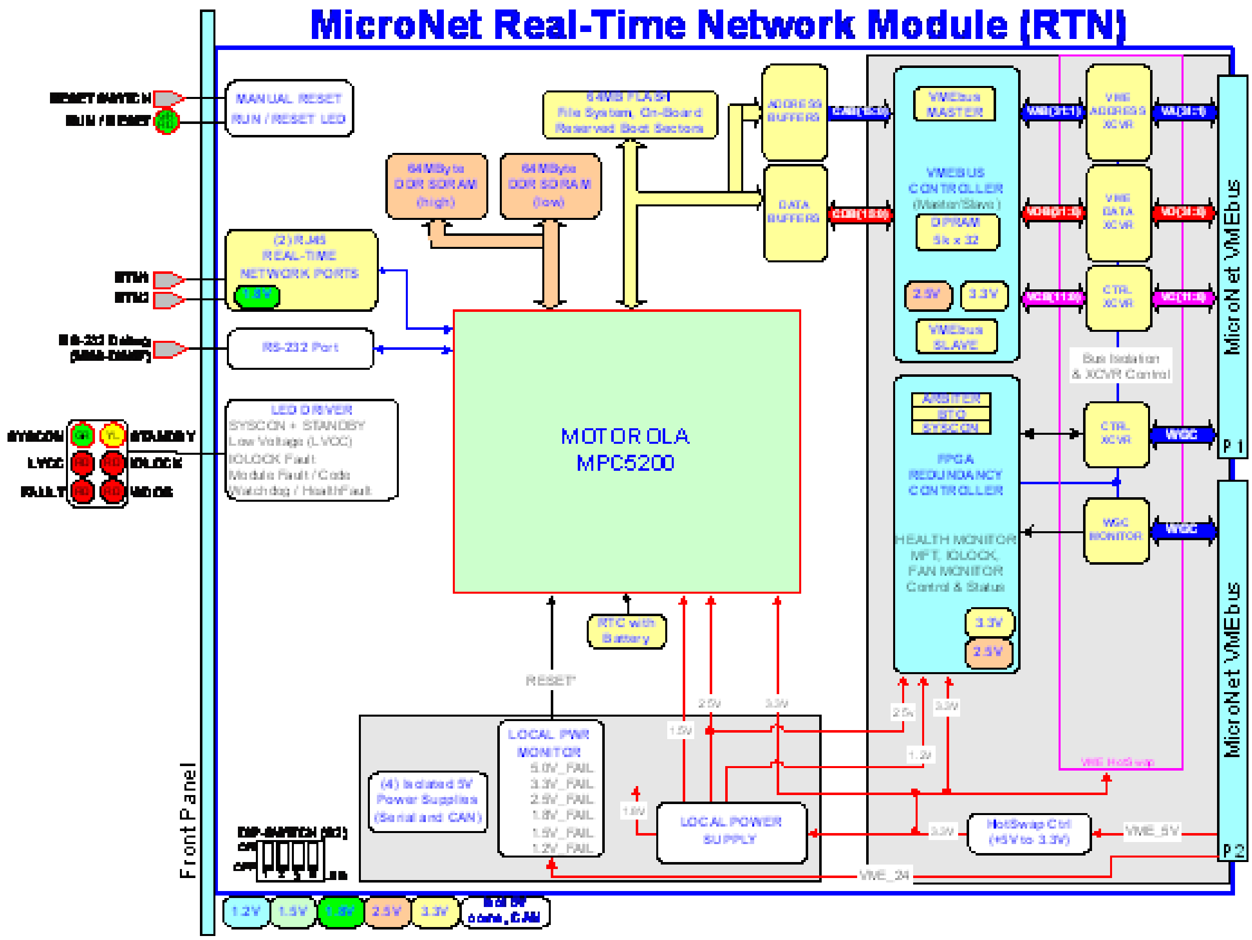


Figure 6-2. Remote RTN Module Block Diagram

6.1.2. 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 6-1. System Redundancy Options Using Remote RTN Modules

	CPU and Remote RTN modules for Main and Expansion racks		
Redundancy Option	**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.

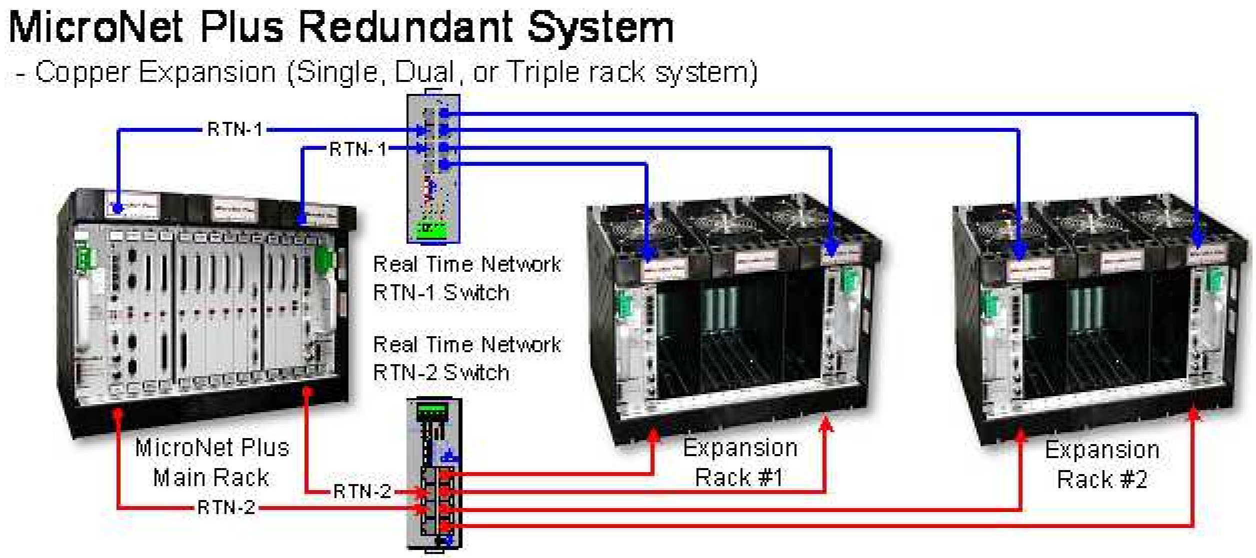


Figure 6-3. MicroNet Plus Redundant System (copper, 3-rack)

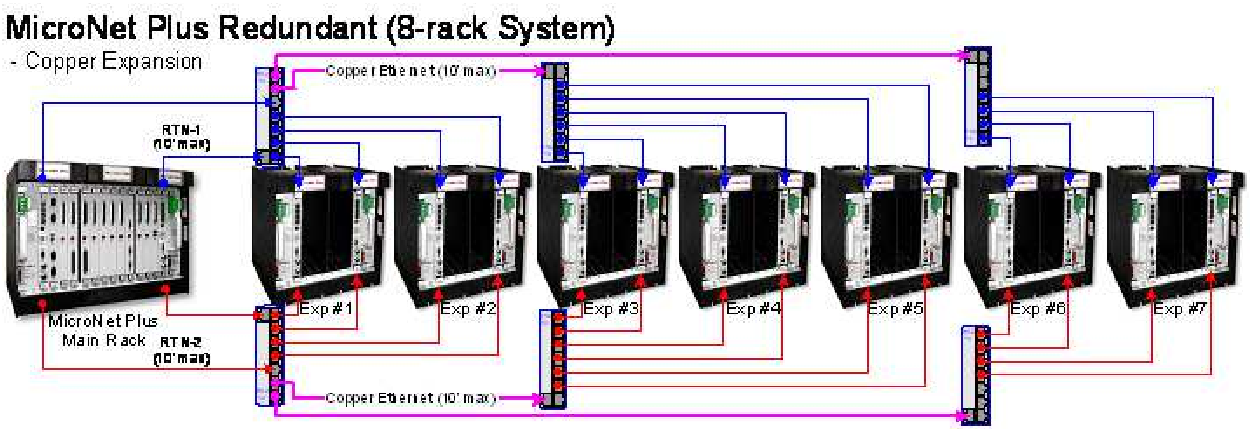


Figure 6-4. MicroNet Plus Redundant System (copper, 8-rack)

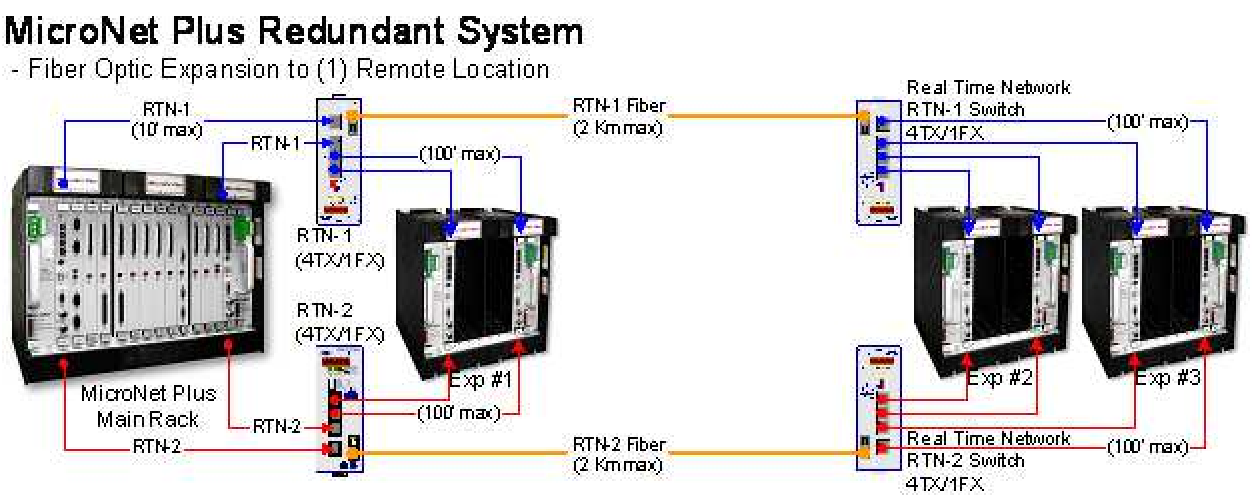


Figure 6-5. MicroNet Plus Redundant System (fiber, 2 locations)

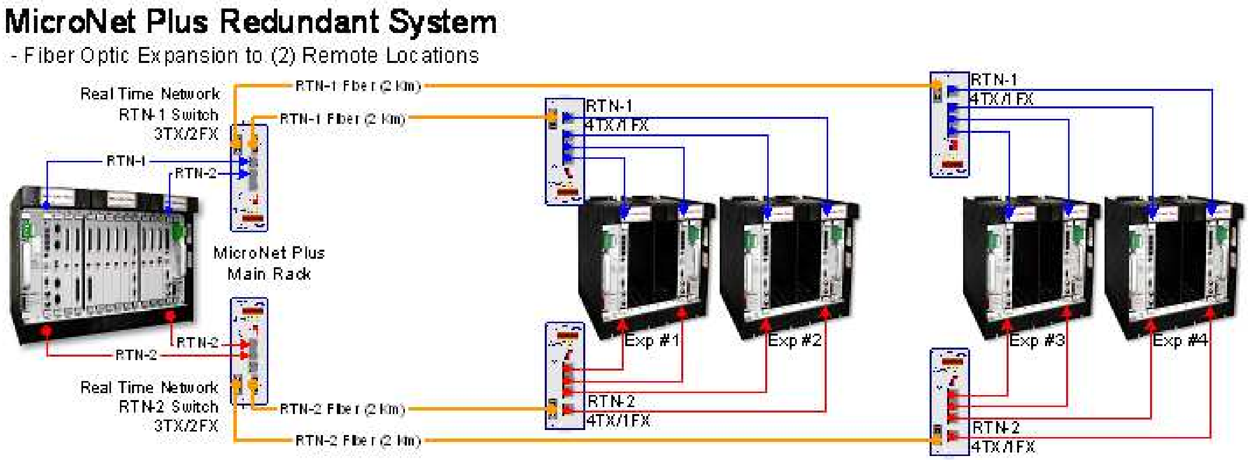


Figure 6-6. MicroNet Plus Redundant System (fiber, 3 locations)

Note: As of Dec 2016, the dual fiber 3TX/2FX Hirschmann switches were no longer manufactured. For applications requiring dual fiber using the approved Phoenix 7TX/1FX switches, users will need to modify their network configuration as required.

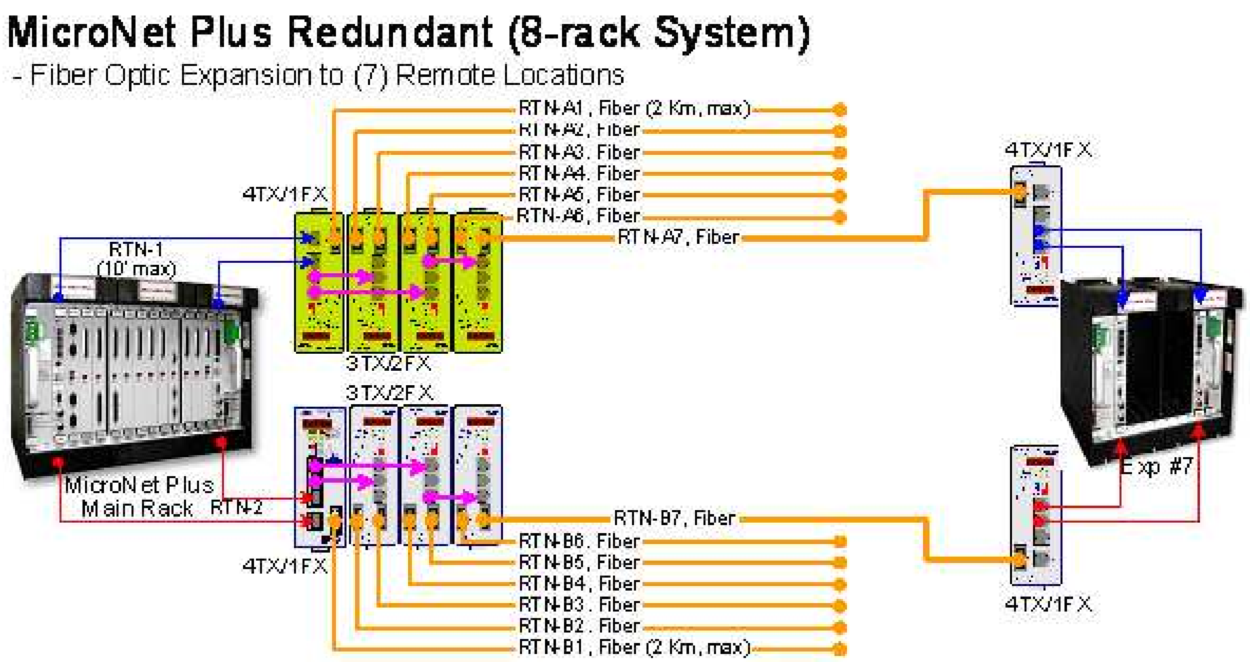


Figure 6-7. MicroNet Plus Redundant System (fiber, 8 locations)

6.1.3. 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.

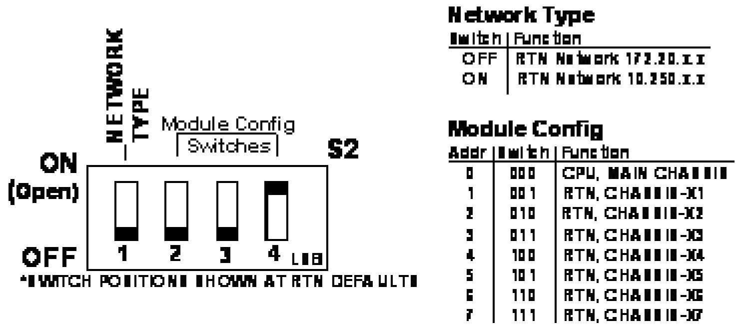


Figure 6-8. Remote RTN Module Hardware Configuration

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

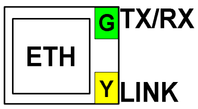
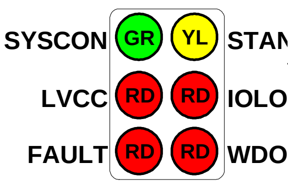
If the Remote RTN module is incorrectly configured for CPU mode, Ethernet ports #1 and #2 are active and have been factory-set to fixed Ethernet IP addresses of:

- **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**

6.1.4. Front Panel Indicators (LEDs)

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

Table 6-2. Remote RTN Module Front Panel LED’s

LED	Name	Description
	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	Low VCC Power Fault (RED)—A CPU or VME power supply high or low tolerance fault has been detected. - Local CPU power faults could be 1.2 V, 1.5 V, 1.8 V, 2.5 V, or 3.3 V. - VME power faults could be VME_5V, VME_5VPC, or VME_24V.
	IOLOCK	IOLOCK (RED)—This LED indicates that an I/O LOCK condition exists either locally on the CPU itself and/or on the VMEbus. **Note:** IOLOCK is a condition driven by the SYSCON where all I/O modules are placed into a failsafe condition and outputs are driven to a known state.
	FAULT	CPU FAULT (RED)—Actively flashes CPU fault codes as necessary.
	WATCHD OG	CPU Watchdog / Health Faults (RED)—The processor watchdog or Health monitor has tripped and the CPU or Remote RTN module is prevented from running. The CPU Watchdog includes a 1 ms failover event and an 18 ms timeout event. Health faults include GAP fault, Watchdog events, and local SYSCLK and MFT hardware faults.

6.1.5. 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

RESET MODULE BEFORE REMOVAL

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

6.1.6. 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.**

6.1.6. 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.

Notes:

The Real Time Network (RTN) is a dedicated Woodward I/O expansion network-- no external Ethernet devices are allowed.
Each RTN Switch on the dedicated RTN network must be the same Make and Series. No mixing and matching the on the RTN network is allowed.
1752-423, Hirschmann copper Ethernet switch (RS2-TX, 8port) Obsolete Dec 2016
1711-1069, Hirschmann Fiber Optic Switch (RS2-4TX/1FX) Obsolete Dec 2016
1751-6077, Hirschmann Fiber Optic Switch (RS2-3TX/2FX) Obsolete Dec 2016
1711-1350 , Phoenix copper Ethernet switch (FL SWITCH SFNT 8TX) Available 4th quarter 2016
1711-1351, Phoenix Fiber Optic Switch (FL SWITCH SFNT 7TX/FX) Available 4th quarter 2016

6.1.7. 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

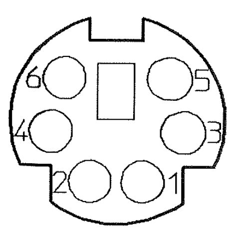
- 62.5 / 125 μm multi-mode, duplex fiber
- Standard SC Type connectors
- Wavelength : 850 nm, 1300 nm
- Attenuation @ 1300 nm : < 1.5 db/km
- Bandwidth @ 1300 nm : > 500 MHz – km
- Flammability type OFNR (riser, UL-1666)
- Minimum bend radius of 7 cm
- Refer to Woodward reference dwg 9097-2077

6.1.8. 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.



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 6-9. RTN Service Port (mini-DIN6F)

6.1.9. 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 6-3. 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

6.2. SIO Module (Smart-Plus Version)

The SIO (Serial In/Out) 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.

6.2.1. Module Description

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

Figure 6-10 is a block diagram of the SIO module. The module manages four serial ports. Port #1 (J1) and port #2 (J2) are RS-232 ports. Port #3 (J3) and Port #4 (J4) are for RS-232, RS-422, or RS-485 communication protocols. Ports #3 and #4 must be at the same baud rate when using 38.4 kBd or 57.6 kBd.

The SIO module has two LEDS (RUN and FAULT) and no switches.

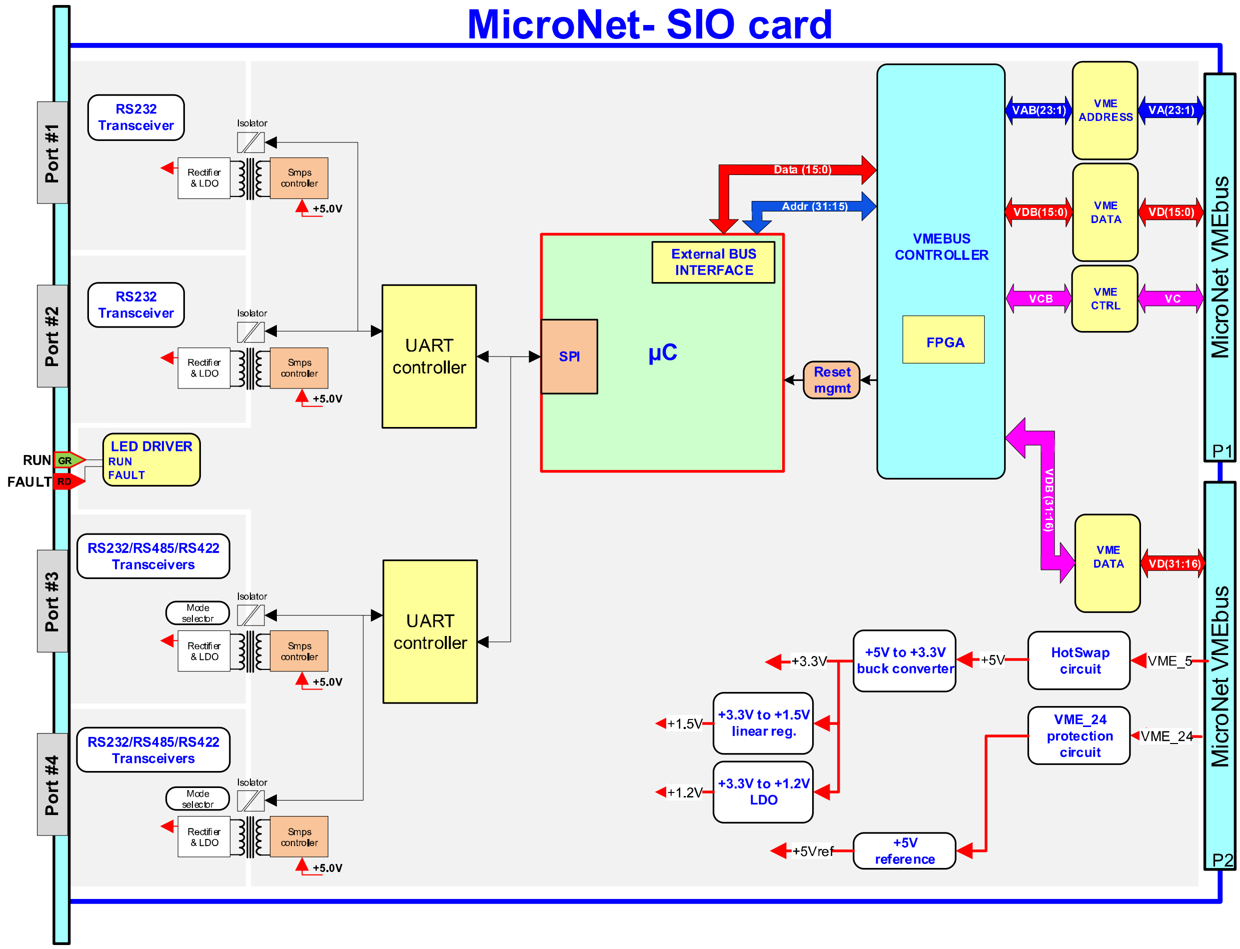


Figure 6-10. SIO Module Block Diagram

Figure 6-11. SIO Module

Table 6-3. 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
Isolation Voltage:	500Vrms to earth ground, control common and between ports
Operating Temperature:	–10 to +65 °C
Software Support:	Modbus RTU
	Modbus ASCII
	Woodward-specific service interface

6.2.2. 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.

Termination

For RS-422, termination should be located at the receiver when one or more transmitters are connected to a single receiver. When a single transmitter is connected to one or more receivers, termination should be at the receiver farthest from the transmitter. Figure 6-12 is an example.

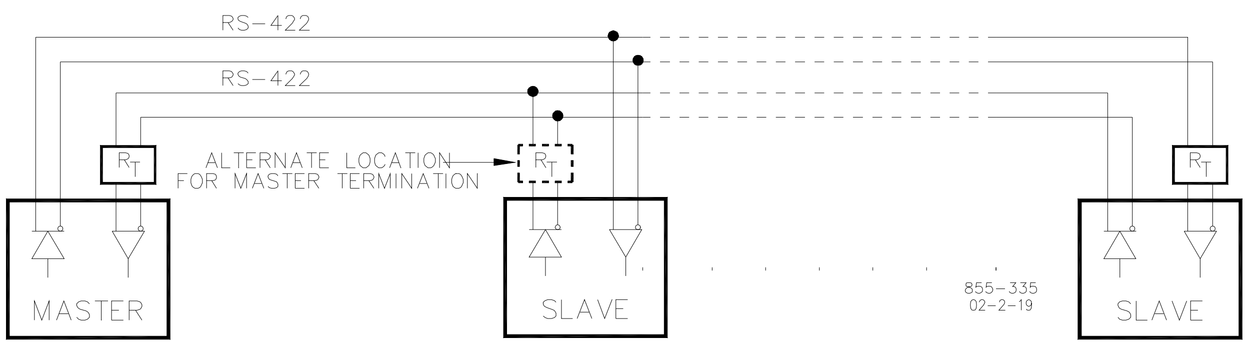


Figure 6-12. RS-422 Terminator Locations

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 6-13 is an example.

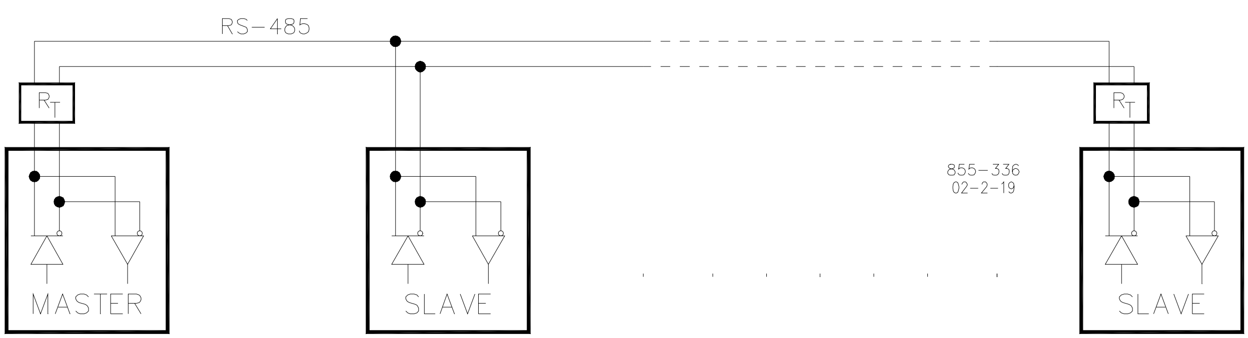


Figure 6-13. RS-485 Terminator Locations

Termination is accomplished using a three-resistor voltage divider between a positive voltage and ground. The impedance of the resistor network should be equal to the characteristic impedance of the cable. This is usually about 100 to 120 Ω. The purpose is to maintain a voltage level between the two differential lines so that the receiver will be in a stable condition. The differential voltage can range between -6 V and 6 V; the maximum voltage between either receiver input and circuit ground must be less than ±25 V. There is one termination resistor network for each port located on the SIO board. Connection to this resistor network is made through the 9-pin connectors on pins 6 and 9. See Figure 6-14 for termination and cable connection examples.

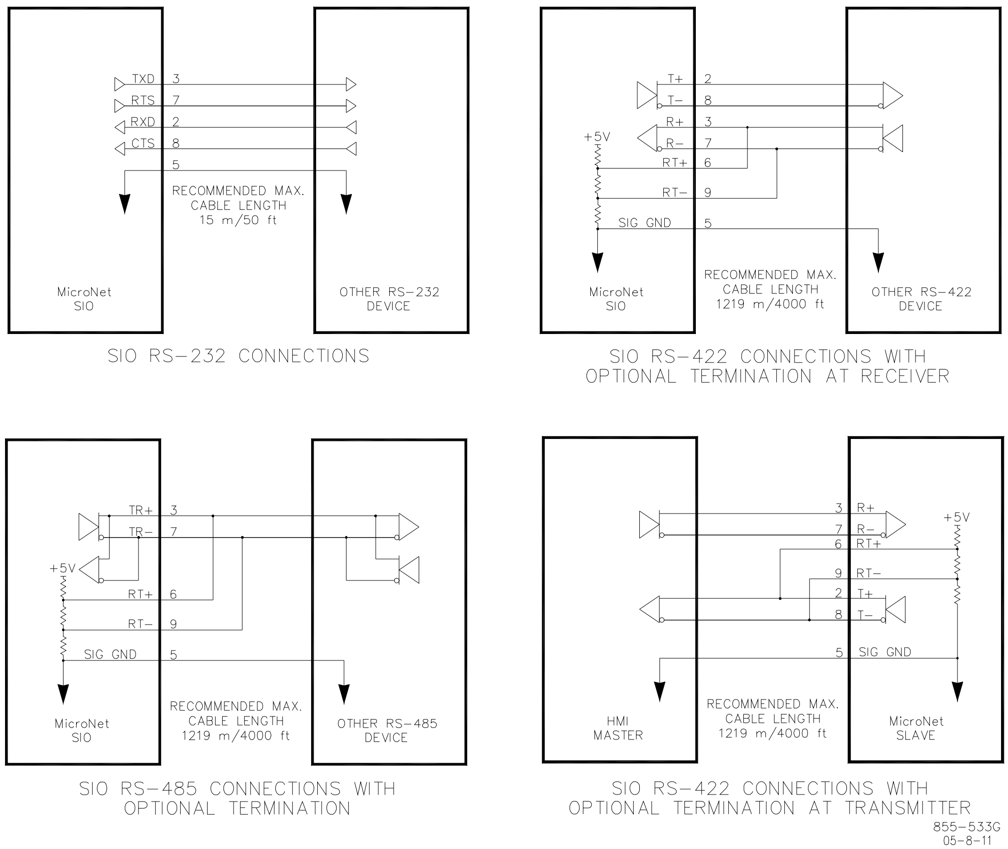


Figure 6-14. Termination and Cable Connection Examples

6.2.3. Grounding and Shielding

The RS-422 and RS-485 specifications state that a ground wire is needed if there is no other ground path between units. The preferred method to do this is to include a separate wire in the cable that connects the circuit grounds together. Connect the shield to earth ground at one point only. The alternate way is to connect all circuit grounds to the shield, and then connect the shield to earth ground at one point only. If the latter method is used, and there are non-isolated nodes on the party line, connect the shield to ground at a non-isolated node, not an isolated node. Figures 6-15 and 6-16 illustrate these cabling approaches.

IMPORTANT	**Non-isolated nodes may not have a signal ground available. If a signal ground is not available, use the alternate wiring scheme in Figure 6-15 with the signal ground connection removed on those nodes only.**

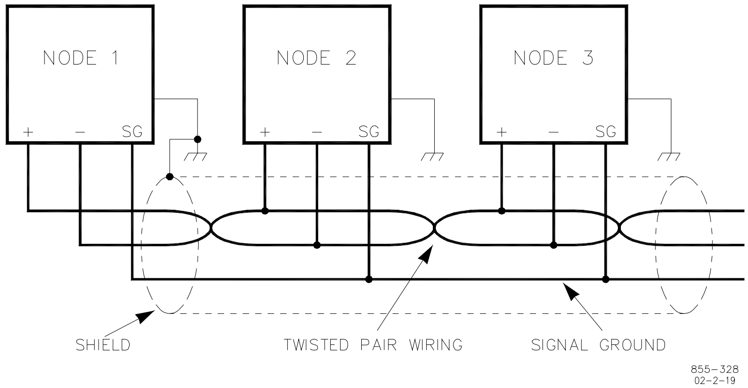


Figure 6-15. Preferred Multipoint Wiring Using Shielded Twisted-Pair Cable with a Separate Signal Ground Wire

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

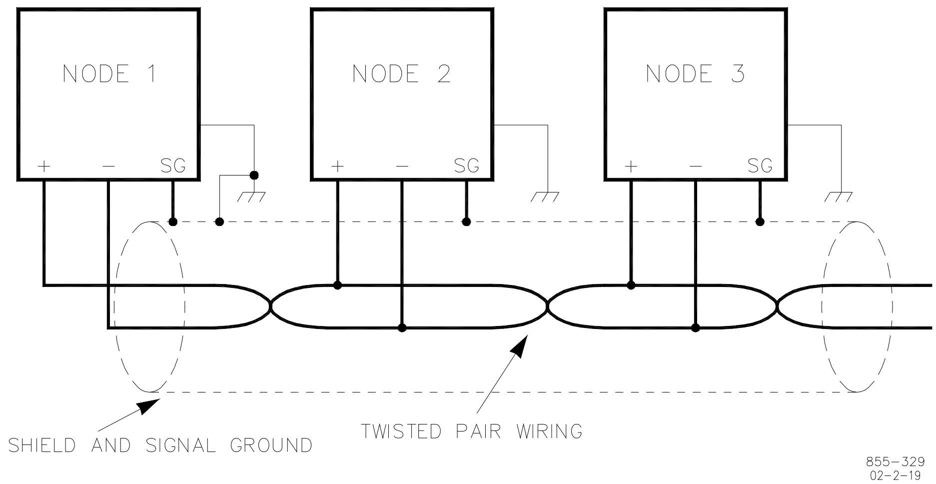


Figure 6-16. Alternate Multipoint Wiring Using Shielded Twisted-Pair Cable without a Separate Signal Ground Wire

6.2.4. Troubleshooting

Each MicroNet SIO 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, initialization is successful and application has started, the red LED goes off and green RUN LED is turned on.

If the Fault LED on a module is illuminated after the initialization process passed, the module may be faulty or may be located in the wrong slot.

Table 6-1. LED Indications of Failure

Number of LED Flashes	Failure	Number of LED Flashes	Failure
1	Watchdog/MFT Lost Failure	9	Software Slip
2	No Application	10	RAM Memory Failure
3	Flash Memory Failure		
4	Exception Failure/UART Chip 1 or UART Chip 2 Error/ Shared Memory Error	11	Software Failure
5	FPGA Failure	12	Power Supply Failure
6	Non-Volatile Memory Error	13	Configuration or Parameter Error
7	Kernel Watchdog Error	15	Parallel to Serial Bus Error
8	MFT Timing Failure		

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

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, SIO module has Fault LEDs on, check the chassis' CPU module for a failure. If during normal control operation only the SIO module's Fault LED is on or flashing, insure that it is installed in the correct slot or if it is installed correctly. If it is, then replace that module. See instructions for replacement in Chapter 15, Installation (System Level Installation). When a module fault is detected all SIO Ports are blocked.

1. If the SIO module is not functioning or not functioning properly, verify the cable connections.
2. If the cable connections are verified and module is still not functioning check if SIO module is properly connected in chassis.
3. If the module is still not functioning properly after verifying the cable connections, replace the cables connecting to module.
4. If the module is still not functioning properly after replacing cables, replace the module.

Chapter 7.
Discrete I/O Modules

7.1. Introduction

There are 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 requirement 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 were they are restricted to be on the engine/turbine. In addition, coil or wetting voltage commons, as applicable, must be routed with the field I/O wire bundles inside the shielding. Shielding may be electrically continuous metal conduit, cable armor, or completely enclosed metal 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.

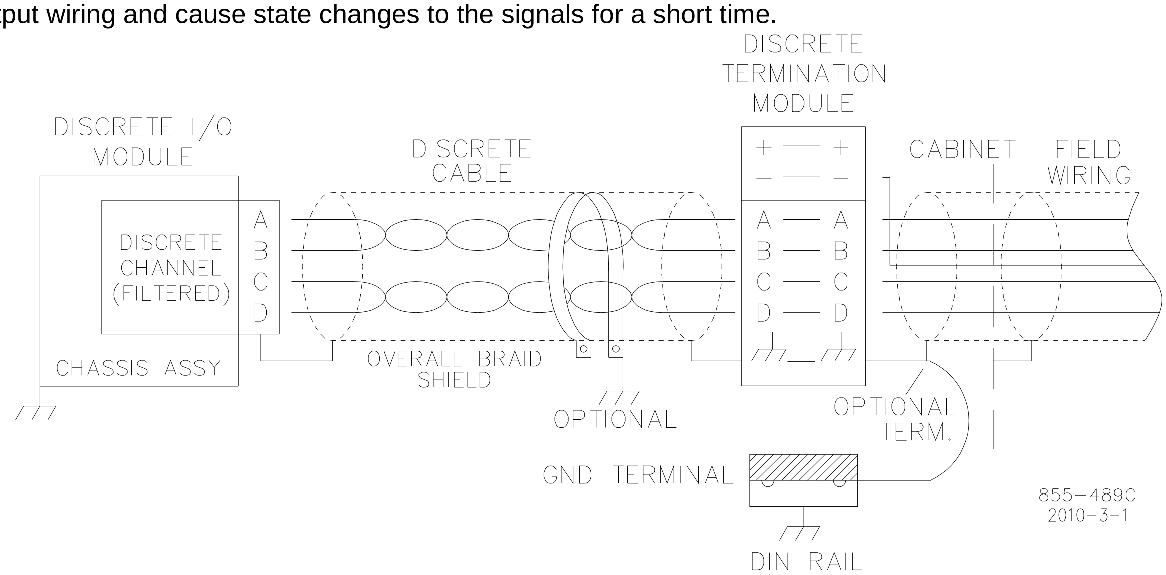


Figure 7-1. DI/DO Field Wire Shielding Example (Non-Marine)

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

7.2.1. 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 7-3 and 7-7 for examples of configurations.

Figure 7-2. Discrete Combo Module (HDDIO)

Table 7-1. 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 µs 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.

7.2.2. 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 7-3 for an example of configuration.

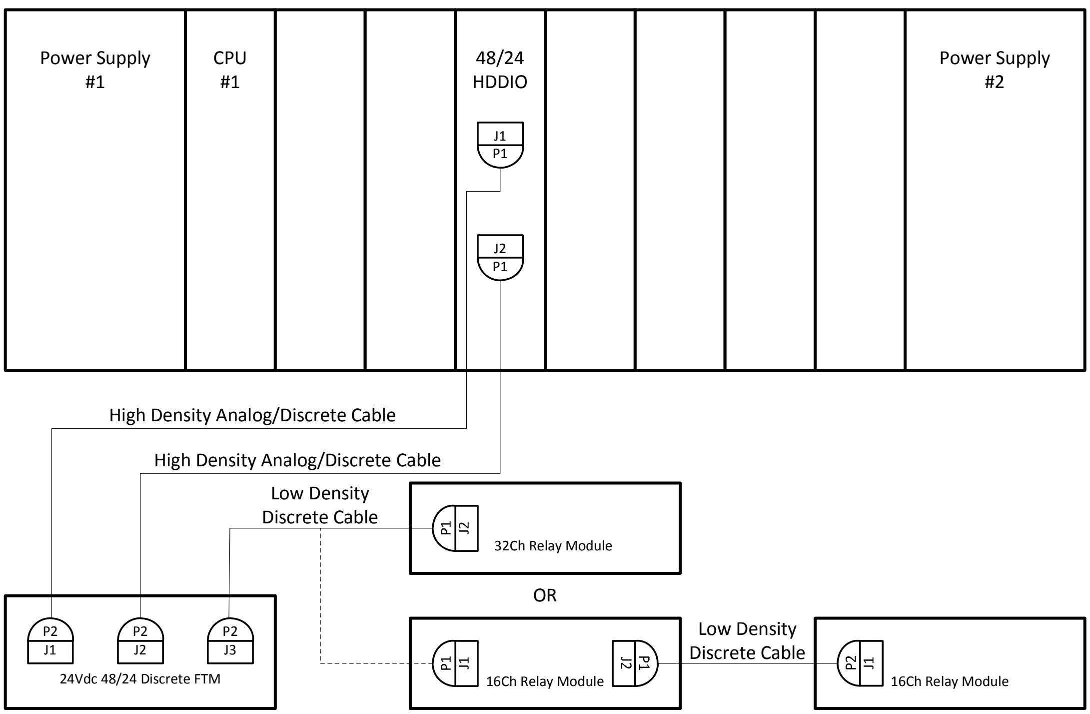


Figure 7-3. Configuration 1, One 48/24 Discrete FTM with Relay Module(s)

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 7-4 illustrates different discrete input wiring configurations based on the input voltage.

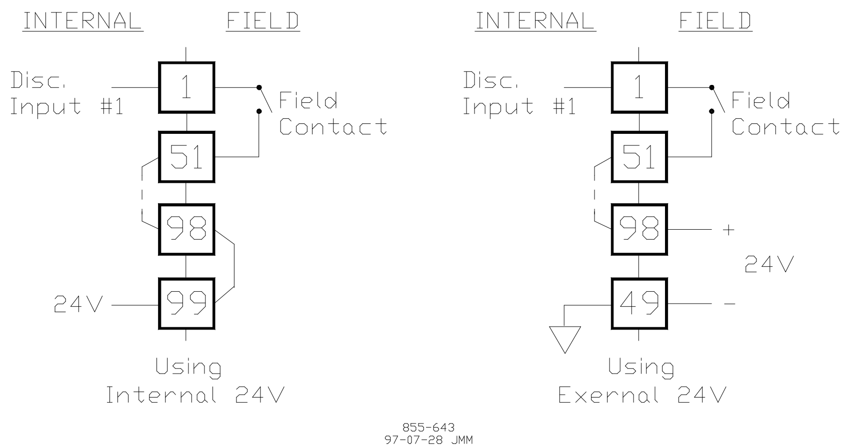


Figure 7-4. Discrete Input Interface Wiring to a 24 Vdc 48/24 Discrete FTM

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 7-4).
- 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 7-4). Power for contacts must be supplied by the control's power supplies, or the external power supply outputs must be rated to Class II at 30 Vdc or less and outputs must be fused with appropriately sized fuses (a maximum current rating of 100 ÷ V, where V is the supply's rated voltage or 5 A, whichever is less).

Discrete Outputs

For the 48/24 Discrete Combo FTM configuration, there are three types of relay output boxes that can be used. These consist of the 16Ch Relay (Phoenix) Module, 16Ch Relay Module, and the 32Ch Relay Module (see Chapter 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 7-1). Internal wiring on the 48/24 Discrete I/O FTM provides this dual relay functionality. The application software may use these relays for outputs where extra relay contacts are needed, such as alarm or shutdown outputs.

Table 7-2. Discrete Outputs/Relay Module Configuration

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

See Chapter 13 for field wiring of discrete output relays.

Figures 7-5 and 7-6 illustrate examples of different discrete output wiring configurations.

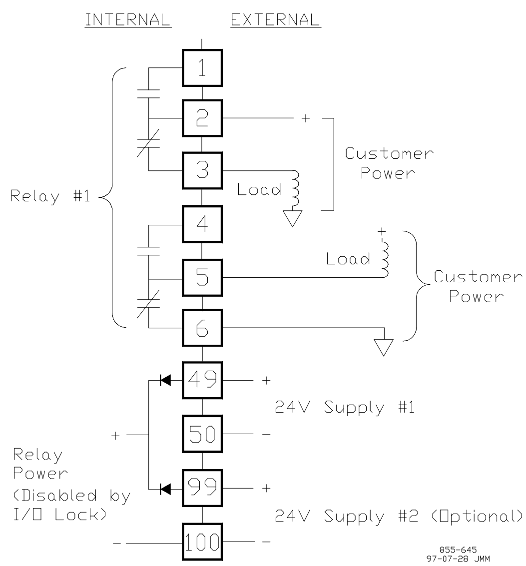


Figure 7-5. Relay Output Interface Wiring to a 16Ch Relay Module

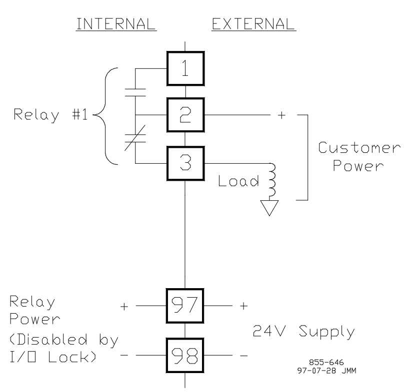


Figure 7-6. Relay Output Interface Wiring to a 32Ch Relay Module

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 7-7 for an example of configuration.

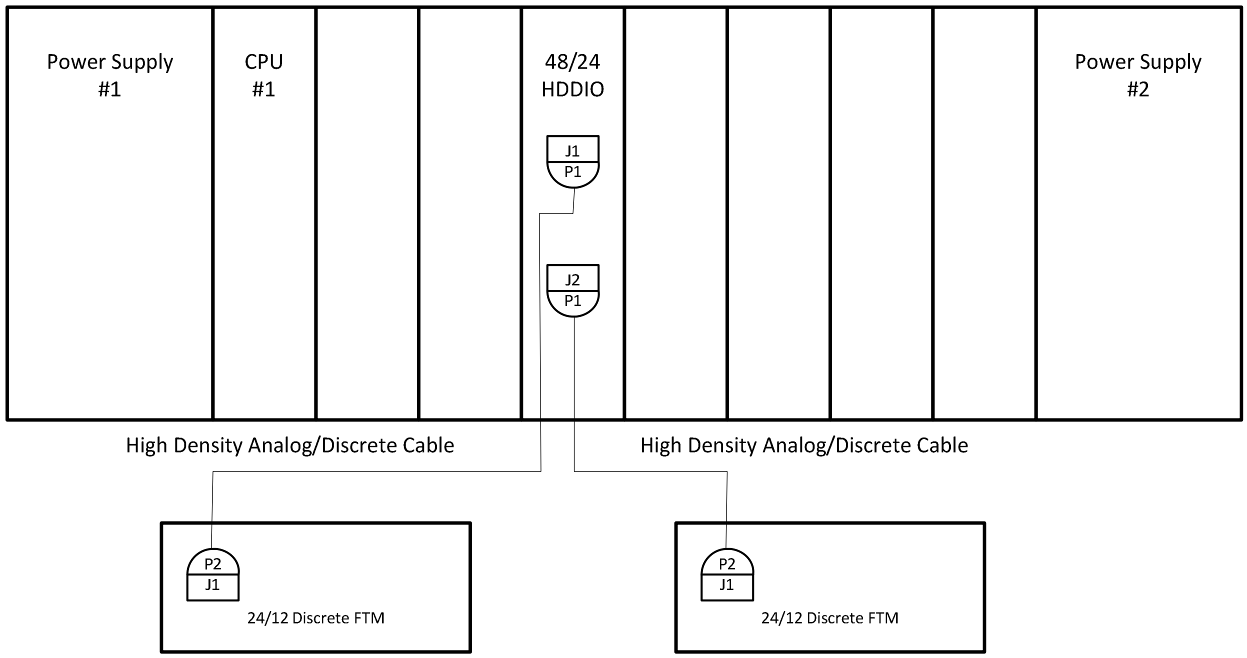


Figure 7-7. Configuration 2, Two 24/12 Discrete FTMs

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 7-8).

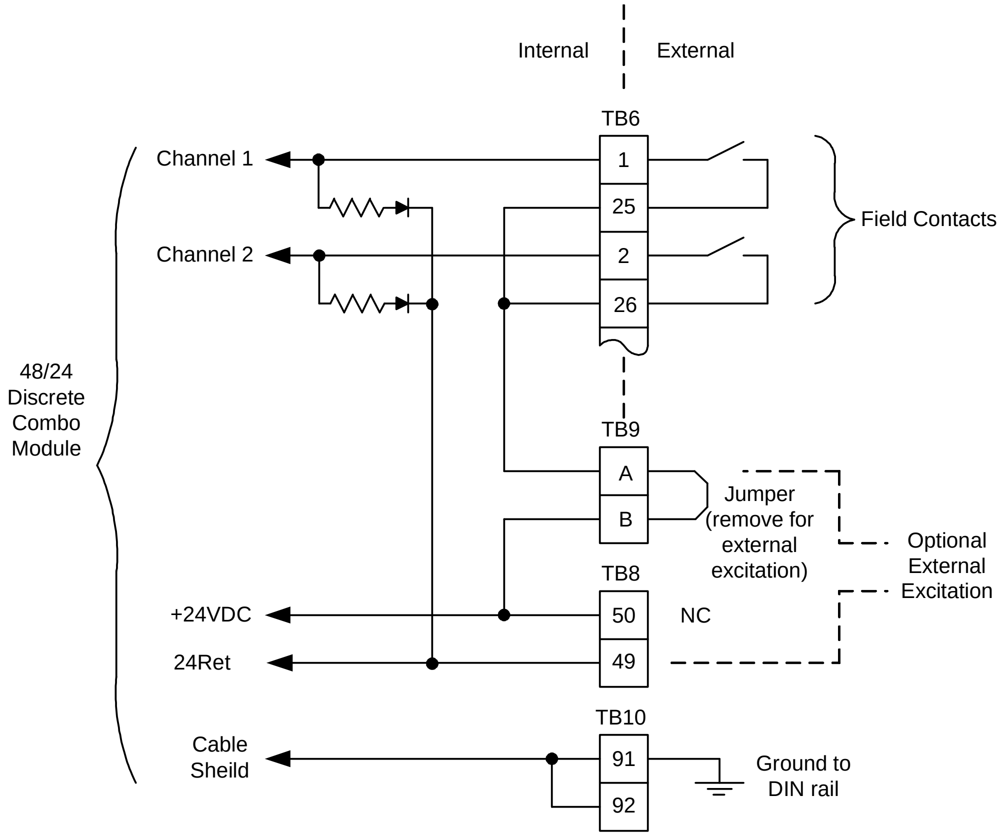


Figure 7-8. Discrete Input Interface Wiring to a 24/12 Discrete FTM

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 7-8).
- If an external 24 Vdc is used, the common for the external 24 Vdc must be tied to the discrete input common (see Figure 7-8). 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 7-9 illustrates an example of a discrete output wiring configuration.

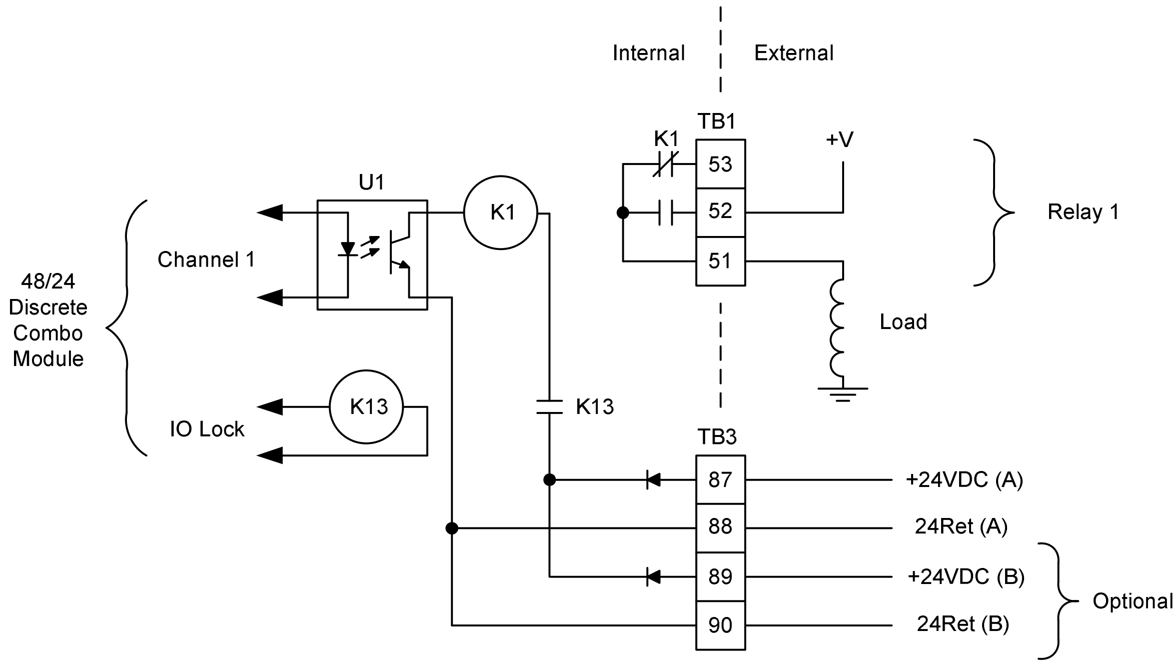


Figure 7-9. Relay Output Interface Wiring to a 24/12 Discrete FTM

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.

7.2.3. FTM Reference

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

7.2.4. 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 7-3. LED Indications of Failure

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

Fault Detection (I/O)

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

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

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

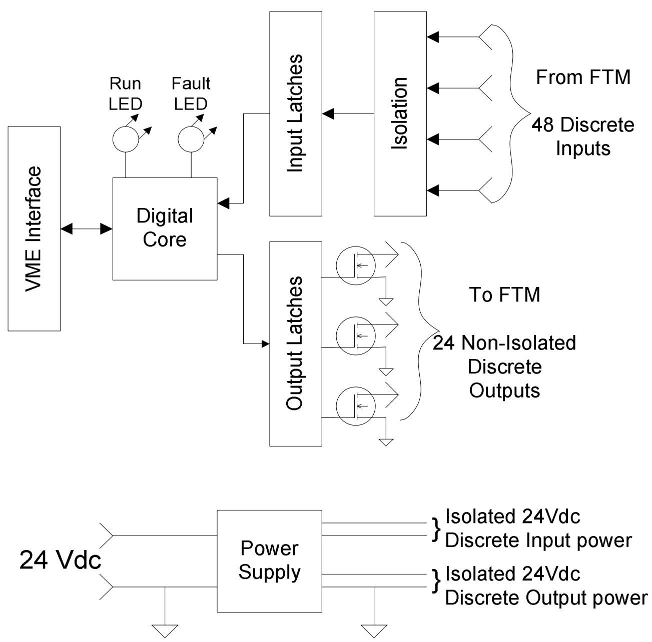


Figure 7-10. 48/24 Discrete Combo Module Block Diagram

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.

7.3. 48 Channel Discrete Input Module

7.3.1. 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 7-11. 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.

Table 7-4. Module Specification

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

7.3.2. 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.

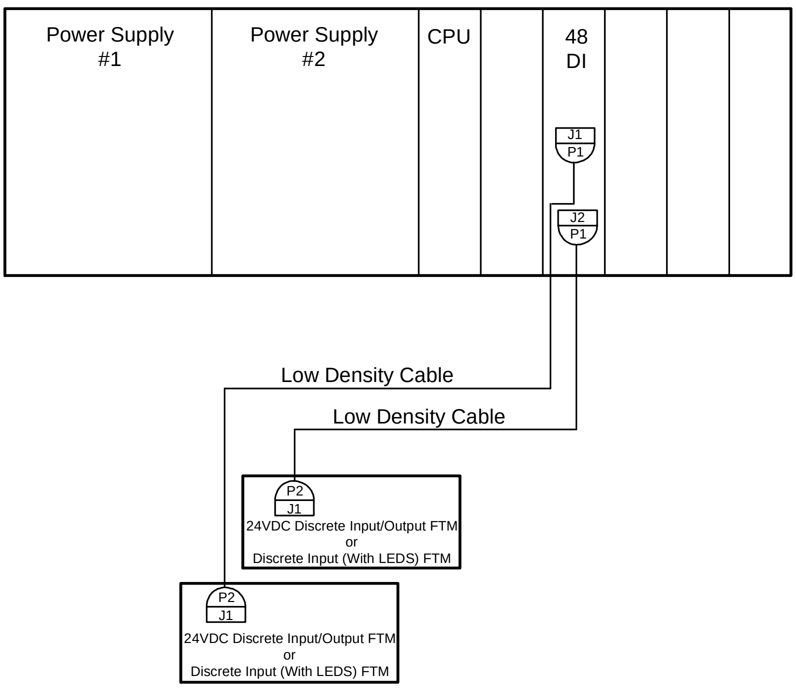


Figure 7-12. 48Ch DI Module with two FTMs

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.

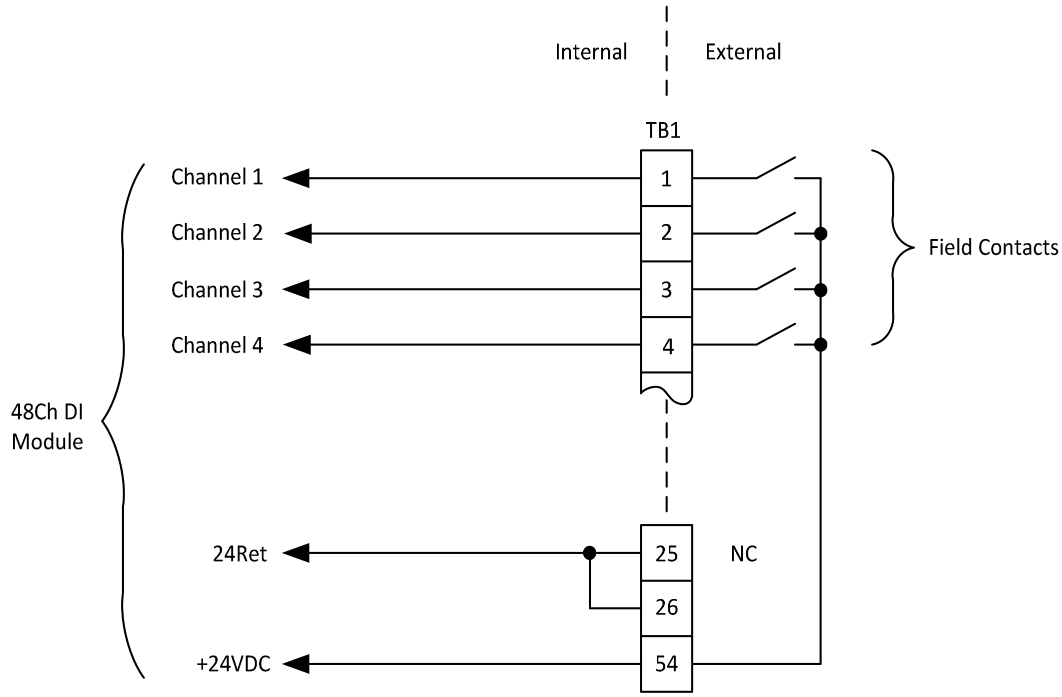


Figure 7-13. Discrete Input Interface Wiring with Internal Power Source to a 24 Vdc Discrete Input/Output FTM

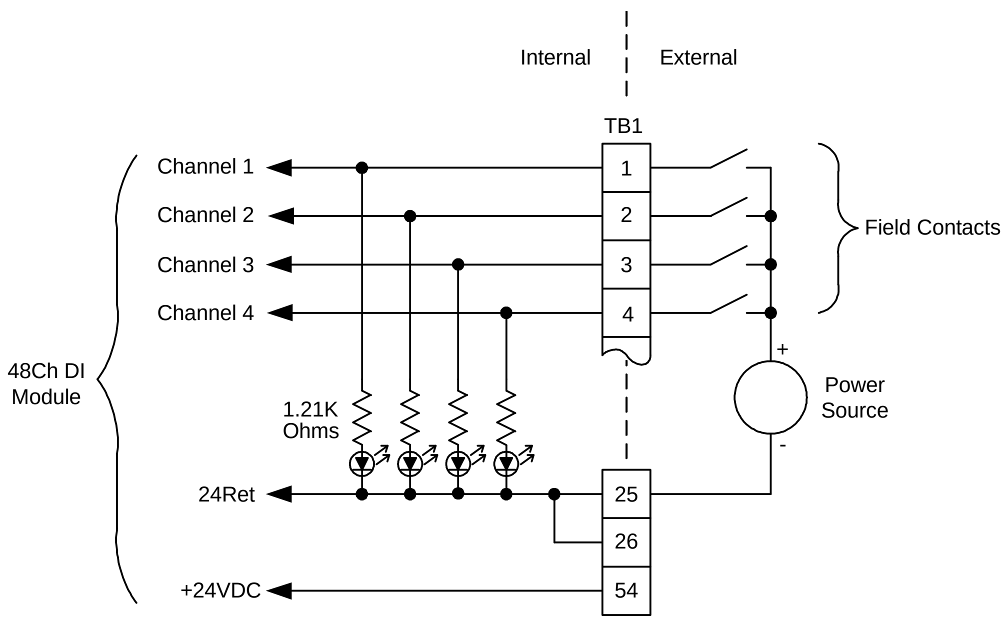


Figure 7-14. Discrete Input Interface Wiring with External Power Source to a Discrete Input (with LEDs) FTM

Configuration Notes:

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

7.3.3. FTM Reference

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

7.3.4. 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.

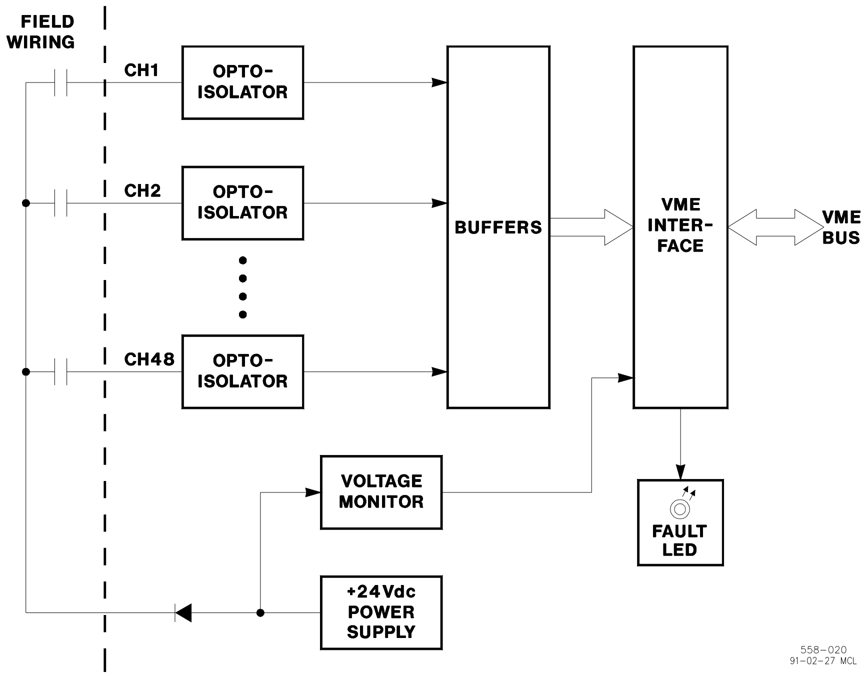


Figure 7-15. Discrete Input Module Block Diagram

Figure 7-15 is a block diagram of the Discrete Input module. The module receives information from as many as 48 field switches and relays. Field wiring is isolated from the MicroNet circuitry by optical isolators in each channel; the state of each discrete input is passed through an optoisolator to the buffers. The CPU then obtains the data for each channel through the VME interface.

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

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

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

7.4. 64 Channel Discrete Output Module

7.4.1. Module Description

Figure 7-16. 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).

Table 7-5. 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.

7.4.2. 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 7-32 for system installation configuration.

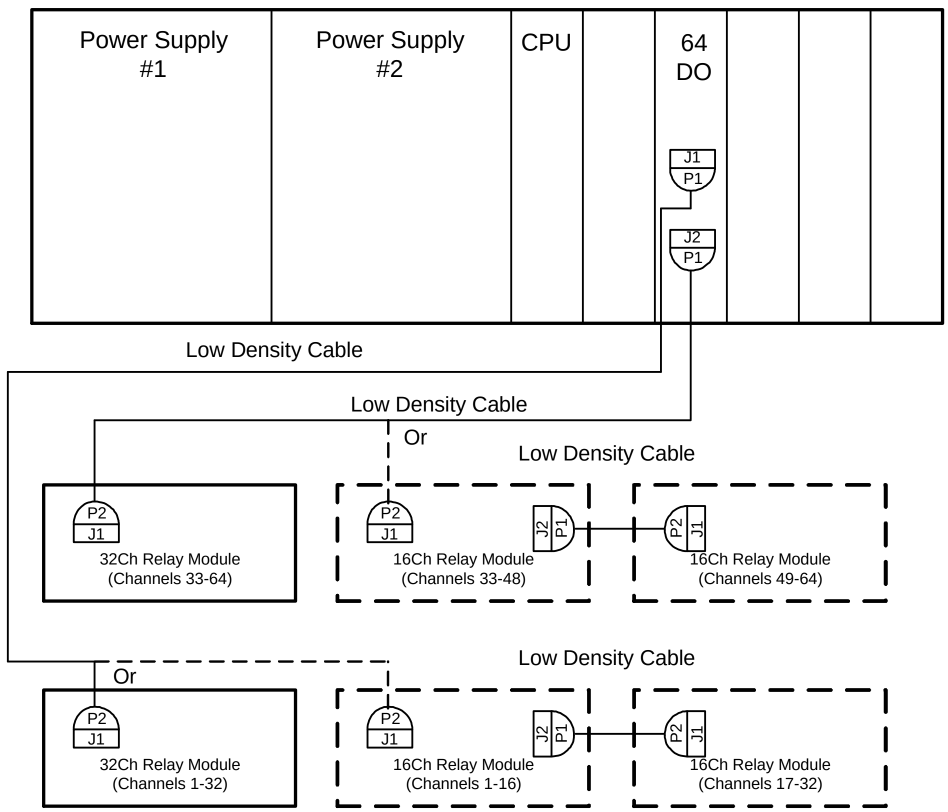


Figure 7-17. 64Ch DO Module with Relay Modules

See Chapter 13 for field wiring of discrete output relays.

Figures 7-18 and 7-19 illustrate examples different discrete output wiring configurations.

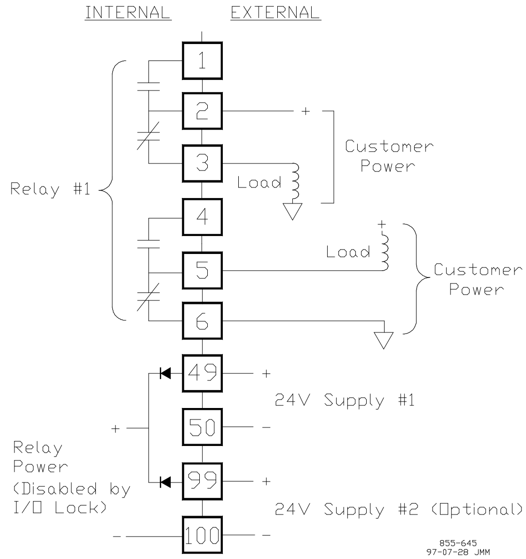


Figure 7-18. Relay Output Interface Wiring to a 16Ch Relay Module

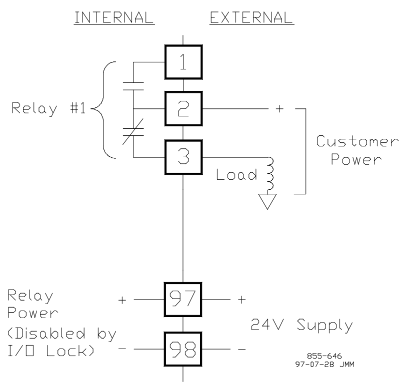


Figure 7-19. Relay Output Interface Wiring to a 32Ch Relay Module

Configuration Note

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

7.4.3. FTM Reference

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

7.4.4. 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 8.
Analog I/O Modules

8.1. Introduction

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

8.2. Combination I/O Modules

There are four Analog Combination I/O modules available from Woodward. These are described in sections 8.3 through 8.6 and 8.28

8.3. Speed Sensor Smart-Plus Module

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

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

8.3.1. 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.

Table 8-1. Specification

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

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

Figure 8-1. Speed Sensor Smart-Plus Module

8.3.2. 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 8-2 for MPU and Eddy probe wiring examples.

IMPORTANT

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

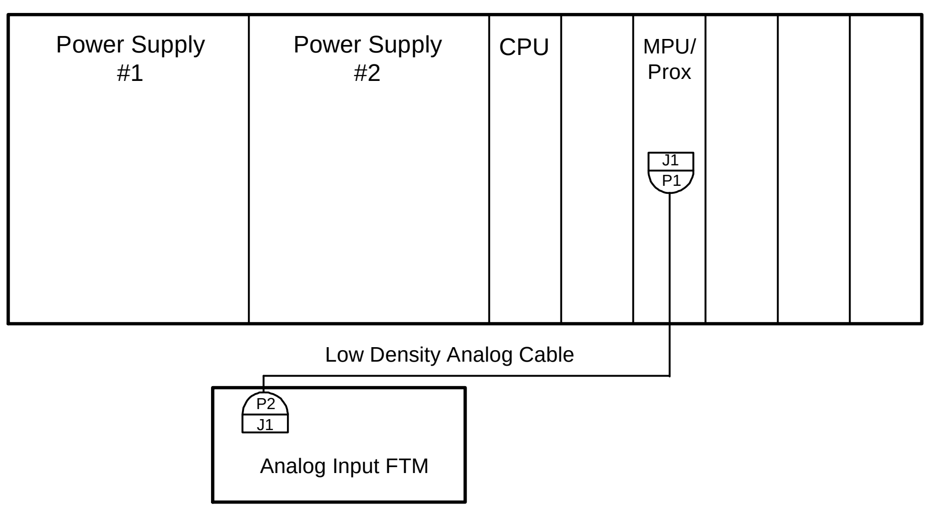


Figure 8-2. Ch MPU/Eddy Module

8.3.4. FTM Reference

See Figure 8-3 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.

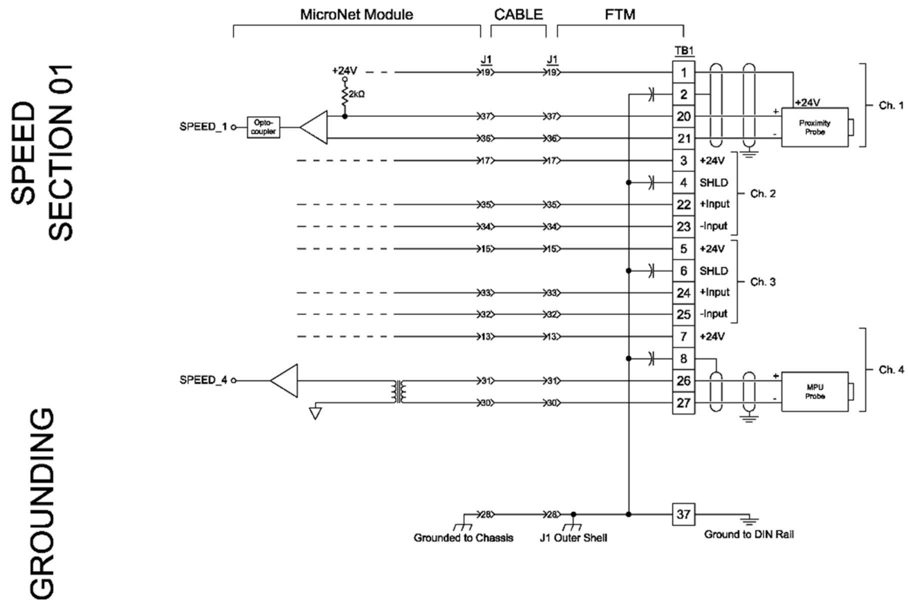


Figure 8-3. MPU and Eddy Probe Interface Wiring

8.3.5. Troubleshooting

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

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

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

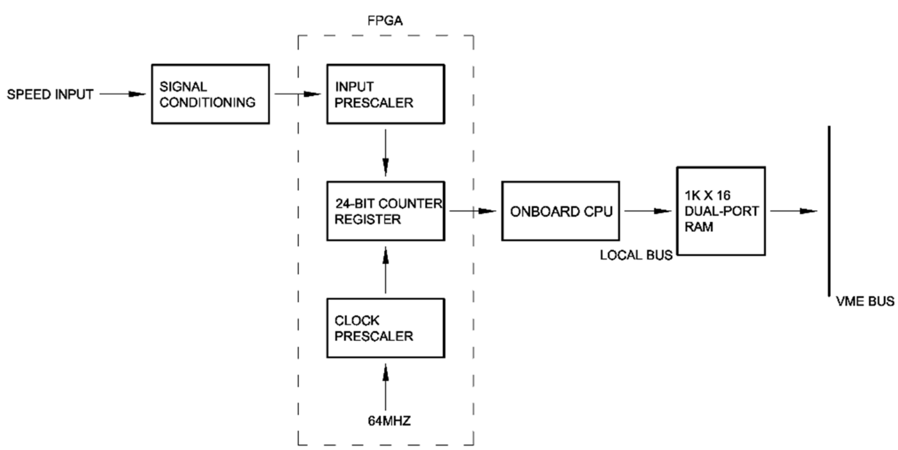


Figure 8-4. Digital Speed Sensor Module Block Diagram

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

Table 8-2. 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.

8.4. 24/8 Analog Smart Plus Module

8.4.1. 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.

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

Twenty-four channels of 4-20 mA inputs with eight channels of 4-20 mA outputs (2-pole 10 ms filter on all input channels, except channels 23 and 24, which have 2-pole 5 ms filter). 24 channels of 0-5Vdc inputs, with eight channels of 4-20 mA outputs (2-pole 10 ms filter on all input channels, except channels 23 and 24, which have 2-pole 5 ms filter).

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

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

Figure 8-5. 24/8 Analog Smart Plus Module

Table 8-3. 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

Table 8-4. 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 back Resolution	
Source:	12 bits
Return:	8 bits
Read back Accuracy	
Source:	0.5% of 0-25 mA full scale
Return:	1% 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.

Note: AI and AO readback accuracy may be affected if the control is placed in a high electrical noise environment.

8.4.2. 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 8-6 for an example.

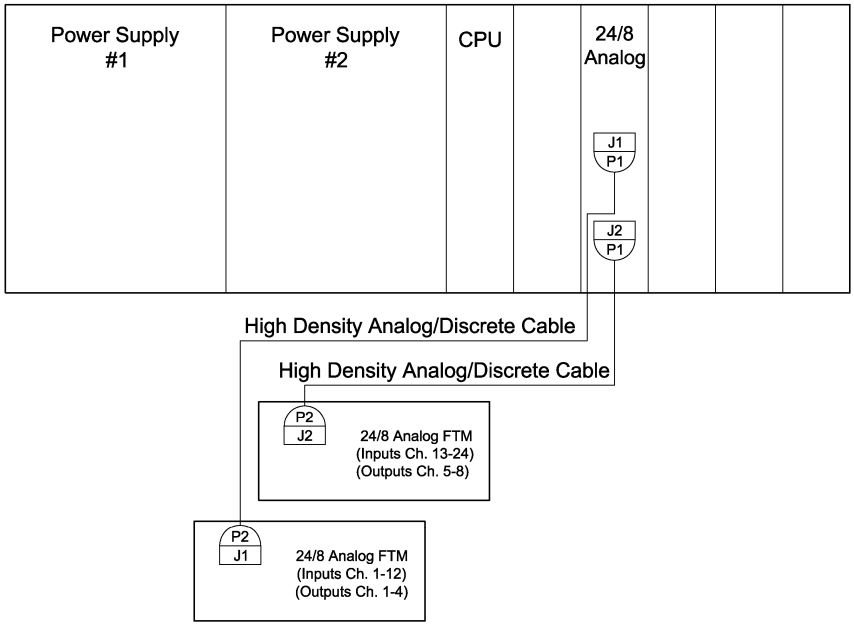


Figure 8-6. Simplex System Configuration Example

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 8-3 for analog input connection. This power is protected with a 100 mA fuse on each channel located at the FTM to prevent an inadvertent short from damaging the module. The 24 Vdc outputs are capable of providing 24 Vdc with ±10% regulation. Power connections can be made through terminals located on the 24/8 Analog FTMs. See Chapter 13 for complete field wiring information for the 24/8 Analog FTM.

IMPORTANT	**Maximum loop power current is 0.32A per 12 inputs located on the same FTM.**

IMPORTANT	**When configuring the AI Combo block in GAP, set Conf. input field to 0 for all inputs working in 1-5V voltage mode. This will disconnect input 200ohms sense resistor and allow the block to use the module factory voltage calibration values.**

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

IMPORTANT	**When configuring the AI Combo block in GAP, set Conf. input field to 2 for all 4-20 mA inputs when used with the Dataforth current input plug-in module. This will allow the block to use the module factory voltage calibration values with a gain factor for a 200 ohm external resistor on the Dataforth FTM.**

IMPORTANT Input type configuration is factory set for backward compatible part numbers.

IMPORTANT For modules with GAP selectable inputs, when changing the Conf. input field to a new value an application save and application restart is required before the module can be used. This save and restart allows the hardware and software to be properly initialized together.

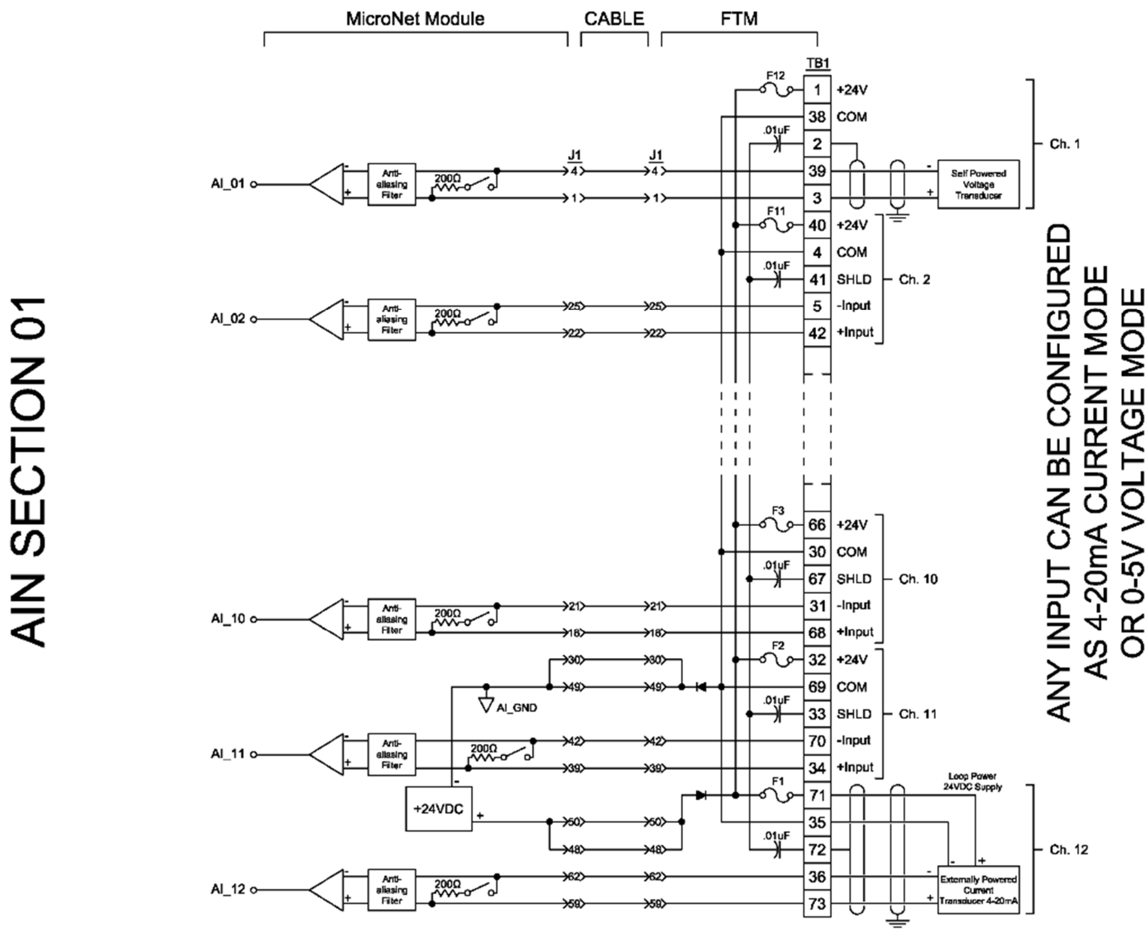


Figure 8-7. Analog Input Wiring for a 24/8 Analog FTM

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 8-4 for analog output connection. Each output monitors the output source and return current for fault detection. All of the analog outputs may be individually disabled. When a channel fault or a module fault is detected, the application program may annunciate the fault, disable the channel and stop using data in system calculations or control. Care should be taken to prevent ground loops and other faults when interfacing to non-isolated devices. See Chapter 13 for complete field wiring information for the Analog High Density FTM.

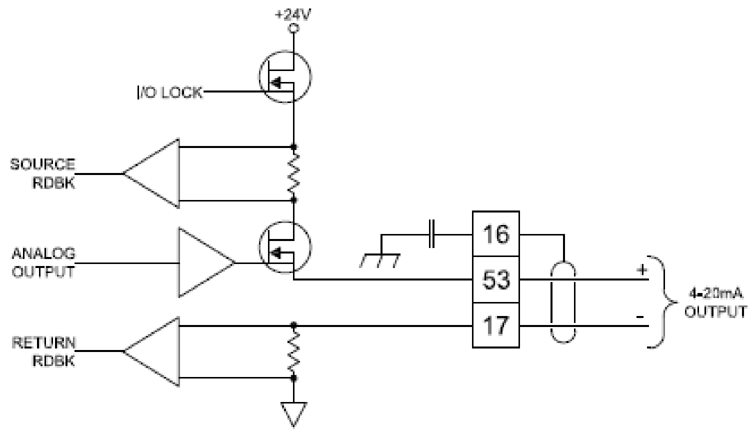


Figure 8-8. Analog Output Wiring for a 24/8 Analog FTM

8.4.4. FTM Reference

See Chapter 13 for complete field wiring information for the Analog High Density FTM. See Appendix A for part number Cross Reference for modules, FTMs, and cables.

8.4.5. Troubleshooting

Each 24/8 Analog Smart Plus module has a red Fault LED that is turned on when the system is reset. During initialization of a module, which occurs after every CPU reset, the CPU turns the Fault LED on. The CPU then tests each module using diagnostic routines built into the software. If the diagnostic test is not passed, the LED remains on or blinks. If the test and initialization is successful, the red LED goes off and green RUN LED is turned on.

If the Fault LED on a module is illuminated after the diagnostics and initialization have been run, the module may be faulty or may be located in the wrong slot.

Table 8-5. LED Indications of Failure

Number of LED Flashes	Failure	Number of LED Flashes	Failure
1	Watchdog/MFT Lost Failure	11	Software Failure
2	No Application	12	Power Supply Failure
3	Flash Memory Failure	13	Configuration or Parameter Error
4	Exception Failure	15	Parallel to Serial Bus Error
5	FPGA Failure	16	AI ADC Error
6	Non-Volatile Memory Error	17	AO Read back ADC Error
7	Kernel Watchdog Error	20	AI ADC Timeout
8	MFT Timing Failure	21	AO Read back ADC Timeout
9	Software Slip	22	AO DAC Timeout
10	RAM Memory Failure		

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

Fault Detection (I/O)

In addition to detecting the High Density Analog I/O module hardware faults, the application software may detect I/O faults.

Analog Input Faults: The application software may be set with a high and low latch set point to detect input faults.

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

IMPORTANT	**Backward compatible modules do not monitor return side current read back.**

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

Troubleshooting Guide

If during normal control operation, all of the 24/8 Analog Smart Plus modules have Fault LEDs on, check the chassis' CPU module for a failure. If during normal control operation only the 24/8 Analog module's Fault LED is on or flashing, insure that it is installed in the correct slot. If it is, then replace that module. See instructions for replacement in Chapter 15, Installation (System Level Installation). When a module fault is detected, its outputs will be disabled or de-energized.

Analog Inputs

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

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 15, Installation (System Level Installation).
2. Measure the input voltage on the FTM terminal block. It should be in the range of 0-5 V.
3. Verify that there are no or minimal AC components to the Analog Input signal. Improper shielding may introduce AC noise on the input terminals.
4. Check the wiring. If the inputs are reading 0 or the engineering units that correspond to 0 mA, look for a loose connection on the terminal blocks, disconnected or misconnected cables, a missing jumper on the terminal block if the input is a current input, or a blown fuse on the 24 Vdc on the FTM.
5. If all of the inputs are reading high, check that the 24 Vdc is not connected across the input directly.
6. Check the software configuration to ensure that the input is configured properly.
7. After verifying all of the above, exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the module.
8. If the readings are incorrect on several channels of the 24/8 Analog module, corresponding to both cables, replace the module.
9. If replacing the module does not fix the problem, replace the FTM. The FTM contains only traces and a few discrete components, so failure is extremely unlikely. See instructions for replacing the FTM in Chapter 15, Installation (System Level Installation).

Analog Outputs

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

1. Check that the cable is shielded and the shield is properly grounded per the Shields and Grounding section in Chapter 15, Installation (System Level Installation).
2. Check the load resistance to ensure that it is not greater than 600 ohms.
3. Check to ensure that the load wiring is isolated.
4. Check the wiring for a loose connection on the FTM terminal blocks and disconnected or misconnected cables.
5. Disconnect the field wiring and connect a resistor across the output. If the output is correct across the resistor, there is a problem with the field wiring.
6. Check the software configuration to ensure that the output is configured properly.
7. After verifying all of the above, exchange the J1 and J2 cables. If the problem moves to a different channel, replace the cable. If not, replace the module.
8. If the readings are incorrect on several channels of the module, corresponding to both cables, replace the module.
9. If replacing the module does not fix the problem, replace the FTM. The FTM contains only traces and a few discrete components, so failure is extremely unlikely. See instructions for replacing the FTM in Chapter 15, Installation (System Level Installation).

IMPORTANT

Recommendation:
The module should be returned to Woodward every 6 years for health check and technical updates. This health check shall increase in frequency when the module is more than 20 years old.

8.5. Speed/Analog IO Combo Smart-Plus Module

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

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

8.5.1. Module Description

This module has four speed inputs that are configurable in GAP application as either MPU, Prox or Eddy inputs.

The module contains circuitry for twelve analog inputs and four 4-20 mA outputs.

Analog inputs are configurable in GAP application as either 0-5Vdc voltage mode or 4-20mA current mode. All inputs have 2-pole 10ms filter, except channels 11 and 12, which have 2-pole 5ms filter.

> **Note:** When changing a GAP selectable input type the application must be saved and an application restart is required. This allows both the hardware and software to initialize to the new input "type" setting.

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

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

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

8.5.2. Specification

Table 8-6. Specifications

Number Channels:	4
Input Type:	MPU/Prox/Eddy Detector (configured in GAP application)
MPU ratings	
Input Frequency Range:	50 Hz to 25 KHz
Input Amplitude:	1 Vrms min, 25 Vrms max,
Input Impedance:	2000 Ω or 6000 Ω over 80 to 2000Hz
Prox ratings	
Input Frequency Range:	0.04 Hz to 25 KHz
Input Amplitude:	0-24Vpk,
Input Impedance:	2000 Ω 12mA short circuit current
Eddy ratings	
Input Frequency Range:	1 Hz to 25 KHz
Input Amplitude:	0-24Vpk,
Input Impedance:	2000 Ω 12mA short circuit current
Common characteristics	
Isolation Voltage:	500Vrms to earth ground and control common, no galvanic isolation between channels
Resolution:	16 bits 0.0015% of range per LSB
Speed Accuracy (max):	
P/N5466-1105	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)

Table 8-7. 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

Table 8-8. 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:	
Source:	0.5% of 0-25 mA full scale
Return:	1% of 0-25 mA full scale
Read back temp drift:	400 ppm/C, maximum

Note: AI and AO readback accuracy may be affected if the control is placed in a high electrical noise environment.

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 8-9. Speed/Analog IO Combo Smart-Plus 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.

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 8-10 for an example.

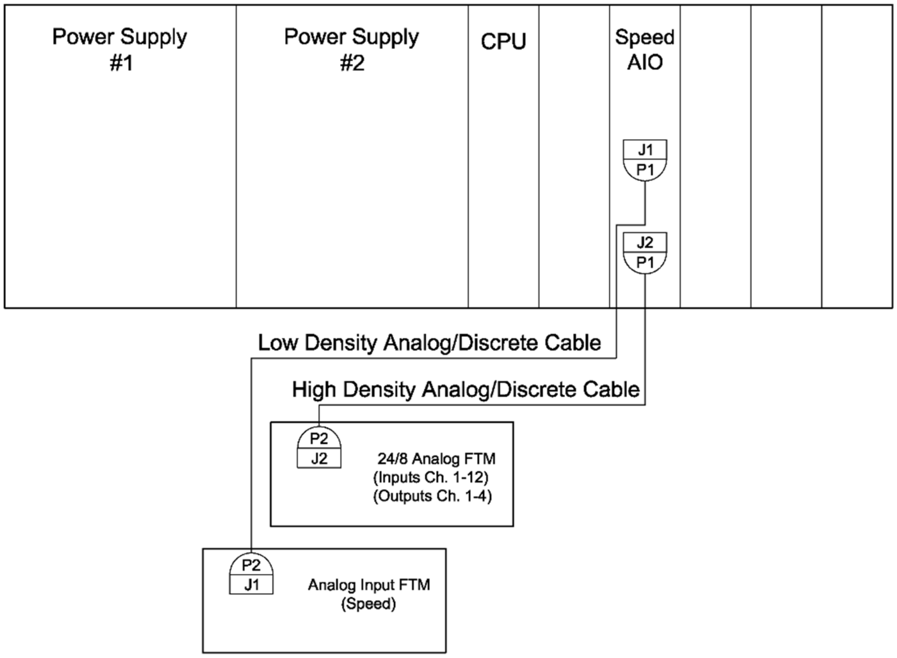


Figure 8-10. Simplex System Configuration Example.

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 8-11 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.

8.5.4. FTM Reference

See Figure 8-11 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.

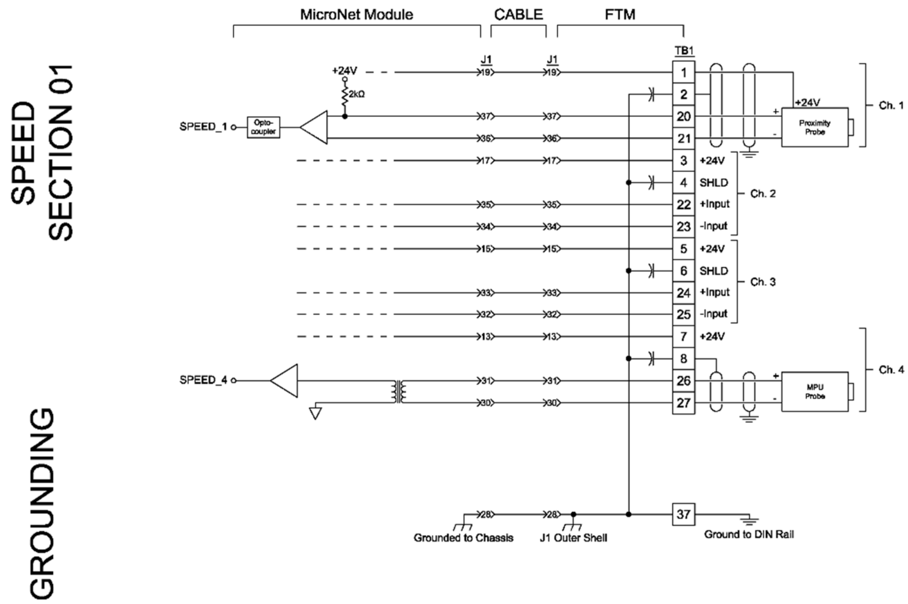


Figure 8-11. MPU and Prox Probe Interface Wiring

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 8-12 for analog input connection. This power is protected with a 100 mA fuse on each channel located at the FTM to prevent an inadvertent short from damaging the module. The 24 Vdc outputs are capable of providing 24 Vdc with ±10% regulation. Power connections can be made through terminals located on the 24/8 Analog FTMs. See Chapter 13 for complete field wiring information for the 24/8 Analog FTM.

IMPORTANT **Maximum loop power current is 0.32A per 12 inputs located on the same FTM.**

IMPORTANT **When configuring the AI Combo block in GAP, set Conf. input field to 0 for all inputs working in 1-5V voltage mode. This will disconnect input 200ohms sense resistor and allow the block to use the module factory voltage calibration values.**

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

IMPORTANT	**When configuring the AI Combo block in GAP, set Conf. input field to 2 for all 4-20 mA inputs when used with the Dataforth current input plug-in module. This will allow the block to use the module factory voltage calibration values with a gain factor for a 200 ohm external resistor on the Dataforth FTM.**

IMPORTANT	**For modules with GAP selectable inputs, when changing the Conf. input field to a new value an application save and application restart is required before the module can be used. This save and restart allows the hardware and software to be properly initialized together.**

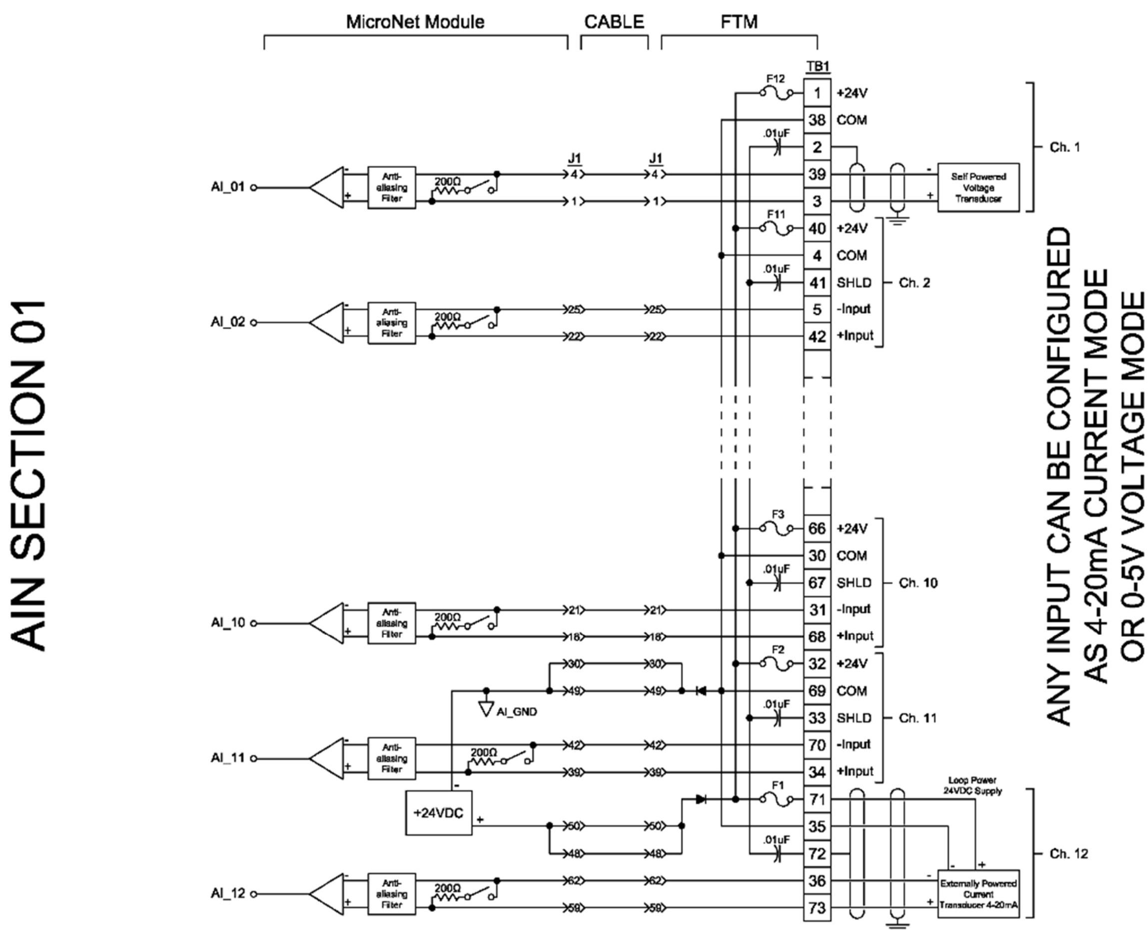


Figure 8-12. Analog Input Wiring for a 24/8 Analog FTM

Analog Outputs

There are four analog output channels of 4–20 mA with a full scale range of 0-25 mA. All Analog Outputs can drive a maximum load of 600 ohms (load + wire resistance). See Figure 8-13 for analog output connection. Each output monitors the output source and return current for fault detection. All of the analog outputs may be individually disabled. When a channel fault or a module fault is detected, the application program may annunciate the fault, disable the channel, and stop using data in system calculations or control. Care should be taken to prevent ground loops and other faults when interfacing to non-isolated devices. See Chapter 13 for complete field wiring information for the Analog High Density FTM.

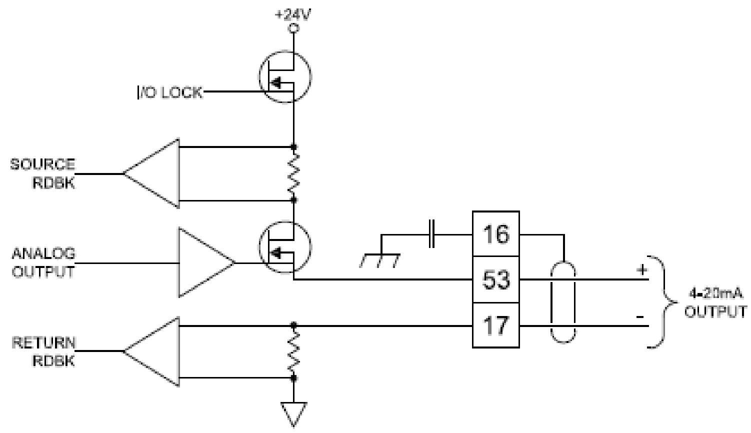


Figure 8-13. Analog Output Wiring for a 24/8 Analog FTM

8.5.5. Troubleshooting

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

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

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

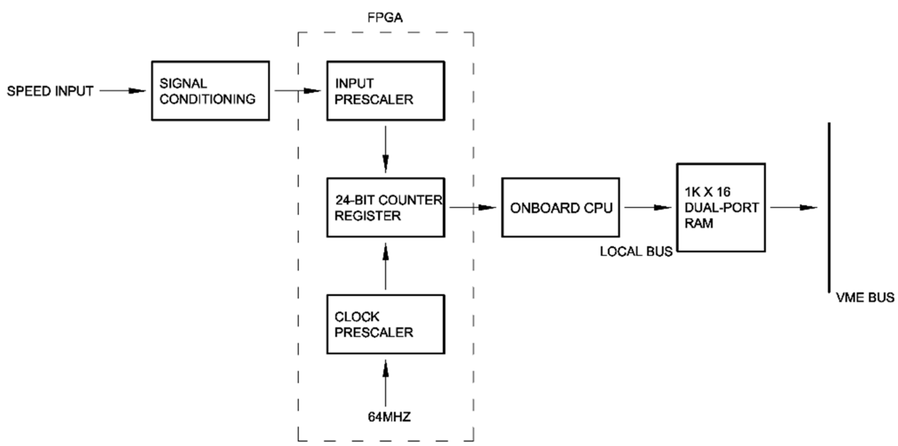


Figure 8-14. Digital Speed Sensor Module Block Diagram

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

Table 8-9. LED Indications of Failure

Number of LED Flashes	Failure	Number of LED Flashes	Failure
1	Watchdog/MFT Lost Failure	11	Software Failure
2	No Application	12	Power Supply Failure
3	Flash Memory Failure	13	Configuration or Parameter Error
4	Exception Failure	15	Parallel to Serial Bus Error
5	FPGA Failure	16	AI ADC Error
6	Non-Volatile Memory Error	17	AO Readback ADC Error
7	Kernel Watchdog Error	19	Speed Error
8	MFT Timing Failure	20	AI ADC Timeout
9	Software Slip	21	AO Readback ADC Timeout
10	RAM Memory Failure	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 a 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 U—
- Added Restriction of Hazardous Substances information to Regulatory and Compliance Section
- New Section 1.3 added to Chapter 1
- Moved Chapter 3 to Volume 3. Renumbered remaining Chapters
- New Section title to the SIO Module "SIO Module (Smart-Plus Version)" in Chapter 6
- Multiple changes to the SIO Module (Smart-Plus Version) section in Chapter 6
- Replaced Figure 6-10

Changes in Revision T—
- IMPORTANT box – EMC Compliance added to Regulatory Compliance Section
- Det Norske Veritas replaced by DNV/GL in Regulatory Compliance Section
- Warning box added to Special Conditions for Safe Use section.
- IMPORTANT box added to section 6.1.6
- Note added to Chapter 7 beneath Figure 7-6

Changes in Revision R—
- Ethernet specification added to Table 6-5
- 1 Mbps Specification added to Tables 6-6 and 7-2
- Notes added to Section 7.1.6
- Note added to section 9.28.1
- IMPORTANT box added to sections 9.28.3 and 9.29.4
- Note added to section 9.29.1

Changes in Revision P—
- Chapter 6 CPU P1020 section 6.1 added
- Section 9.28 added Readback Accuracy Source and Return to 4-20mA Output Ratings
- Section 9.29 added Readback Accuracy Source and Return to 4-20mA Output Ratings
- Section 9.29 added Note following 4-20mA Output Ratings
- Added 1 Mbps CAN Network Trunk Line Specifications to Table 6-6.
- Moved Section 6.3 through 6.6 information to Volume 3
- Moved Section 7.2 through 7.5 information to Volume 3
- Moved Section 8.3 and 8.5 information to Volume 3
- Moved Section 9.3 through 9.26 information to Volume 3

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.

Changes in Revision K—
- Significant updates to Section 7.6 with changes marked by change bars.

Chapters 9–15 and the appendixes are contained in volume 2.

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B26166V1 : U

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