WOODWARD

Product Manual 26167V2
(Revision P, 8/2024)

Original Instructions

MicroNet TMR®
Digital Control

This manual replaces manual 85584 for the MicroNet TMR

Manual 26167 consists of three volumes (26167V1, 26167V2, and 26167V3)

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

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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.

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

Manual 26167V2

Contents

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

Illustrations and Tables

Warnings and Notices

Important Definitions

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

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

⚠WARNING

Lockout/Tagout LOTO

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

⚠WARNING

Overspeed / Overtemperature / Overpressure

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

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

⚠WARNING

Personal Protective Equipment

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

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

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

WARNING

Start-up

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

WARNING

Automotive Applications

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

WARNING

IOLOCK

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

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

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

The IOLOCK state is asserted under various conditions, including:

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

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

NOTICE

Battery Charging Device

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

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

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

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

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

Follow these precautions when working with or near the control.

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

IMPORTANT

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

Chapter 9.
Actuator Modules

WARNING

Refer to Manual 26167, Volume 1 for Required Safety Instructions, Special Conditions for Safe Use and Hazardous Location Requirements to ensure the control is used in a safe manner in Ordinary and Hazardous, locations. Volume 1 must be fully understood and complied with for all applications.

9.1 Introduction

A Smart I/O module has its own on-board microcontrollers. The modules described in this chapter are Smart I/O modules.

During initialization of a smart module, the module's microcontroller turns the LED off after power-on self-tests have passed and the CPU has initialized the module. The LED is illuminated to indicate an I/O fault.

The CPU also tells this module in which rate group each channel is to run, as well as any special information (such as the type of thermocouple in the case of a thermocouple module). 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.

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

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

A smart output module monitors the output voltage or current of each channel and alerts the system if a fault is detected.

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

NOTICE

Do not apply power to the unit until all the cables are connected. If you have the unit powered on before the cables are connected, you can blow the fuses on the output modules when the bare ends of the cables short together.

9.2 Two Channel Actuator Controller

9.2.1 Module Description

Figure 9-3 is a block diagram of the two-channel actuator controller module. Each channel controls an integrating or proportional, hydromechanical or pneumatic actuator. Each actuator may have up to two position feedback devices. There are several versions available, and the module part number indicates the module's maximum output current capability. A MicroNet low-density discrete (gray) cable must be used with this module. Do not use an analog (black) cable.

Figure 9-1. Two Channel Actuator Controller Module

9.2.2 Module Specification

General:

Number of Channels:	2
Actuator Type:	Proportional or integrating, hydro-mechanical or pneumatic actuators
Power Requirements:	+5 V @ 0.5 A, +24 V @ 1 A

Driver:

Current Range:	(range is determined by part number)
10 mA Version:	±12.25 mA max
25 mA Version:	±30 mA max
50 mA Version:	±60 mA max
100 mA Version:	±120 mA max
200 mA Version:	±245 mA max
Dither Current:	25 Hz, 25% duty cycle, tunable amplitude
Max Load Resistance:	10/(maximum current required, in amps)

Position Feedback:

Feedback Devices:	1 or 2 per channel
Device Types:	LVDT, RVDT
Excitation:	3 kHz sine wave, amplitude programmable from 2 to 8 Vrms, 120 mA maximum, 1% THD maximum.
Input Impedance of Feedback Circuit:	200 kΩ

Fault Detection:

Driver:	Alarm if current error > 10% Alarm if open Alarm if shorted
Excitation:	Alarm if voltage error > 10% or if in current limit
Feedback:	Alarms for: open-wire, voltage-out-of-range, computed position out-of-range; ranges are programmable
Position Error:	Programmable threshold and delay
Microcontroller:	Software watchdog is monitored by the CPU module. Hardware watchdog monitors logic power, microcontroller activity.
System:	Outputs turn off if communications with the CPU module are lost

Performance:

Position Accuracy:	0.25% of full-scale @ 25 °C, does not include transducer error
Position Drift:	150 ppm/°C, does not include transducer drift
Output Current Tolerance:	±1% of full scale
Current Read back Tolerance:	±5% of full scale

9.2.3 Installation

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

Figure 9-2 shows examples of the field wiring for various transducer types.

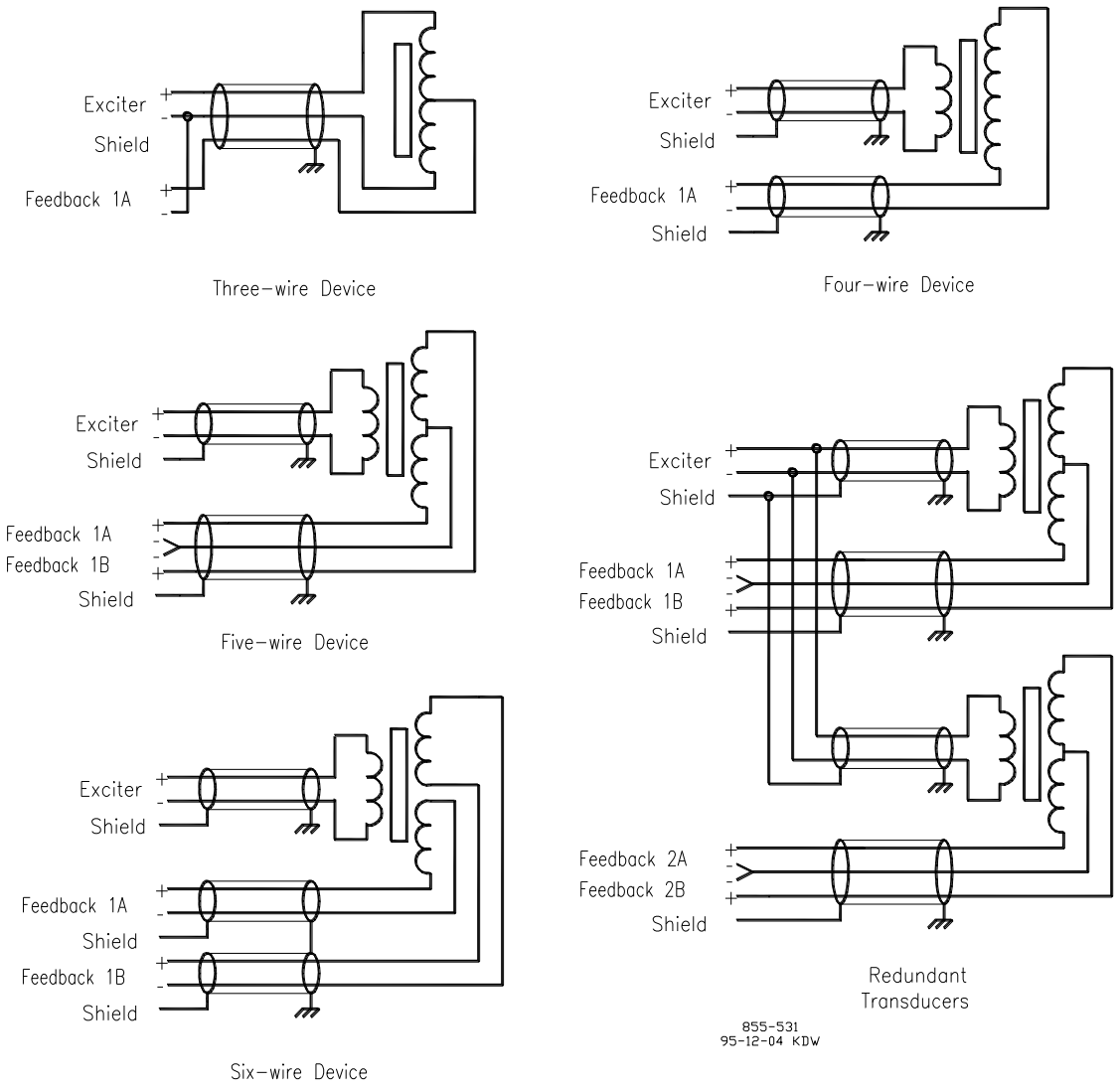


Figure 9-2. Two Channel Actuator Controller Module, Wiring Example

9.2.4 FTM Reference

See Chapter 12 for complete field wiring information for the Two Channel Actuator Controller FTM. See Appendix A for part number cross reference for modules, FTMs, and cables.

9.2.5 Troubleshooting

Each I/O module has a red fault LED, which indicates the status of the module. This LED will help with troubleshooting if the module should have a problem. A solid red LED indicates that the actuator controller is not communicating with the CPU module. Flashing red LEDs indicate an internal problem with the module, and module replacement is recommended.

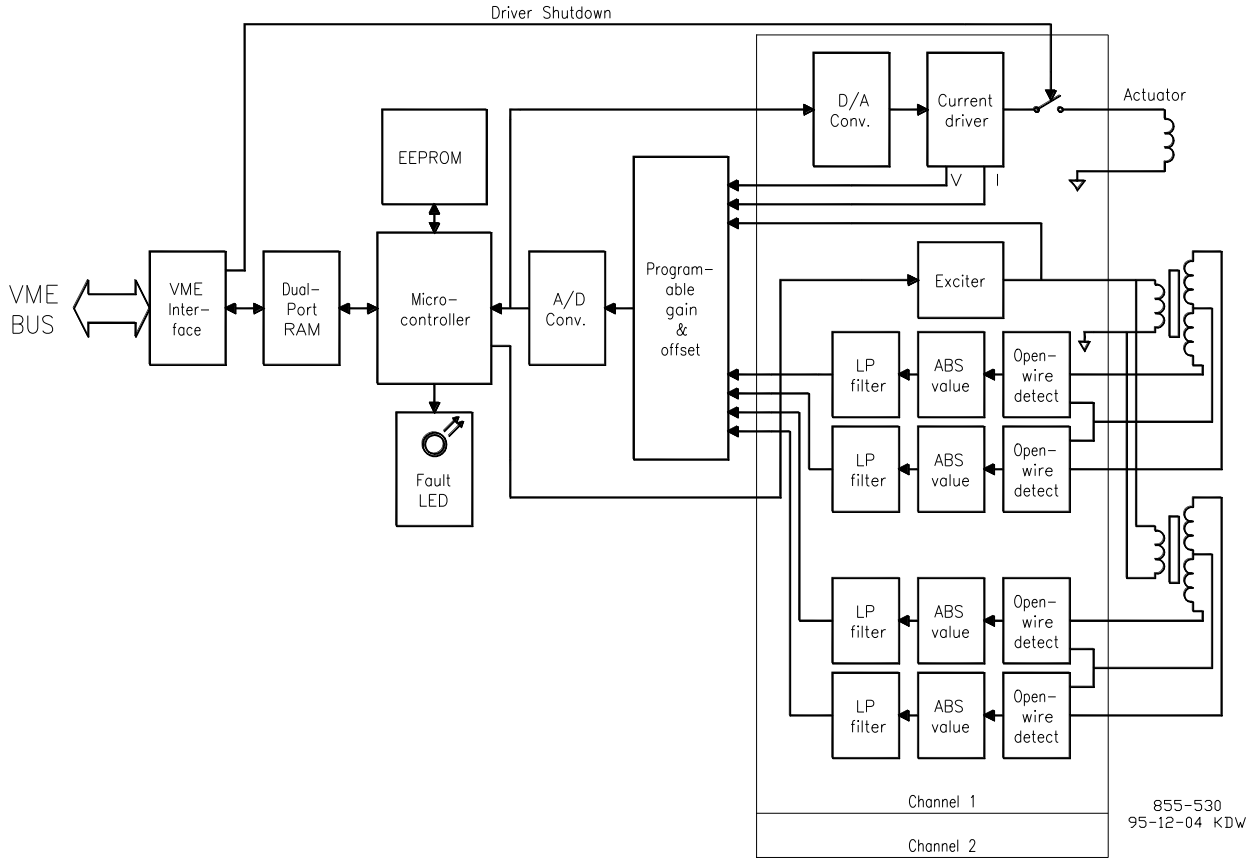


Figure 9-3. Two Channel Actuator Controller Module Block Diagram

Table 9-1. LED Indications of Failure

Number of LED Flashes	Failure
1	Internal RAM test failure
2	Dual Port RAM test failure (Low Byte)
3	Dual Port RAM test failure (High Byte)
4	Dual Port RAM test failure (Both)
5	Initialization Failure
6	Missing Calibration Data
7	Missing MFT Pulse
8	Loss of Communications with CPU
9	Ch1 Calibration failure
10	Ch2 Calibration failure

9.3 Four Channel Actuator Module

Information for this module is in Volume 3, Chapter 6.

9.4 Simplex Real Time SIO

9.4.1 Module Description

Each Real Time SIO Module contains the circuitry for three RS-485 ports. Each port is designed to communicate with up to 20 EM or GS/LQ Digital Actuator Drivers. The rate group that is supported for each port depends on the number of drivers. For each port, one driver is allowed for every 5 ms, so two drivers would require a 10 millisecond rate group, 4 drivers would require a 20 millisecond rate group, and so on. Each driver is identified by its address switches, which must match the driver number in the GAP application program. The RS-485 communications to the Universal Digital Drivers can be used for monitoring or control purposes.

The Real Time SIO Module features:

- 5 ms update rate for critical parameters, with one driver per port
- Digital Actuator Driver interface
- Each RS-485 port may run in a different rate group
- Communication fault detection for each driver, drivers with communication faults are disabled
- Monitoring of driver parameters remotely
- Configuration of driver parameters remotely
- Allows a fast and very accurate position command (16 bits, no noise) for the drivers

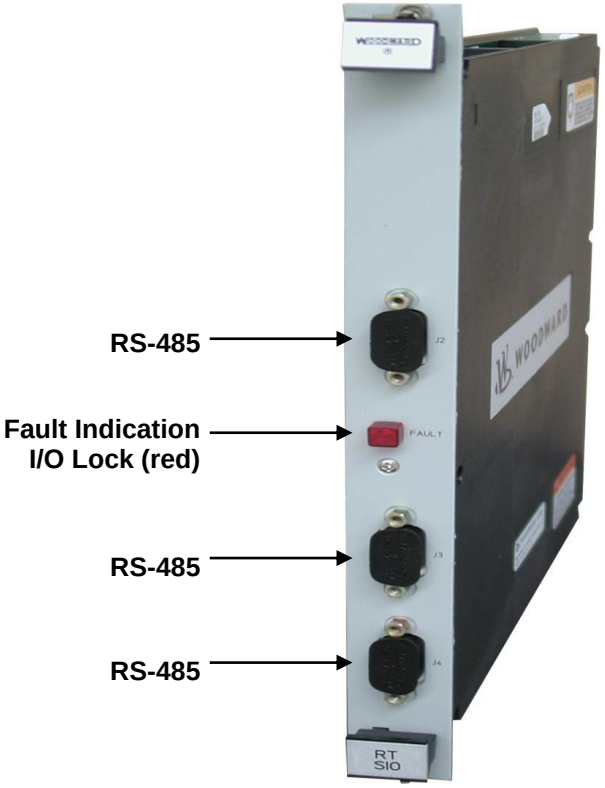


Figure 9-4. Real Time SIO Module

9.4.2 Module Specification

RS-485 Ports

Rate Group	One driver, per port, per 5 milliseconds (that is, 2 drivers in a 10 ms rate group)
Protocol	RS-485 UART, Woodward proprietary protocol
Baud Rate	417 kbaud
Parity	None
Data Bits	8
Stop Bit	1

9.4.3 Module Application

This module is designed to be used with Digital Drivers. Each Real Time SIO module contains three RS-485 ports, which may communicate with up to 20 Digital Drivers. Additional drivers are daisy chained to the first driver, with the plus, minus, and common connections carried through to the last driver. The units at each end of the network should have their termination resistors installed, to prevent reflections. The rate group that is supported is dependent on the number of drivers on each port.

The RS-485 interface may be used in one of three ways:

- It can be used to send the position demand and configuration information to the driver, as well as monitor the driver status outputs.
- It can be used to configure the driver and monitor the status outputs, but not to send a position demand. The driver position demand would be from a 4–20 mA input or the CAN bus interface.
- It can be used to monitor the driver status outputs, but not configure the driver or send a position demand to the driver. The driver position demand could be from a 4–20 mA input or from the CAN bus interface, and the configuration input could be from RS-232 or from the CAN bus interface.

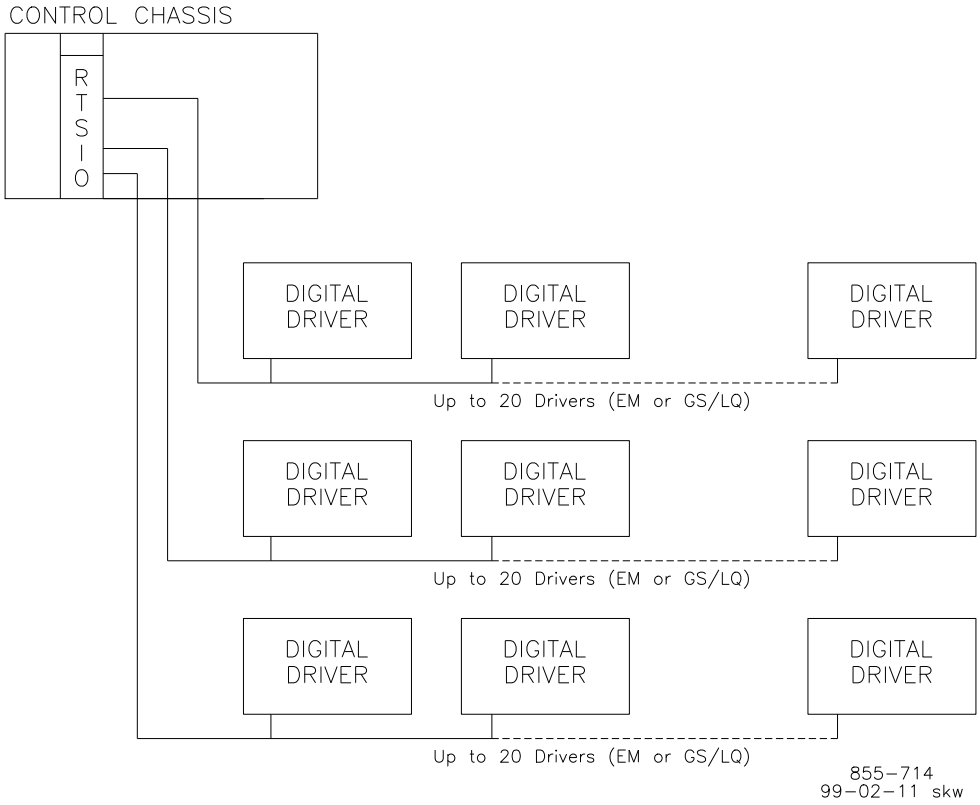


Figure 9-5. Sample System Configuration

9.4.4 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 module. Also at the top and bottom are two handles which, when toggled, move the modules out just far enough for the boards to disengage the motherboard connectors.

The drivers have address switches on the control circuit board. These switches allow up to 99 drivers, although the Real Time SIO module can support a maximum of 20 drivers per channel. During initialization, the driver reads these switches, and this becomes its address. It responds to data to this address and sends data with this driver address. The GAP application has an input field for address, which should be configured by the customer or application engineer to match the driver address switches.

The Real Time SIO Module and the Digital Driver contain optional termination resistors, which should be installed in the first and last modules in the network.

9.4.5 Field Wiring

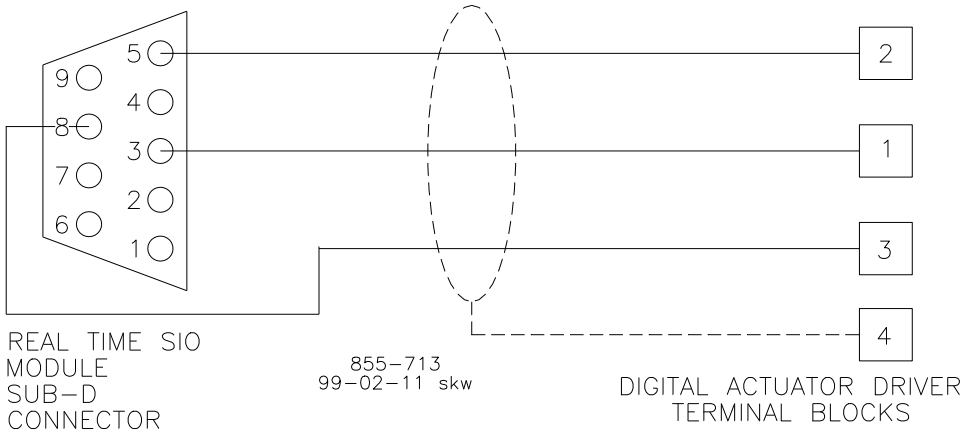


Figure 9-6. Wiring Diagram for the Real Time SIO Module

- Shields should be connected to earth ground at all intermediate terminal blocks, as well as terminated at the control terminal block. The exposed wire length beyond the shield should be limited to 25 mm (1 inch).
- Do not place shielded wires in the same cable conduit with high-voltage or large-current-carrying cables.
- Cable shields must be electrically continuous from the signal source to the point the signal wire enters the field terminal module.
- The address switches on the Digital Drivers should be set to match the addresses in the GAP application program.

The termination resistors should be installed on the last unit on each end of the network. On the Real Time SIO module, the termination resistor is installed by closing switches 3 and 4, and leaving switches 1 and 2 open, for each channel. On the Digital Driver, the termination resistor is installed by moving the RS-485 termination jumpers to the "IN" position.

Wiring Specifications: The RS-485 wiring should meet the requirements in the EIA RS-485 standard document for a 500 kbps network.

Table 9-2. Field Wiring Cable Specifications

Cable Specifications:	
0.2 mm² (24 AWG) or larger standard, shielded, twisted-pair cable	30 m (100 ft.) absolute maximum
0.3 mm² (22 AWG), low-capacitance cable (36 pF/m or 11 pF/ft.)	120 m (400 ft.) absolute maximum
0.5 mm² (20 AWG), low-cap cable (WGC P/N 2008-295, Belden 89207)	150 m (500 ft.) absolute maximum
For cable lengths longer than 150 m (500 ft.), optical repeaters and fiber optic cable should be used.	up to limits of fiber optic cables/transceivers

NOTICE

To assure reliable communications when using copper RS-485 cable, do not use any intervening devices such as relays or terminal blocks. The cable should run directly from one RS-485 device to the next device.

All cable lengths are calculated based on ideal conditions. It is recommended that installations attempt to minimize network problems due to harsh conditions and unforeseen circumstances by keeping the network length under 50% of the absolute maximum ratings.

9.4.6 Shields and Grounding

If the panel that the control chassis is mounted on is not at earth ground potential, connect it to earth ground via a 3.0 mm² (12 AWG) green/yellow wire or braid, keeping the braid or wire as short as possible.

The RS-485 wiring should be shielded, and the shield should be terminated at the MicroNet chassis. The shields should also be connected to earth ground at all intermediate terminal blocks, as well as terminated at the Digital Driver Terminal block. The exposed wire length, beyond the shield, should be limited to 25 mm (1 inch).

For compliance with EMC standards, it is required that all communications wiring be separated from all power wiring.

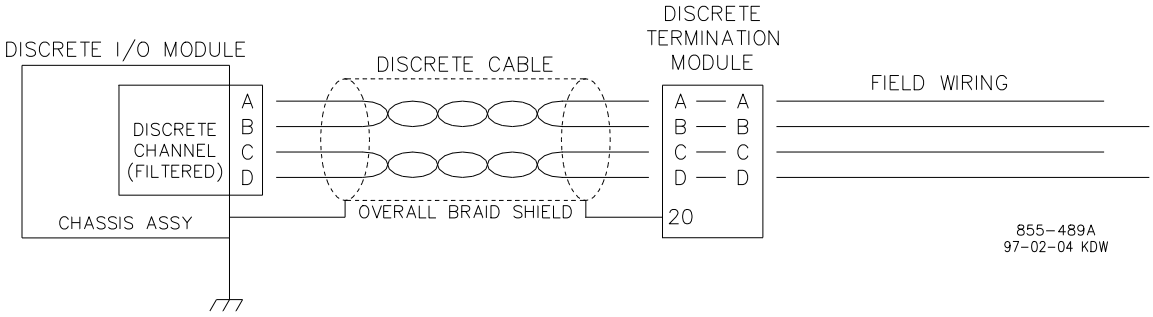


Figure 9-7. Shield Termination Diagram

9.4.7 Troubleshooting

Each I/O module has a red Fault LED controlled by the CPU, which is turned on when the system is reset. During initialization of a Real Time SIO Module, which occurs after every CPU reset, the CPU turns the Fault LED on. The CPU then tests the module using diagnostic routines built into software. If the diagnostic test is not passed, the LED remains on or blinks. If the test is successful, the LED turns off. If the Fault LED on a Real Time SIO Module is illuminated after the diagnostics and initialization have been run, the module may be faulty or in the wrong slot.

Table 9-3. Fault LED Failure Definitions

Number of LED flashes	Failure
1	External RAM test failure
2	Module watchdog time-out
3	Dual Port RAM test failure
7	VME Communications watchdog time out

If during normal control operation, all of a rack's I/O modules have their Fault LEDs on, check the rack CPU for a failure. If during normal control operation, only the Real Time SIO Module's Fault LED is turned on or is flashing, replace that module. When a module fault is detected, its outputs are disabled or de-energized.

In addition to the module hardware detection fault, the Real Time SIO Module detects I/O faults:

Table 9-4. Real-Time SIO Module I/O Faults

RS-485 communication faults	The GAP block output "comm fault" is set true, for any RS-485 faults. These include:
Break Received	
Framing Error	
Parity Error	
Receive Overrun Error	
Carrier Detect Lost	
CRC Error	
Stop Transmit Receive	
Transmitter Overrun	
Address error	
No response	
Actuator or Driver faults:	The applicable GAP block outputs are set true for any Actuator or driver faults. See the Digital Driver manual for a detailed list of alarms and faults.

9.5 EM/TM Position Controller

Information for this module is in Volume 3, Chapter 6.

Chapter 10.
LINKnet I/O Network

Note: This chapter has been moved to Volume 3. Please see manual 26167V3 Chapter 8.

Chapter 11.
Specialty Function Modules

11.1 Pressure Transducer Interface Module

11.1.1 Module Description

The pressure transducer interface module is an input module that communicates with external pressure transducers.

This module has two isolated RS-422 communication ports. Each RS-422 communication port contains a pair of differential transmit lines, a pair of differential receive lines, and +15 V power connections. These two ports are electrically isolated from each other and from the rest of the module.

Pressure data received from external sources is shared with the main CPU module through dual-port RAM on the VME bus. Up to eight pressure transducers may be connected to one pressure transducer interface module.

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 module. Also at the top and bottom are two handles which, when toggled, move the modules out just far enough for the boards to disengage the motherboard connectors.

Figure 11-1. Pressure Transducer Interface Module

11.1.2 Module Specification

Protocol:	RS-422 UART, Honeywell proprietary protocol
Isolated RS-422 Ports:	2
Isolated +15 V Power Supply Connections:	2

Wiring Specifications
The RS-422 wiring should meet the requirements in the EIA RS-422 standard document for a 500 kbps network.

NOTICE

To assure reliable communications when using copper RS-422 cable, do not use any intervening devices such as relays or terminal blocks. The cable should run directly from one RS-422 device to the next device.

All cable lengths are calculated based on ideal conditions. It is recommended that installations attempt to minimize network problems due to harsh conditions and unforeseen circumstances by keeping the network length under 50% of the absolute maximum EIA RS-422 ratings.

11.1.3 Installation

The Pressure Transducer Interface Module contains optional termination resistors, which should be installed on the RS-422 receive ports.

The termination resistors should be installed on the last unit on each end of the network. On the Pressure Transducer Interface Module, the termination resistor is installed by closing switches 3 and 4, and leaving switches 1 and 2 open, for each channel.

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.

See the appropriate Smart Pressure Transducer manual for the wiring diagram (manual 26080 or 85555).

11.1.4 Troubleshooting

The Pressure Transducer Interface Module contains a communications processor, which sends outputs and receives inputs from the RS-422 ports. The CPU module communicates with the Pressure Transducer Interface Module, through the VME bus, and dual port RAM. See Figure 11-2 for a module block diagram.

Each module contains two RS-422 ports, for communication to the pressure transducers.

RS-422 is a standard electrical interface for serial data communications. It is similar to RS-232 but with multi-node functionality versus point to point functionality. RS-422 can communicate with pressure transducers from lengths of up to 328 meters (1000 feet).

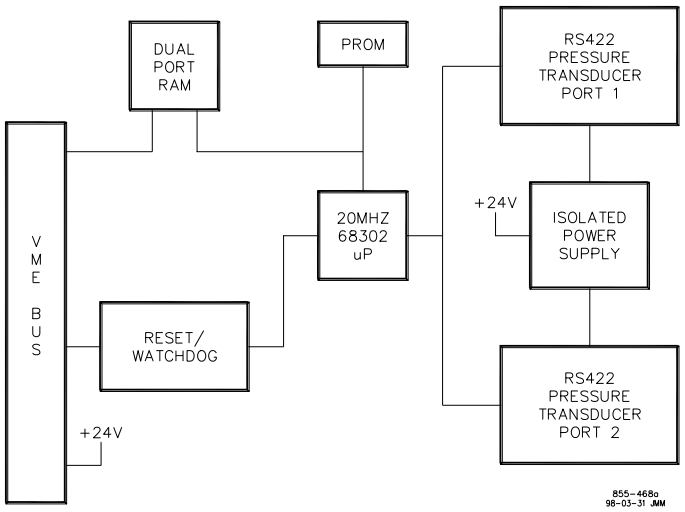


Figure 11-2. Module Block Diagram

Each I/O module has a red Fault LED controlled by the CPU, which is turned on when the system is reset. During initialization of a Pressure Transducer Interface Module, which occurs after every CPU reset, the CPU turns the Fault LED on. The CPU then tests the module using diagnostic routines built into software. If the diagnostic test is not passed, the LED remains on or blinks. If the test is successful, the LED goes off. If the Fault LED on a Pressure Transducer Interface Module is illuminated after the diagnostics and initialization have been run, the module may be faulty or in the wrong slot.

Table 11-1. CPU Fault LED Failure Definitions

Number of LED Flashes	Failure
1	External RAM test failure
2	Unexpected Exception
3	Dual Port RAM test failure
4	Module watchdog time-out

If during normal control operation all a rack's I/O modules have their Fault LEDs on, check the rack CPU for a failure. If during normal control operation, only the Pressure Transducer Interface Module's Fault LED is turned on or is flashing, replace that module.

In addition to the module hardware detection fault, the Pressure Transducer Interface Module detects I/O faults:

Fault Detection

RS-422 communication faults: The GAP block output "comm fault" is set true, for any RS-422 faults. These include:

- Parity Error
- Address error
- No response

Pressure Transducer faults: The GAP block output"env_fault" is set true for a pressure transducer fault.

11.2 Dual Overspeed Module

11.2.1 Module Description

The Dual Overspeed module is used to monitor two independent frequency (shaft speed) inputs and detect for a board configured overspeed and input failed trips. The module uses discrete and analog components, to minimize the time to detect and output signals, when an event occurs. This module is used primarily for General Electric LM (Land & Marine) gas turbines. This module is typically used in conjunction with a Dual Solenoid Monitor Module in order to meet the overspeed to fuel shutoff requirements of the gas turbine manufacturer. The Dual Solenoid Monitor module is used to directly interface with the gas turbine fuel shutoff valve solenoids.

Figure 11-3. Dual Overspeed Module

The components for each channel are completely independent of each other, so that a chip or component failure will only affect one channel and not both. The module has a test feature for each channel that will inject a high frequency directly into the inputs of either channel. In this manner the entire channel is verified from the input to output. The module has configurable jumper settings, which define the overspeed and input failed setpoints. The module has six potentiometers for factory adjustments that are used in conjunction with the configuration jumpers. Four of the potentiometers are for adjusting the overspeed trip points and two are for adjusting the input failure points.

This module will plug directly into any slot of a MicroNet rack, but it has no interface to the data or address busses of the MicroNet. The only interface to the back plane is for power supply inputs; therefore, care should be taken when interfacing the module circuit common to external devices to prevent potential ground loops. The module utilizes the standard analog cable and FTM (see Appendix A).

Input/Output

The module I/O has been designed to minimize the interconnection to external power sources and/or circuit commons. All of the input signals are set by allowing the input to float (pulled high to +5 Vdc) or by connecting to the module circuit common through a dry relay contact (pulled low to circuit common).

The module has two types of output signals that provide an interface to the MicroNet Dual Solenoid Monitor module, and a MicroNet discrete input module or interposing relay coil (indication outputs).

11.2.2 Installation

The module input signals are described below.

Note: FTM TB's are based on using an analog cable.

Table 11-2. Dual Overspeed Module Input Signals

INPUT	DESCRIPTION	PIN(S)	FTM TB(S)	LOGIC STATE
MPU No. 1	Channel No. 1 frequency input signal	PIN 37 PIN 36	TB 20 TB 21	AC signal input.
MPU No. 2	Channel No. 2 frequency input signal	PIN 35 PIN 34	TB 22 TB 23	AC signal input.
Overspeed Test No. 1 Select	Channel No. 1 static overspeed test selection input, must be used in conjunction with Test Activate input.	PIN 27	TB 30	PIN 27 "high" = ON state, OFF state requires PIN 27 pulled "low" to circuit common.
Overspeed Test No. 2 Select	Channel No. 2 static overspeed test selection input, must be used in conjunction with Test Activate input.	PIN 31	TB 26	PIN 31 "high" = ON state, OFF state requires PIN 31 pulled "low" to circuit common.
Test Activate	Input is used as a permissive or activation medium for the static Overspeed Test function	PIN 26	TB 31	PIN 26 "high" = ON state which permits Overspeed Test function, OFF state requires PIN 26 pulled "low" to circuit common which disables Overspeed Test function.
Reset	Input is used to clear overspeed and input failed latch circuits. The reset function is edge triggered and requires the input to be cycled from "low" to "high".	PIN 25	TB 32	PIN 25 transition from "low" to "high" activates reset command.
Input Failed Override	Input overrides the input failed detection circuits. Input must be pulled "low" to activate override.	PIN 23	TB 34	PIN 23 "high" = OFF state for the input failed override, PIN 23 "low" = ON state for input failed override.

The module output signals are below.

Note: FTM TB's are based on using an analog cable.

Table 11-3. Dual Overspeed Module Output Signals

OUTPUT	DESCRIPTION	PIN(S)	FTM TB(S)	LOGIC STATE
Input Failed No. 1 Indication	Indicates Channel No. 1 input failed (input below input failed setpoint). Output can be used to drive a MicroNet discrete input module directly or to drive an interposing relay coil.	PIN 29	TB 28	PIN 29 “low” = input failed state TRUE. Will illuminate module LED DS1.
Input Failed No. 2	Indicates Channel No. 2 input failed (input freq. below input failed setpoint). Output can be used to drive a MicroNet discrete input module directly or to drive an interposing relay coil.	PIN 33	TB 24	PIN 33 “low” = input failed state TRUE. Will illuminate module LED DS2.
Overspeed No. 1	Indicates Channel No. 1 overspeed detected (input freq. above overspeed trip setpoint). Output can be used to drive a MicroNet discrete input module directly or to drive an interposing relay coil.	PIN 28	TB 29	PIN 28 “low” = overspeed detected TRUE. Will illuminate LED DS3.
Overspeed No. 1 Logic	Provides direct connection to the MicroNet Solenoid Monitor module to de-energize the solenoid on when overspeed detected.	PIN 13	TB 7	PIN 13 “low” = overspeed detected TRUE. Will cause solenoid driver to de-energize if connected to the MicroNet Solenoid Monitor module.
Overspeed No. 2	Indicates Channel No. 2 overspeed detected (input freq. above overspeed trip setpoint). Output can be used to drive a MicroNet discrete input module directly or to drive an interposing relay coil.	PIN 32	TB 25	PIN 32 “low” = overspeed detected TRUE. Will illuminate LED DS4.
Overspeed No. 2 Logic	Provides direct connection to the MicroNet Solenoid Monitor module to de-energize the solenoid on when overspeed detected.	PIN 9	TB 11	PIN 9 “low” = overspeed detected TRUE. Will cause solenoid driver to de-energize if connected to the MicroNet Solenoid Monitor module.
Alarm Bus	Output indicates Channel No. 1 or 2 overspeed active or both Channel No. 1 and 2 inputs failed. Output should be connected directly to the Alarm Bus input on the MicroNet Dual Solenoid Monitor module. No other connections to this output should be made.	PIN 30	TB 27	PIN 30 “low” = fault condition TRUE.
Shutdown	Similar to the Alarm Bus, the output indicates Channel No. 1 or 2 overspeed active or both Channel No. 1 and 2 inputs failed. Output should be connected directly to the Shutdown input on the MicroNet Dual Solenoid	PIN 24	TB 33	PIN 24 “low” = fault condition(s) TRUE.

OUTPUT	DESCRIPTION	PIN(S)	FTM TB(S)	LOGIC STATE
	Monitor module. No other connections to this output should be made. Duplicates functionality of the Alarm Bus input.			

11.2.3 Configuration Settings/Calculations

The module has two configuration options (per channel) that the application engineer must determine based on the system level design criteria. The two configurations are the overspeed trip setpoint and the low speed input failed setpoint. Both settings use a combination of jumper settings and potentiometer adjustments to achieve the modules range of settings.

11.2.4 Overspeed Frequency Trip Setpoint Calculation

The following equation can be used to determine range of frequency adjustment for the overspeed setpoint based on the jumper configurations (three per channel):

Channel No. 1 Example

FTRIP = 10 / (1.1 * R23 * C23) + (1.1 (RADJ + REQUIV) * C17

where:

Table 11-4. Dual Overspeed Module Configuration Settings

Channel No. 1	**Channel No. 2**
R23 = 46.4 kΩ	R69 = 46.4 kΩ
C23 = 0.01 microfarads	C54 = 0.01 microfarads
C17 = 0.10 microfarads	C45 = 0.10 microfarads
RADJ = R13 = 0-20 kΩ potentiometer	RADJ = R58 = 0-20 kΩ potentiometer
REQUIV =	**REQUIV =**
R20 (JR11) = 7.50 kΩ R21 (JR12) = 23.2 kΩ R22 (JR13) = 9.75 kΩ Any individual JR or combinations (parallel resistance) can be selected to achieve required REQUIV.	R61 (JR26) = 7.50 kΩ R59 (JR24) = 23.2 kΩ R60 (JR25) = 9.75 kΩ Any individual JR or combinations (parallel resistance) can be selected to achieve required REQUIV.

11.2.5 Overspeed Trip Setpoint Jumper Configuration Options

The jumper settings are used to determine the needed frequency range for the overspeed trip setpoint should take into account the min-max frequency range based on the adjustment of the respective potentiometers for each channel.

Potentiometers R13 (Channel No.1) and R58 (Channel No. 2) are used to set the “coarse” adjustment of the overspeed trip setpoint and potentiometers R14 (Channel No.1) and R62 (Channel No. 2) are used to set the “fine” adjustment.

Listed below are the base frequency ranges for the each of the individual “overspeed trip” setpoint jumpers (and an example of parallel jumper configuration):

Table 11-5. Dual Overspeed Module Base Frequency Ranges

Channel No. 1	Channel No. 2	REQUIV	Freq @ RADJ Min	Freq @ RADJ Max
JR11	JR26	7.50 kΩ	7488 Hz	2828 Hz
JR12	JR24	23.2 kΩ	3265 Hz	1900 Hz
JR13	JR25	9.75 kΩ	6313 Hz	2642 Hz
JR11 & JR13	JR26 & JR 25	4.24 kΩ	10,240 Hz	3148 Hz

11.2.6 Low Frequency Input Failed Setpoint Calculation

The following equation can be used to calculate the input failed frequency setpoint based on the module jumper settings. The jumper settings determine a binary equivalent number (QCNT) that is used in the calculation/setting of the input failed frequency setpoint. The equation can be manipulated to back calculate the needed QCNT binary number which can be achieved by subtracting the individual binary equivalents of each jumper setting, starting with the highest equivalent number that is less than or equal to the target QCNT.

Potentiometers R12 (Channel No. 1) and R57 (Channel No. 2) are used for the precision adjustment of the low frequency input failed setpoint.

FFAIL = FOUT / QCNT

where:

Table 11-6. Low Frequency Input Failed Setpoint by Channel

Channel No. 1	**Channel No.2**
FOUT = 20 KHz	FOUT = 20 KHz
QCNT = Summation of QJPR1. 3. 5. 7, 9	QCNT = Summation of QJPR14. 16. 18. 20, 22
Binary Equivalent of QJPRX =	**Binary Equivalent of QJPRX =**
QJPR1 = 4	QJPR14 = 4
QJPR3 = 8	QJPR16 = 8
QJPR5 = 16	QJPR18 = 16
QJPR7 = 32	QJPR20 = 32
QJPR9 = 64	QJPR22 = 64

Channel No. 1 Example with all Q jumpers installed
FFAIL = FOUT / QCNT
∴ FFAIL = 20 KHz / QJPR1 + QJPR3 + QJPR5 + QJPR7 + QJPR9
∴ FFAIL = 20 KHz / 4 + 8 + 16 + 32 + 64
∴ FFAIL = 161 Hz

Channel No. 1 Example with QJPR1 jumpers installed
FFAIL = FOUT / QCNT
∴ FFAIL = 20 KHz / QJPR1
∴ FFAIL = 20 KHz / 4
∴ FFAIL = 5000 HZ

11.3 Dual Solenoid Monitor Module

This module is used to monitor and control two independent solenoid current inputs for low or high current failed trips. The module uses discrete and analog components, to minimize the time to detect and output signals, when an event occurs. This module is used primarily for GE LM (Land & Marine) gas turbines and is usually used in conjunction with a Dual Overspeed Module. The Dual Solenoid Monitor module is used to directly interface with the gas turbine fuel inlet solenoid valves. This module requires external solenoid driver components to interface to the fuel valve solenoid. The drivers are mounted external from the module for heat dissipation purposes. The components for each channel are completely independent of each other, so that a chip or component failure will only affect one channel and not both. The module has test features to allow each channel to be tested. This module will plug directly into any slot of a MicroNet rack, but it has no interface to the data or address busses of the MicroNet. The only interface to the MicroNet back plane is for power supply inputs. The module has two potentiometers for factory adjustments. The potentiometers are for adjusting the under current trip points for the solenoid currents.

11.3.1 Module Description

Figure 11-4. Dual Solenoid Monitor Module

The module I/O has been designed to minimize the interconnection to external power sources and/or circuit commons. All of the input signals are set by allowing the input to float (pulled high to +5 VDC) or by connection to the module circuit common through a dry relay contact (pulled low to circuit common).

The module has two types of output signals that provide an interface to MicroNet discrete input modules or interposing relay coils (indication outputs).

The module input signals are described in the following table:

Table 11-7. Dual Solenoid Monitor Module Input Signals

INPUT	DESCRIPTION	PIN (S)	FTM TB(S)	LOGIC STATE
#1 MPU Overspeed	Discrete input showing when an Overspeed has been detected for MPU input #1. This input is usually tied to the Dual Overspeed module and is normally high. A low on this input indicates an overspeed condition, which will shut down the #1 solenoid.	PIN 25	TB 32	“High” = no Overspeed ; “Low” = Overspeed .
#2 MPU Overspeed	Discrete input showing when an Overspeed has been detected for MPU input #2. This input is usually tied to the Dual Overspeed module and is normally high. A low on this input indicates an overspeed condition, which will shut down the #2 solenoid.	PIN 24	TB 33	“High” = no Overspeed ; “Low” = Overspeed .
Solenoid Test No. 1 Select	Discrete input used to test the #1 Solenoid trip circuit. When this input is activated, it will cause the #1 solenoid to de-energize; when it is deactivated it will then cause the #2 solenoid to de-energize. The solenoid test is used to check that the solenoids turn off. To conduct a test, energize or turn on the solenoids first. NOTE: For the Test to be conducted, the Test Activate discrete input must also be ‘TRUE’.	PIN 32	TB 25	“High” = ON state. Pull low to circuit common for OFF.
Solenoid Test No. 2 Select	Discrete input used to test the #2 Solenoid trip circuit. When this input is activated, it will cause the #2 solenoid to de-energize; when it is deactivated it will then cause the #1 solenoid to de-energize. The solenoid test is used to check that the solenoids turn off. To conduct a test, energize or turn on the solenoids first. NOTE: For the Test to be conducted, the Test Activate discrete input must also be ‘TRUE’.	PIN 26	TB 31	“High” = ON state. Pull low to circuit common for OFF.
Emergency Shutdown	Discrete input used to shutdown both solenoids. When this input is activated it will turn on LED DS3.	PIN 22	TB 35	“High” = ON state. Pull low to circuit common for OFF.
Reset	This input is used to clear the over and under current failed latches. To activate, this input must be pulled low to common and then released. When the input is released, the pull up resistor on the input will generate the reset. The input circuit has a built in one shot, so it is not required for the input to be toggled a second time.	PIN 21	TB 36	Transition from “Low” to “High” activates reset.
Solenoid Failure Override	This discrete input is used to override both under and over current failed detection circuits. IMPORTANT NOTE: Before attempting to turn on the solenoids, this contact must be active before the reset is initiated, for the solenoids to energize.	PIN 19	TB 1	“High” = ON state. Pull low to circuit common for OFF.
Alarm Bus	Discrete input used to shutdown both solenoids. This input is a normally ‘HIGH’ signal, which causes the solenoids to shutdown when it is pulled low. This input should be connected directly to the alarm bus output of the Dual Overspeed module.	PIN 13	TB 7	Normally “High” = run mode. “Low = Fault.

INPUT	DESCRIPTION	PIN (S)	FTM TB(S)	LOGIC STATE
Turn Off Solenoids	Discrete input used to turn off both solenoids. This input must be pulled 'LOW' (Contacts closed) in order for the solenoids to be turned on. On power up of the module, this input is momentarily set to a 'TRUE'.	PIN 15	TB 5	"High" = ON state. Pull low to circuit common for OFF.
Turn On Solenoids	Discrete input used to turn on both solenoids. This input is normally 'TRUE', so to initiate turning on the solenoids, the contacts to this input should be left open. To prevent energizing of the solenoids, the Turn On solenoids contact can be closed, or the Turn Off contacts can be left open.	PIN 17	TB 3	"High" = ON state. Pull low to circuit common for OFF.
Test Activate	Discrete input used to allow the solenoid circuits to be tested. This input is normally 'TRUE', so to prevent a test the contacts to this input must be closed. The solenoid test is used to check that the solenoids turn off. To conduct a test, energize or turn on the solenoids first. Start the turbine and run up to idle. The Test Activate input can then be tied to a speed switch based on idle speed. Initiating either test should shutdown the turbine provided the solenoid fuel valves are in series. If the solenoid being tested fails to close, the second solenoid should shutdown the turbine when the test discrete input is opened.	PIN 3	TB 17	"High" = ON state. Pull low to circuit common for OFF.
+ 24 Vdc Externally Supplied	+ 24 Vdc input that is used to power the solenoid drive circuits as well as the over and under current circuits. This source is usually supplied by the customer and is tapped off of the power supply for solenoids. This input supply is isolated from all of the MicroNet power supplies through optoisolators. NOTE: Use both pins to distribute current demand.	PIN 7 PIN 5	TB 13 TB 15	External isolated power supply (+) input.
24 Vdc External Common	24 Vdc common from an external source used for the solenoids. NOTE: Use both pins to distribute current demand.	PIN 9 PIN 11	TB 11 TB 9	External isolated power supply (-) input.

The module output signals are described in the following table:

Table 11-8. Dual Solenoid Monitor Module Output Signals

OUTPUT	DESCRIPTION	PIN (S)	FTM TB(S)	LOGIC STATE
#1 Undercurrent	Discrete output that can be used to drive a relay or feed directly into a MicroNet discrete input. This output can be tied together with other outputs if only one relay output is desired. The output is diode isolated to prevent other outputs from turning on LED DS2.	PIN 33	TB 24	"Low" = under current cond. of #1 solenoid.
#2 Undercurrent	Discrete output that can be used to drive a relay or feed directly into a MicroNet discrete input. This output can be tied together with other outputs if only one relay output is desired. The output is diode isolated to prevent other outputs from turning on LED DS6.	PIN 27	TB 30	"Low" = under current cond. of #2 solenoid.

OUTPUT	DESCRIPTION	PIN (S)	FTM TB(S)	LOGIC STATE
#1 Overcurrent	Discrete output that can be used to drive a relay or feed directly into a MicroNet discrete input. This output is 'TRUE' (relay energized) when LED DS1 is 'ON'. This output can be tied together with other outputs if only one relay output is desired. The output is diode isolated to prevent other outputs from turning on LED DS1.	PIN 34	TB 23	"Low" = over current cond. of #1 solenoid.
#2 Overcurrent	Discrete output that can be used to drive a relay or feed directly into a MicroNet discrete input. This output is 'TRUE' (relay energized) when LED DS5 is 'ON'. This output can be tied together with other outputs if only one relay output is desired. The output is diode isolated to prevent other outputs from turning on LED DS5.	PIN 28	TB 29	"Low" = over current cond. of #2 solenoid.
Solenoid Current Sensor #1	Discrete connection that is actually an input, but is shown with the Driver (-) and (+) connections. This signal should be connected to the current sense resistor on the external solenoid driver. The external solenoid driver is a transistor drive circuit that is mounted off of the module because of the heat sink requirements. This input is used to check the current being passed through the solenoid, for over and under current conditions.	PIN 35	TB 22	Solenoid current from #1 driver circuit. Usually across 1 Ω resistor. 1 Amp = 1 Volt.
Driver #1 (-)	This signal should be connected to the (-) input of the #1 external solenoid driver. See diagram 1.0 for the external solenoid driver wiring connections.	PIN 36	TB 21	Solenoid # 1 (-) conn. to driver circuit.
Driver #1 (+)	This signal should be connected to the (+) input of the #1 external solenoid driver. See diagram 1.0 for the external solenoid driver wiring connections.	PIN 37	TB 20	Solenoid # 1 (+) conn. to driver circuit.
Solenoid Current Sensor #2	Discrete connection that is actually an input, but is shown with the Driver (-) and (+) connections. This signal should be connected to the current sense resistor on the external solenoid driver. The external solenoid driver is a transistor drive circuit that is mounted off of the module because of the heat sink requirements. This input is used to check the current being passed through the solenoid, for over and under current conditions.	PIN 29	TB 28	Solenoid current from #2 driver circuit. Usually across 1 Ω resistor. 1 Amp = 1 Volt.
Driver #2 (-)	This signal should be connected to the (-) input of the #2 external solenoid driver. See diagram 1.0 for the external solenoid driver wiring connections.	PIN 30	TB 27	Solenoid # 2 (-) conn. to driver circuit.
Driver #2 (+)	This signal should be connected to the (+) input of the #2 external solenoid driver. See diagram 1.0 for the external solenoid driver wiring connections.	PIN 31	TB 26	Solenoid # 2 (+) conn. to driver circuit.

OUTPUT	DESCRIPTION	PIN (S)	FTM TB(S)	LOGIC STATE
Current Faults Cleared	This output is used to indicate when all of the faults have cleared and the current to the solenoids are in their respective operating ranges. This output can be connected directly to a discrete input or to a relay, and can be used to turn off the Solenoid Failure Override input.	PIN 2	TB 18	"Low" = all faults cleared on both channels.
Common	Internal +5 or +24 Vdc Common.	PIN 23	TB 34	Common

IMPORTANT **See the board layout and schematic listed in Appendix A.**

11.3.2 Configuration Settings/Calculations

- R44 Optional resistor to set the overcurrent fault point for solenoid #1. To Determine the value for this resistor use the following:
Imax = Overcurrent trip value in amps
Rsense = Value of sense resistor on the external solenoid driver
Vmax = Imax*Rsense
Vtrip = Overcurrent trip setting on U9-A
Set Vtrip = Vmax
Vzener = Voltage across VR6 ∴ 18 Vzener ∴ Range of 17.1 to 18.9 Vdc
Vtrip = Vzener*R44/(R44 + R45)
Solving for R44
R44 = R45*Vtrip/(Vzener - Vtrip) ∴ R45 = 75K*Vtrip/(18 - Vtrip)
Range of Vtrip will vary +/- 5 % based on range of Vzener.
Most common selection: '12.1 K' (BOM 1648-885).
If Rsense = 1.0Ω, Vtrip = 2.5 A

- R72 Optional resistor to set the overcurrent fault point for solenoid #2. To Determine the value for this resistor use the following:
Imax = Over current trip value in amps
Rsense = Value of sense resistor on the external solenoid driver
Vmax = Imax*Rsense
Vtrip = Over current trip setting on U17-A
Set Vtrip = Vmax
Vzener = Voltage across VR9 ∴ 18 Vzener ∴ Range of 17.1 to 18.9 Vdc
Vtrip = Vzener*R72/(R72 + R73)
Solving for R72
R72 = R73*Vtrip/(Vzener - Vtrip) ∴ R73 = 75K*Vtrip/(18 - Vtrip)
Range of Vtrip will vary +/- 5 % based on range of Vzener.
Most common selection: '12.1 K' (BOM 1648-885).
If Rsense = 1.0 Ω, Vtrip = 2.5 A

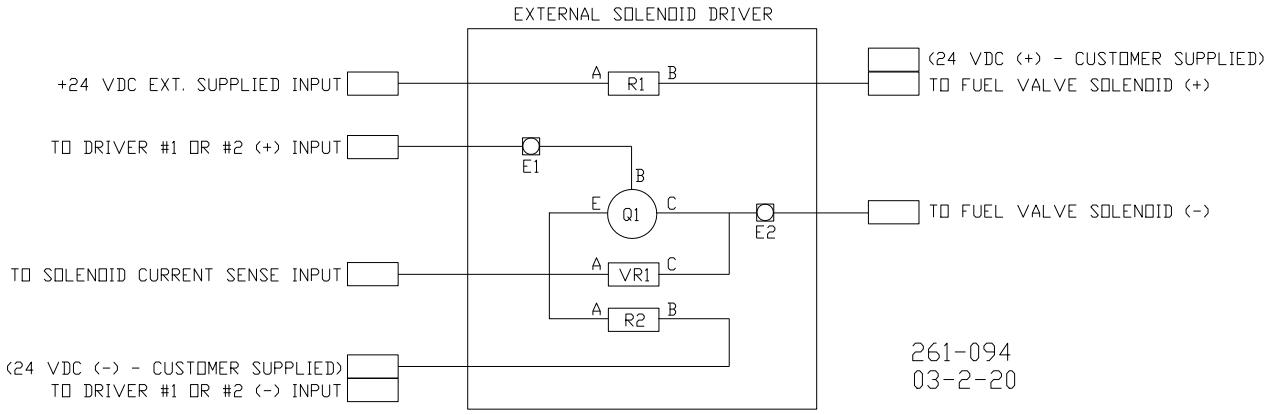


Figure 11-5. External Solenoid Driver

Chapter 12.
Field Termination Modules (FTMs)

12.1 Introduction

Field Termination Modules (FTM) are used to connect field wiring to the front of the MicroNet control's I/O Modules. They connect to the subminiature D-type connectors on the front of the I/O modules and provide cage-clamp terminal connection points for field wiring. They also provide shield termination and EMI protection. All FTMs can be mounted on 35 mm DIN Rails and take the place of interposing terminal blocks to field wiring.

The cage-clamp terminals on the FTMs and relay modules accept a maximum of one #12 AWG wire or two #18 AWG wires. Field wiring hookup is performed by stripping the wire back 0.312 inches (8 mm), inserting into the cage clamp and tightening the screw.

12.2 Analog I/O FTMs

12.2.1 TMR 24/8 Analog FTM

The TMR 24/8 Analog FTM is used with the TMR 24/8 Analog Modules (see Chapter 8 MicroNet TMR module information and Appendix A for FTM part number). Three MicroNet High Density Analog/Discrete cables are used to connect the FTM with the three TMR 24/8 Analog Modules (see Appendix A for part numbers). There are twelve +24 Vdc connections available for sourcing 4–20 mA inputs. Each connection is protected with a 0.1 A fuse.

Replacing a Fuse on the Field Termination Module (FTM)

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

⚠WARNING

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

2. Remove the FTM cover carefully, to prevent contact with any FTM circuitry under the cover. To remove the FTM cover, pinch the retaining barb and lift the cover.
3. Locate and replace the fuse with another fuse of the same size, type, and rating. See Figure 12-1 for channel fuse location.
4. Replace the FTM cover.

12.2.2 TMR Analog Combo FTM

The TMR Analog Combo FTM is used with the TMR Analog Combo Module (see Chapter 8 MicroNet module information and Appendix A for FTM part number). The FTM can connect to two speed sensor inputs, four analog inputs, two analog outputs, and one proportional actuator driver output. Three MicroNet Low Density Analog cables are used to connect the FTM with the three TMR Analog Combo Modules (see Appendix A for part numbers). There are four +24 Vdc connections available for sourcing 4–20 mA inputs. Each connection is protected with a 0.1 A fuse (F1-F4). There are two +24/12 Vdc output connections available for powering two proximity sensors. Each of these connections is protected with a 0.1 A fuse (F5, F6).

Figure 12-1. TMR Analog Combo FTM

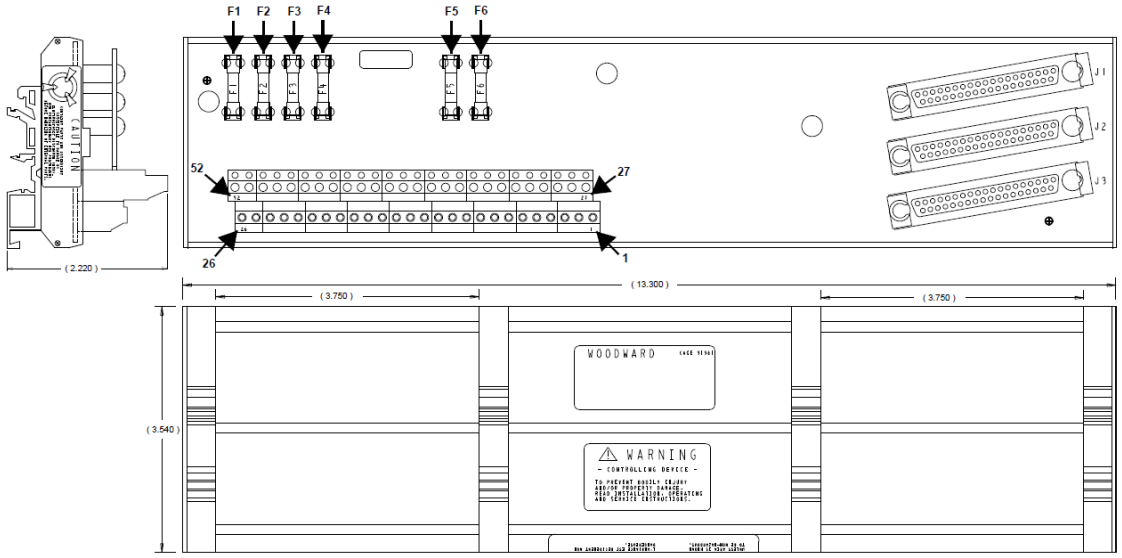


Figure 12-2. TMR Analog Combo FTM Outline Dimensions

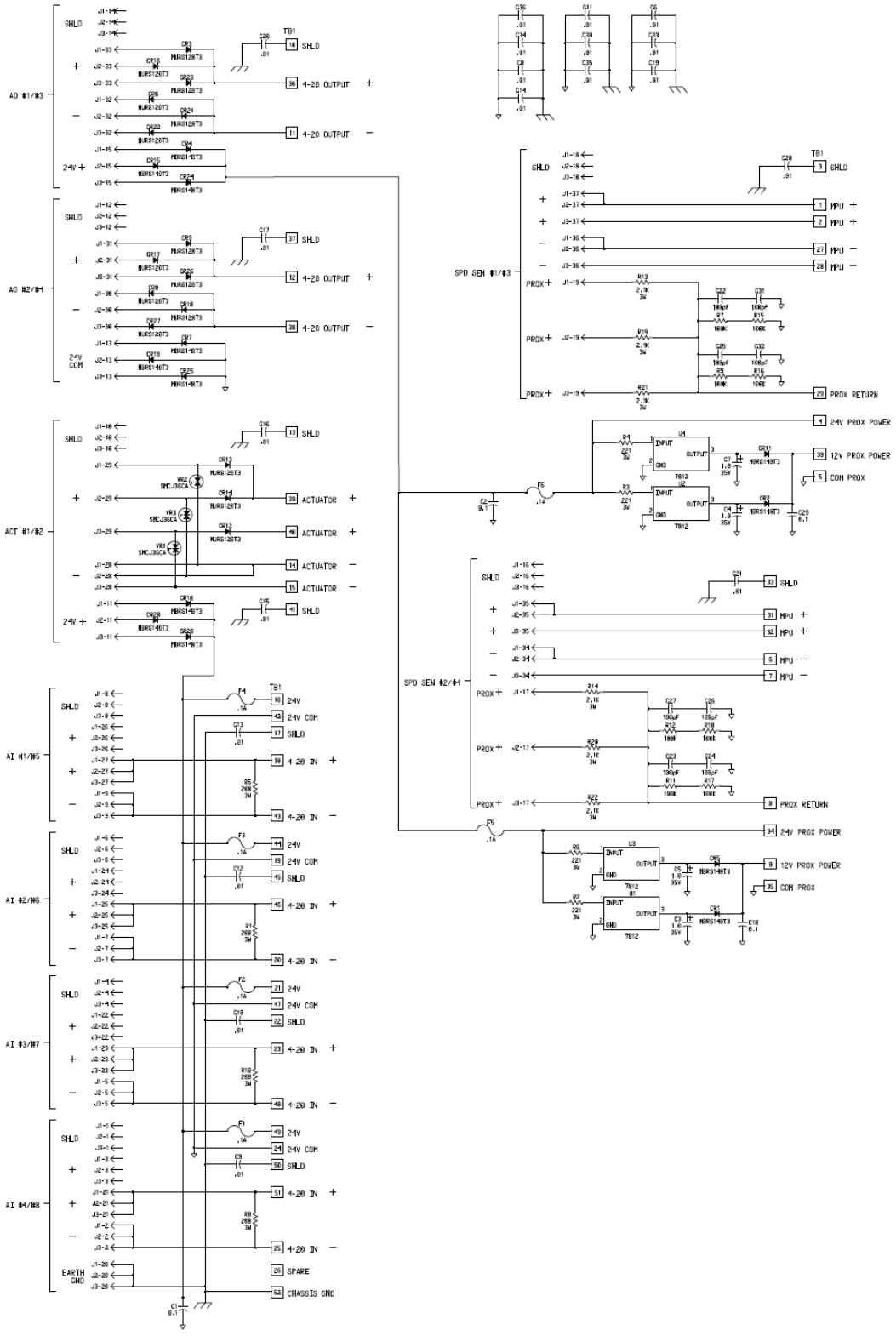


Figure 12-3. TMR Analog Combo FTM Schematic

12.2.3 34Ch HDVIM FTM (AI/RTD/TC)

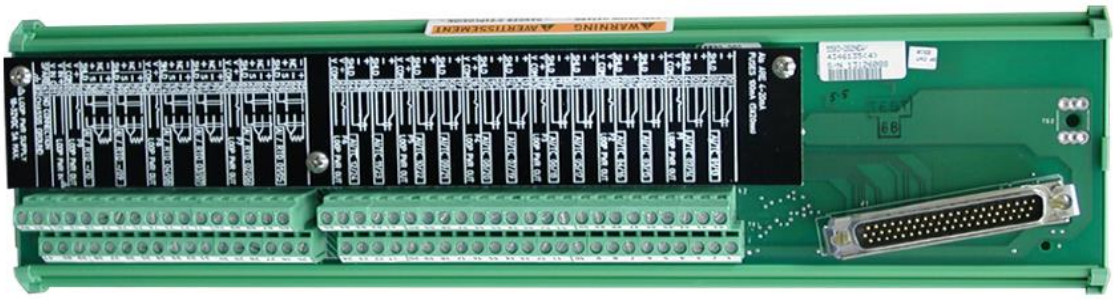


Figure 12-4. 34Ch HDVIM FTM

The 34Ch HDVIM FTM is used with the 34Ch HDVIM Module (see Chapter 8 MicroNet module information and Appendix A for FTM part number). One MicroNet High Density Analog/Discrete cable is use to connect the FTM with the 34Ch HDVIM Module (see Appendix A for part numbers). There are nine +24 Vdc connections available for sourcing 4-20 mA inputs. Each connection is protected with a 0.1 A fuse.

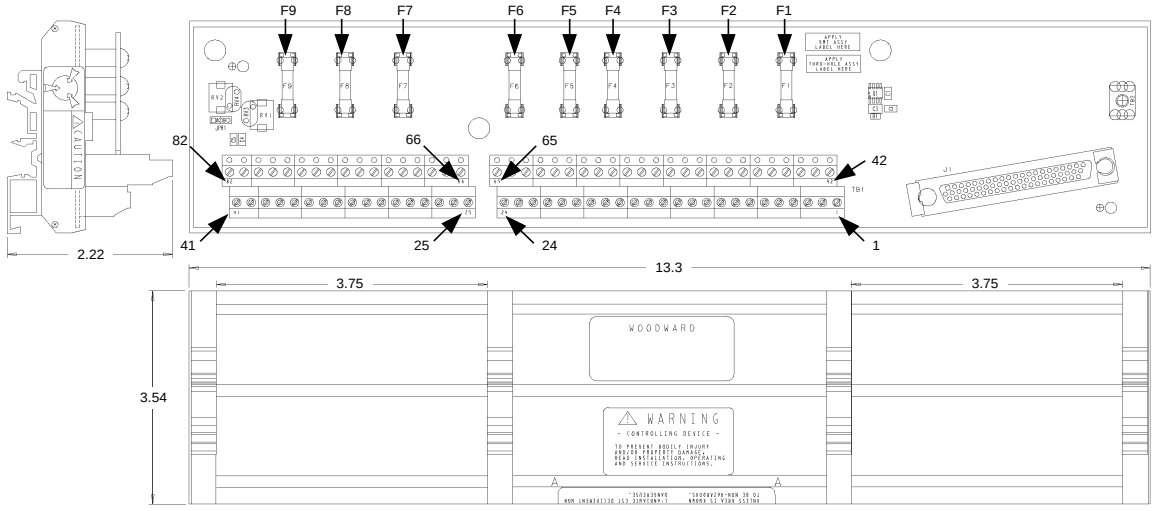


Figure 12-5. 34Ch HDVIM FTM Outline Dimensions

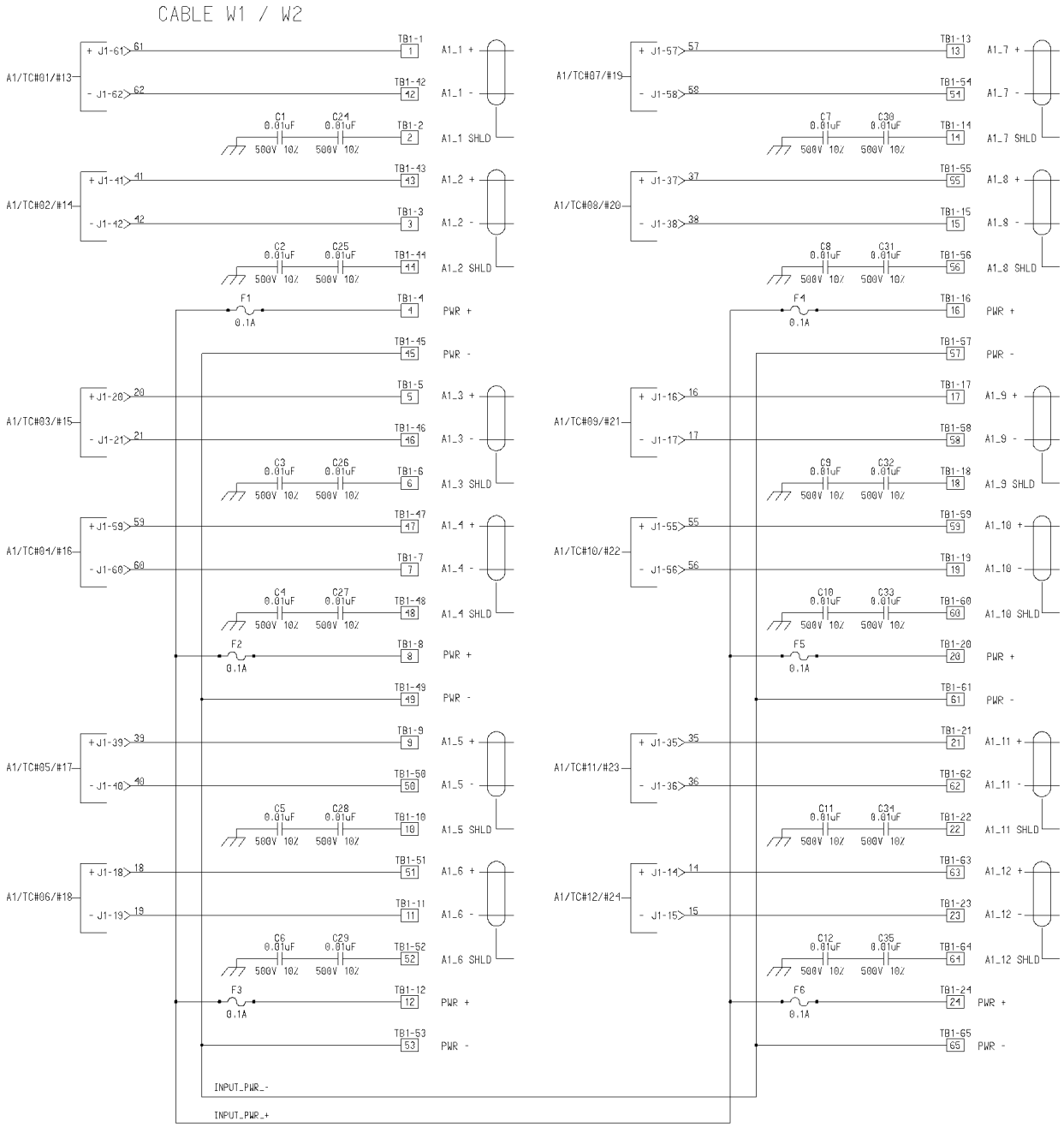


Figure 12-6a. 34Ch HDVIM FTM Schematic (part 1)

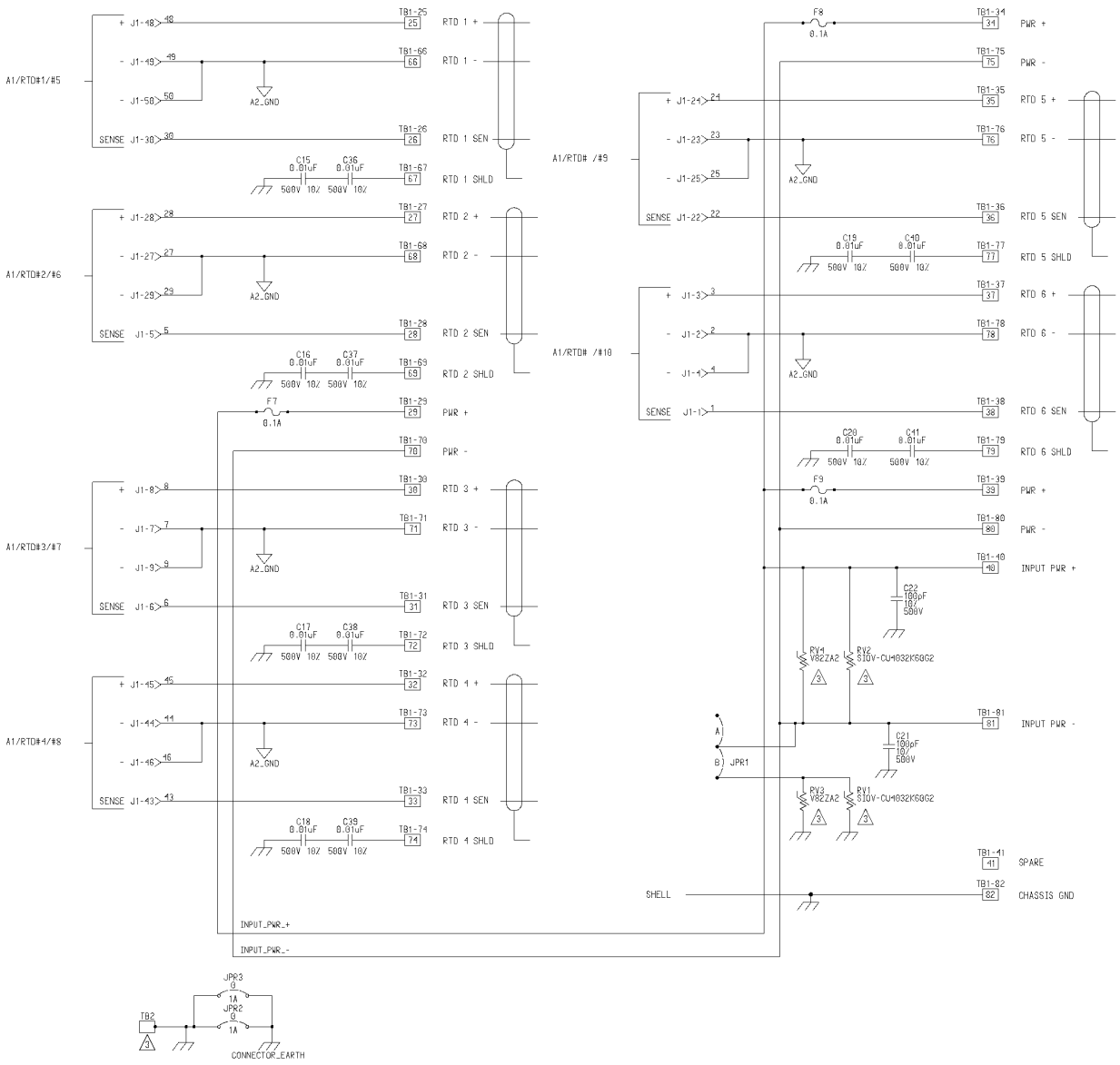


Figure 12-6b. 34Ch HDVIM FTM Schematic (part 2)

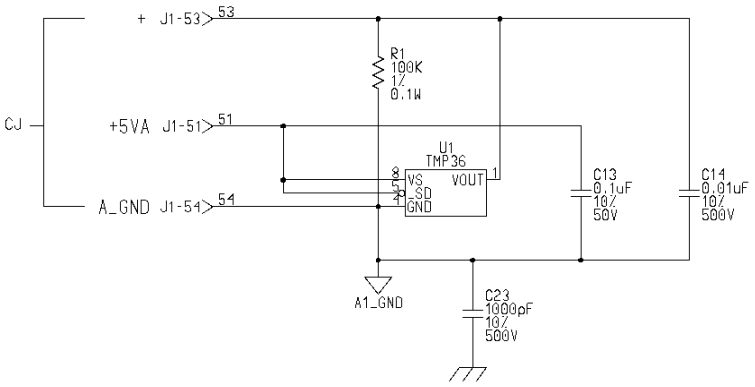


Figure 12-6c. 34Ch HDVIM FTM Cold Junction Sensor Schematic

12.2.4 24/8 Analog FTM

Figure 12-6d. 24/8 Analog FTM

The 24/8 Analog FTM is used with the 24/8 Analog Modules (see Chapter 8 MicroNet module information and Appendix A for FTM part number). One MicroNet High Density Analog/Discrete cable is use to connect the FTM with the 24/8 Analog Module (see Appendix A, Table M for part numbers). There are twelve +24 Vdc connections available for sourcing 4–20 mA inputs. Each connection is protected with a 0.1 A fuse.

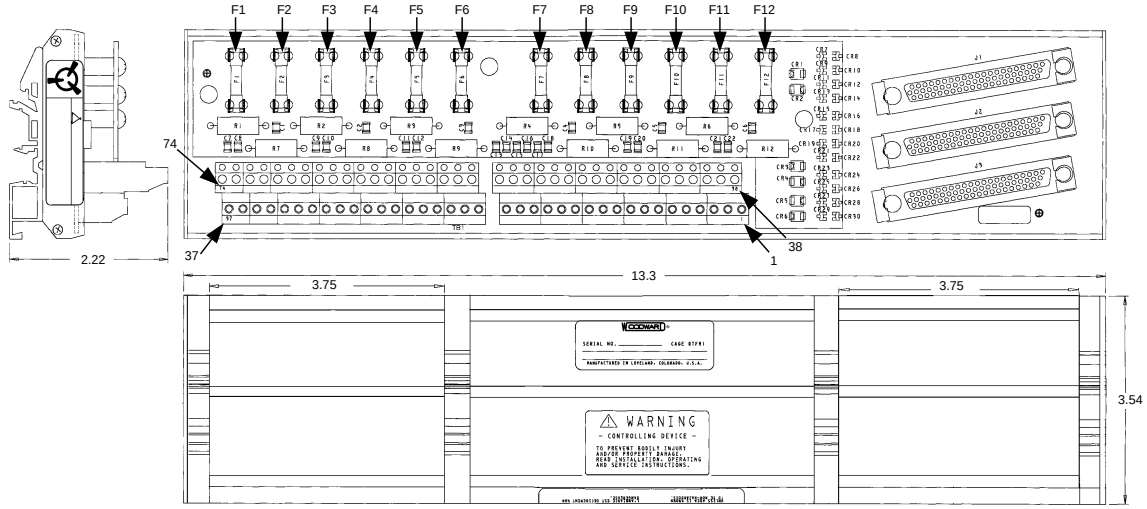


Figure 12-6e. 24/8 Analog FTM Outline Dimensions

Replacing a Fuse on the Field Termination Module (FTM)

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

WARNING

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

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

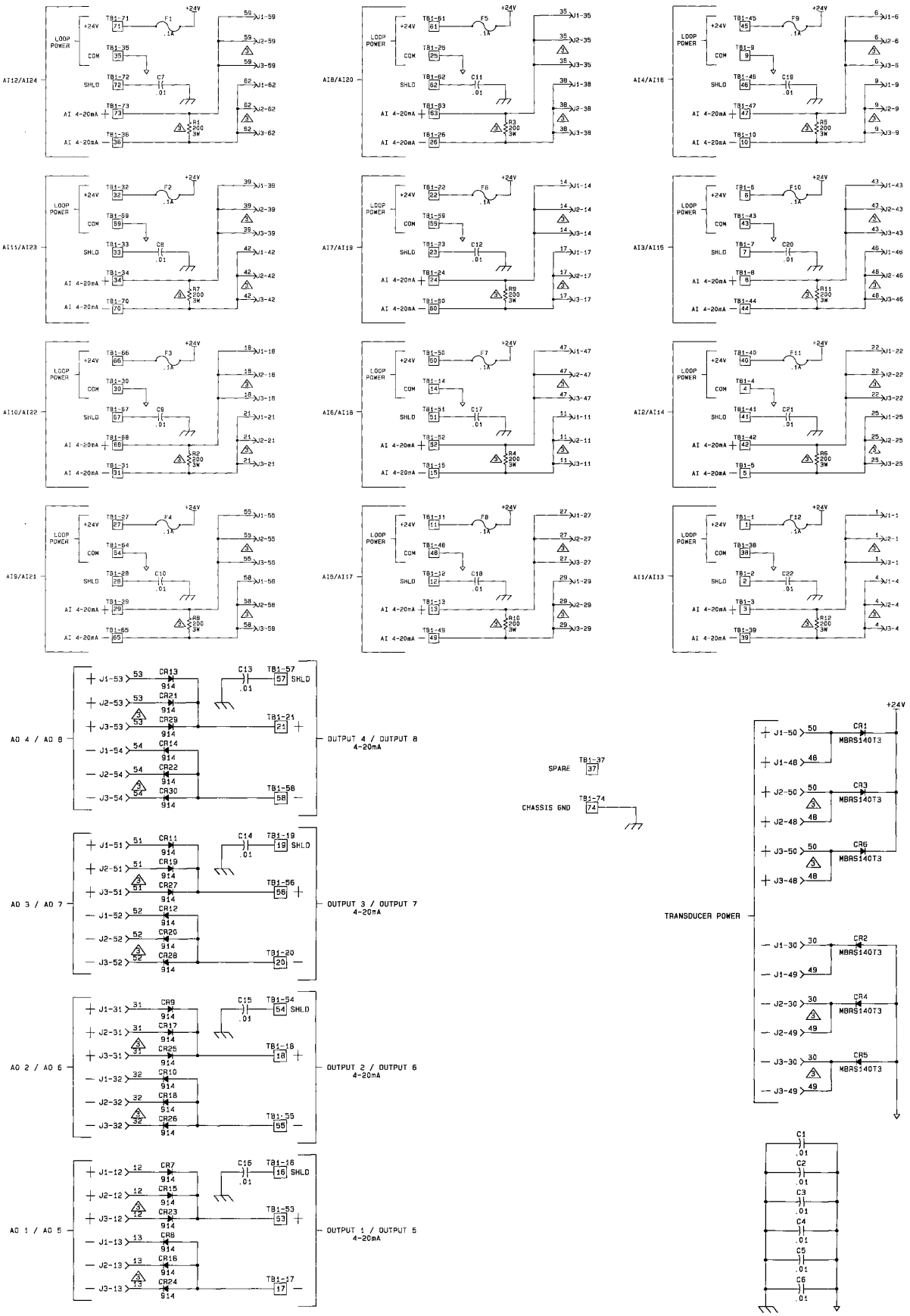


Figure 12-7. 24/8 Analog FTM Schematic

12.2.5 Dataforth FTM

[Shown without I/O modules installed]

Figure 12-8. Dataforth FTM

The Dataforth FTM is used with the Dataforth Module (see Chapter 8 MicroNet module information and Appendix A for FTM part number). One MicroNet High Density Analog/Discrete cable is use to connect the FTM with the Dataforth Module (see Appendix A for part numbers). Each FTM has twelve analog input and four analog output channels. Each input channel is individually configurable via a plug-in standard isolated Dataforth SCM7B converter that has been modified to meet Woodward's bandwidth and input temperature range requirements. Each module can plug into any of the 12 channels on the FTM. Each plug-in module converts the incoming signal to a 1 to 4 volt signal. No Calibration is required on the FTM or its plug-in modules. The plug-in modules are powered directly through the cable connector; resulting in no need for external power connections to the FTM. There are twelve +24 Vdc connections available for sourcing 4–20 mA inputs. Each connection is protected with a 0.1 A fuse (F3 – F14). Jumpers P3 through P1 are used to configure the module for self-powered or loop-powered setups. See Chapter 8 for proper jumper configurations.

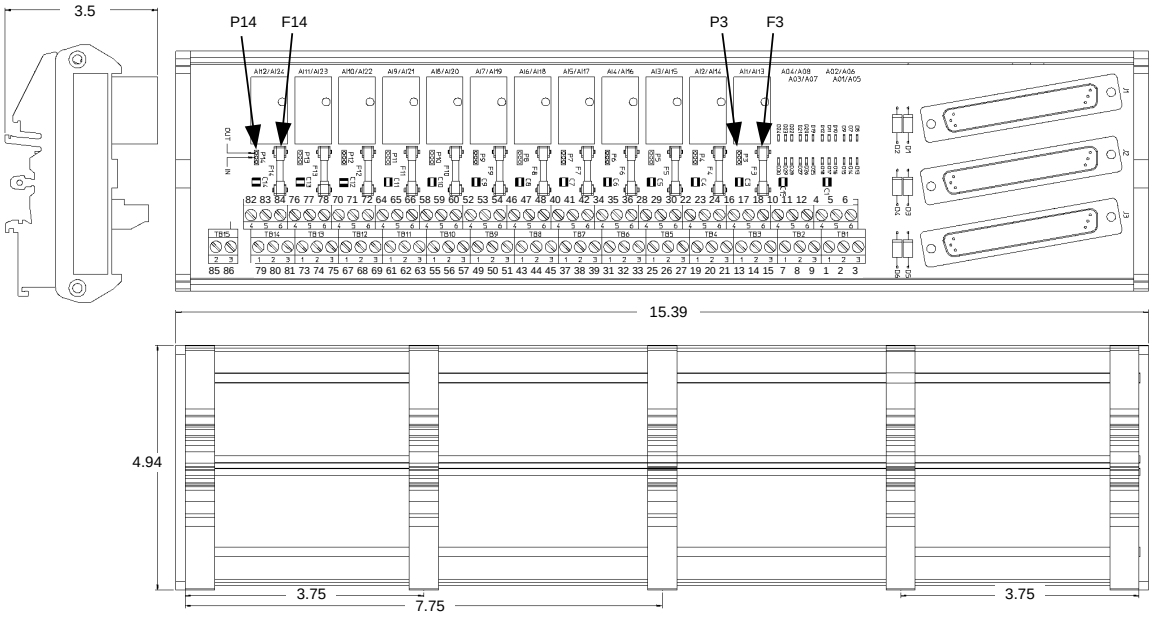


Figure 12-9. Dataforth FTM Outline Dimensions

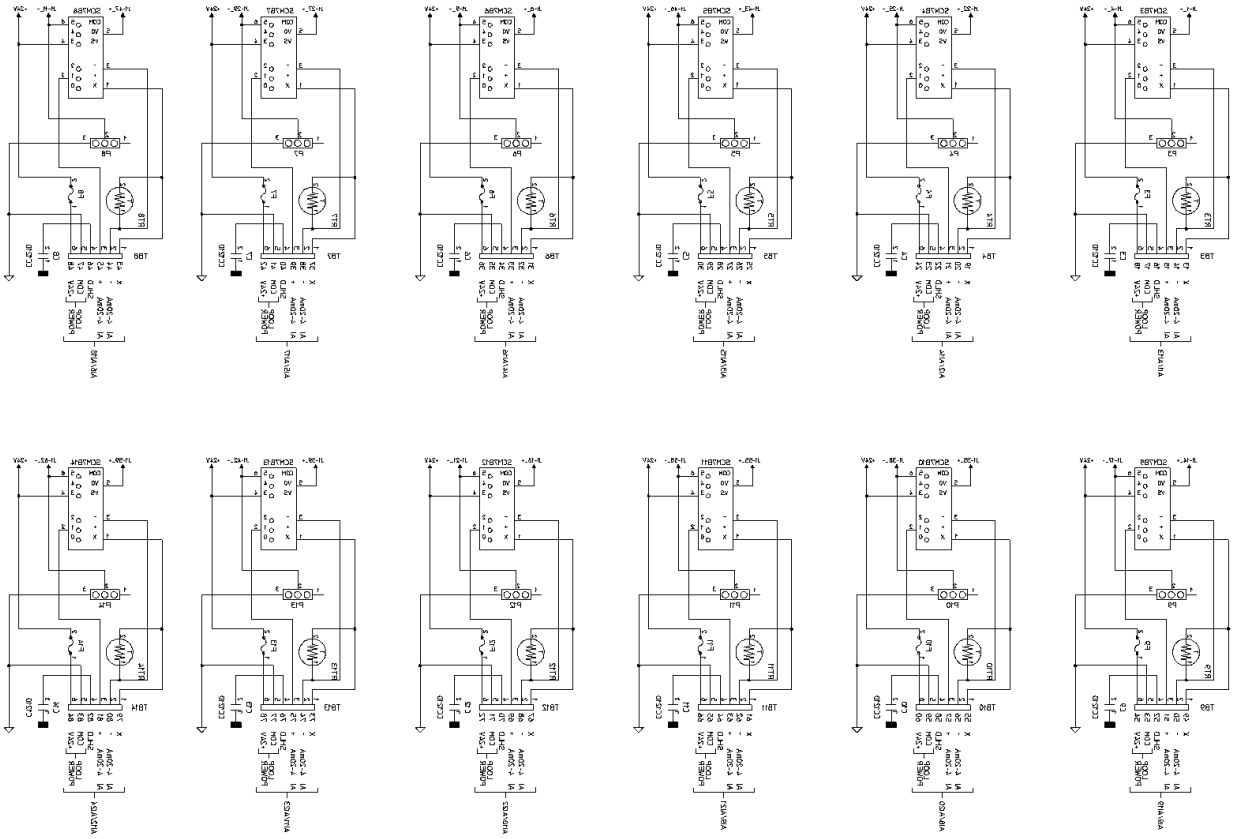


Figure 12-10. Dataforth FTM Schematic (Inputs)

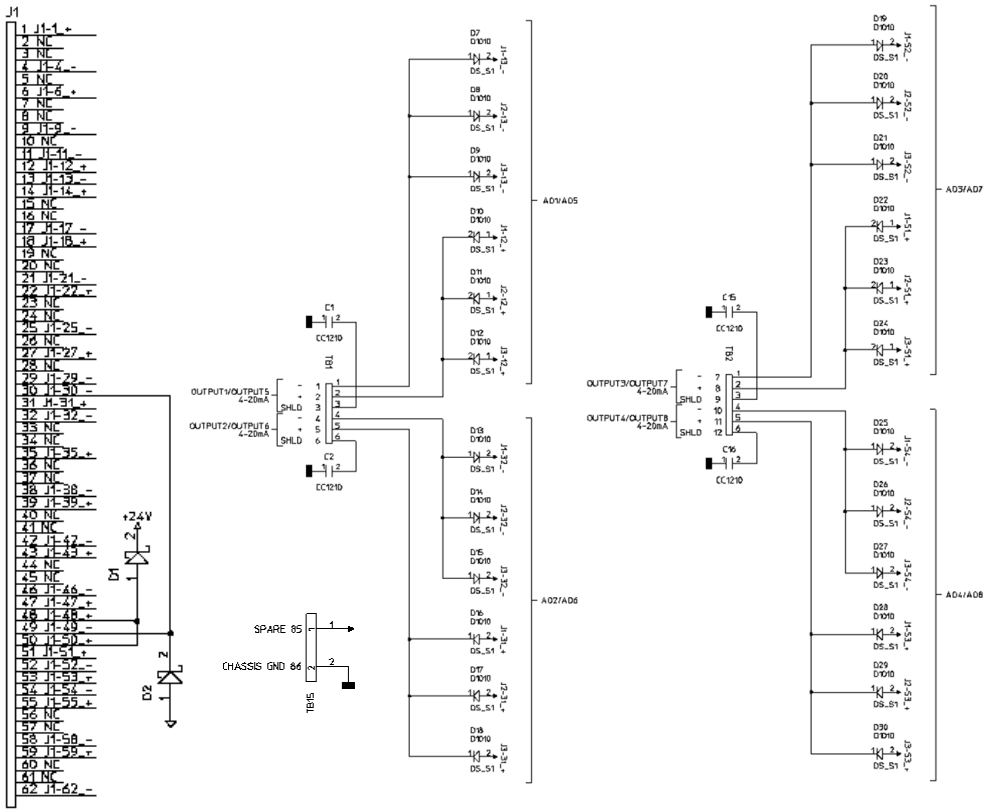


Figure 12-11. Dataforth FTM Schematic (Outputs)

There are currently five SCM7B signal conditioning modules available for the Dataforth FTM. See Table 12-1 for available signal conditioning modules.

Table 12-1. Dataforth Module Types

Type Module	Description	Woodward P/N	Dataforth P/N
4–20 mA Input Module	Pass Through +200 Ω Module	1784-659	SCM7BPT-1460
0–5 Vdc Input Module	Pass Through Module	1784-657	SCM7BPT
RTD (100 Ω) Module	European Curve	1784-655	SCM7B34-1582
RTD (200 Ω) Module	European Curve	1784-675	SCM7B34-1583
TC Module	Type K	1784-1028	SCM7B47K-1574

[See Appendix A for Woodward part numbers.]

Figure 12-12. Example of Dataforth SCM7B Modules

For additional information on the Dataforth SCM7B Modules, go to www.dataforth.com.

12.2.6 Four Channel Actuator Driver FTM

The Four Channel Actuator FTM is used with either the 4Ch Actuator (200 mA) or (25 mA) Module (see Chapter 9 MicroNet module information and Appendix A for FTM part number). One MicroNet Low Density Analog cable is use to connect the FTM with the 4Ch Actuator module (see Appendix A for part numbers).

Figure 12-13. Four Channel Actuator FTM

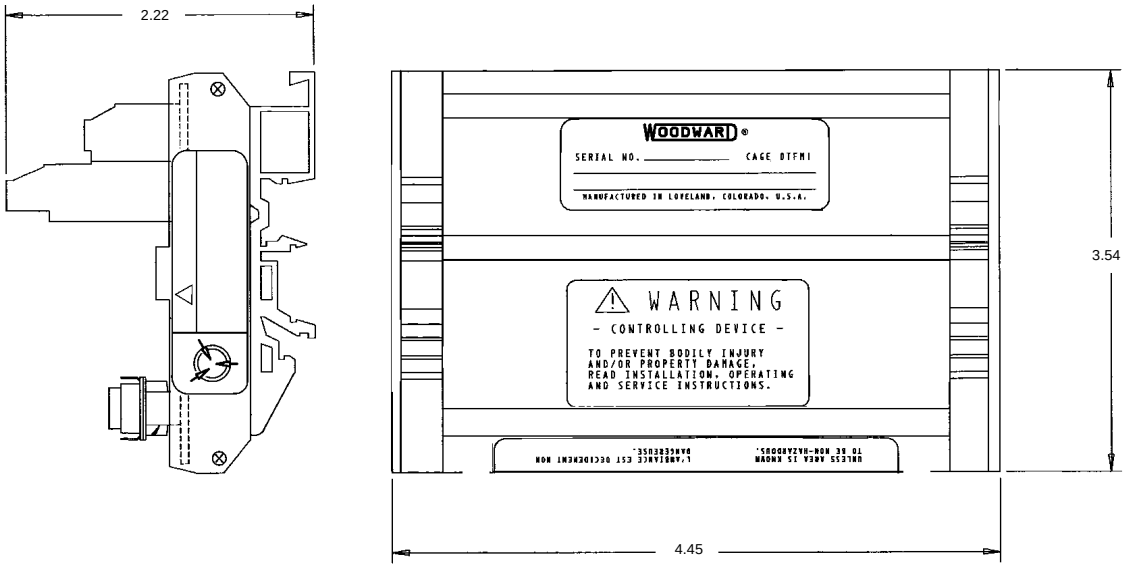


Figure 12-14. Four Channel Actuator Driver FTM Outline Dimensions

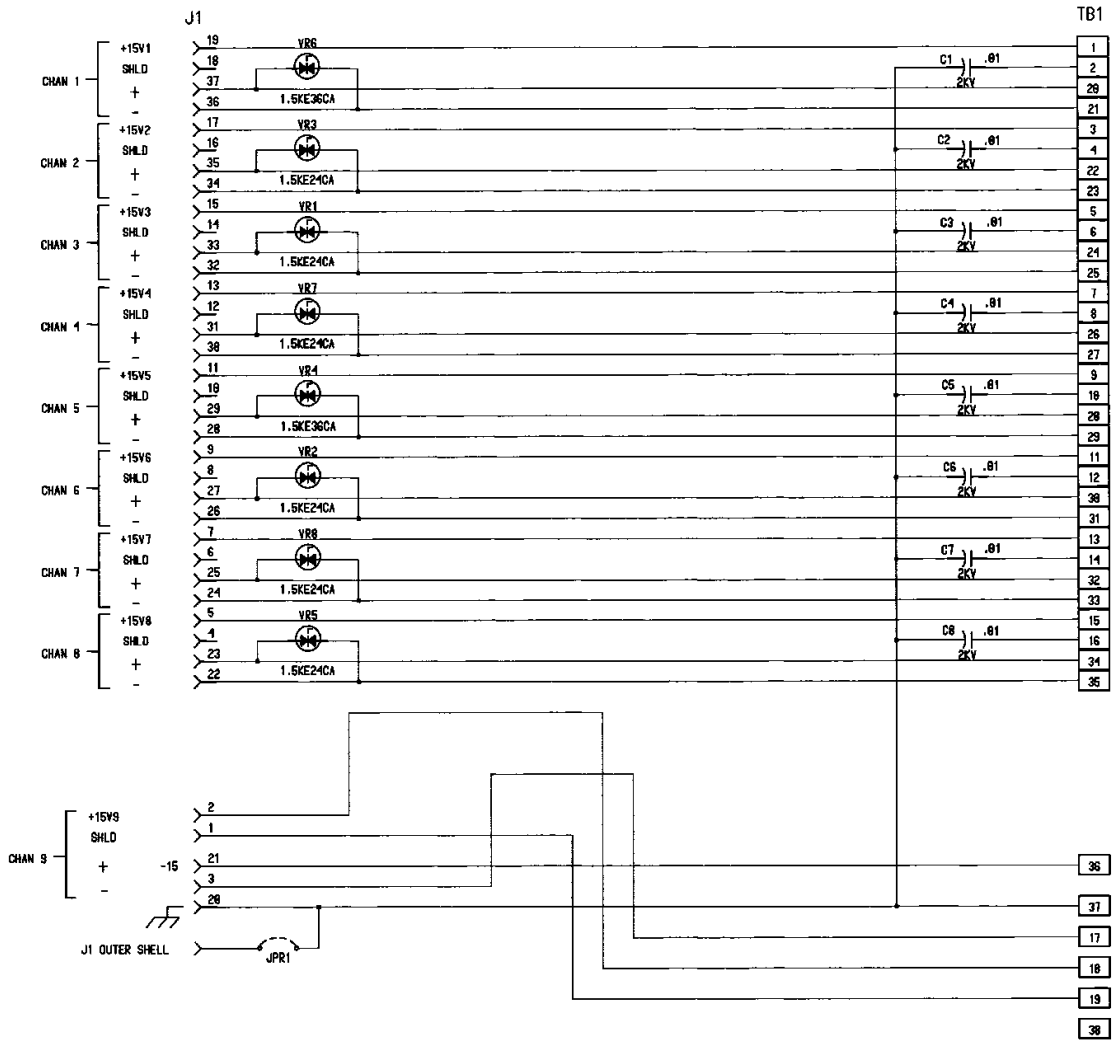


Figure 12-15. Four Channel Actuator Output FTM Schematic

12.2.7 Two Channel Actuator Controller FTM

The Two Channel Actuator Controller FTM is used with the 2Ch Actuator (200, 100, 50, 25, or 10 mA) Modules (see Chapter 9 MicroNet module information and Appendix A for FTM part number). One MicroNet Low Density Discrete cable (gray) is used to connect the FTM with the 2Ch Actuator module (see Appendix A for part numbers). Do not use Analog (black) cable.

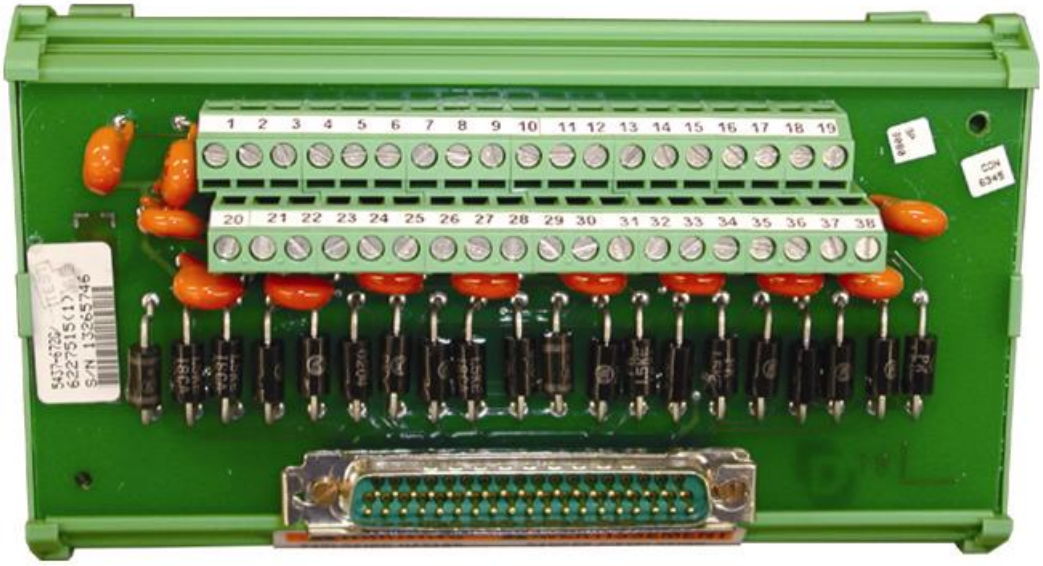


Figure 12-16. Two Channel Actuator Controller FTM

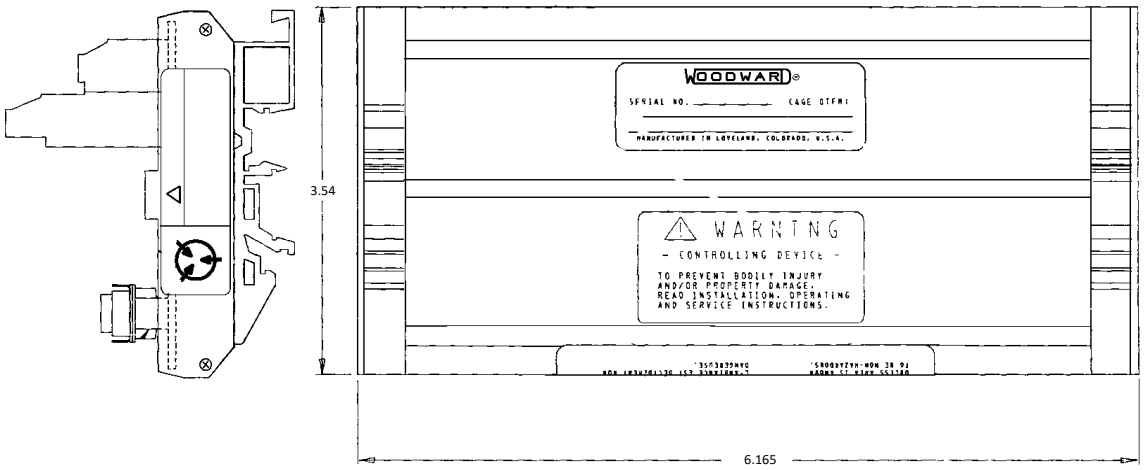


Figure 12-17. Two Channel Actuator Controller FTM Outline Dimensions

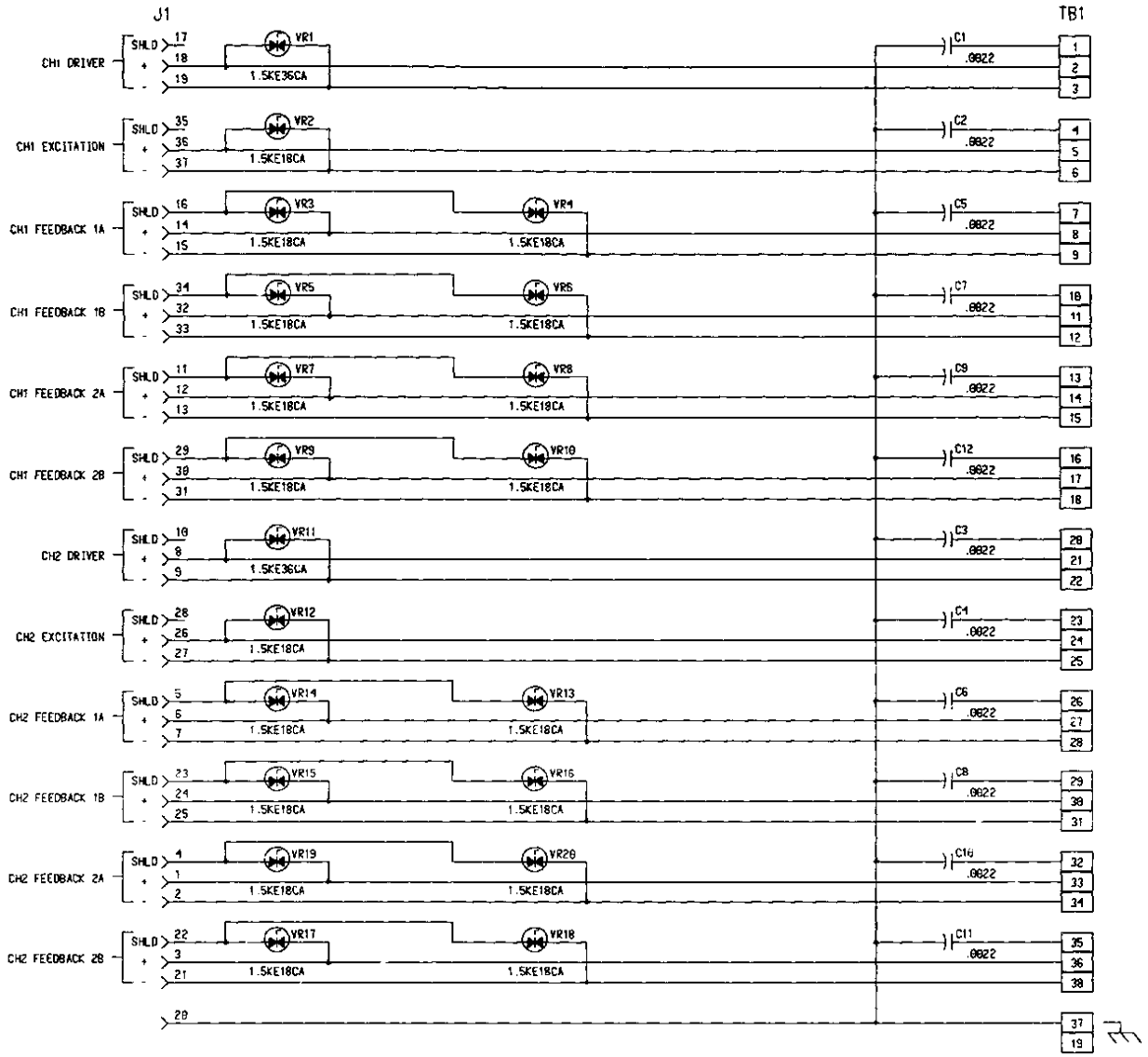


Figure 12-18. 2Ch Actuator Output FTM Schematic

12.2.8 Analog Input FTM

The Analog Input FTM is used with MPU, 4-20 mA input, 4-20 mA output, voltage input, voltage output, RTD, Pressure input, and overspeed switch modules. (See Chapter 8 MicroNet module information and Appendix A for FTM part number). One MicroNet Low Density Analog cable is used to connect the FTM with the Analog modules (see Appendix A for part numbers).

Figure 12-19. Analog Input FTM

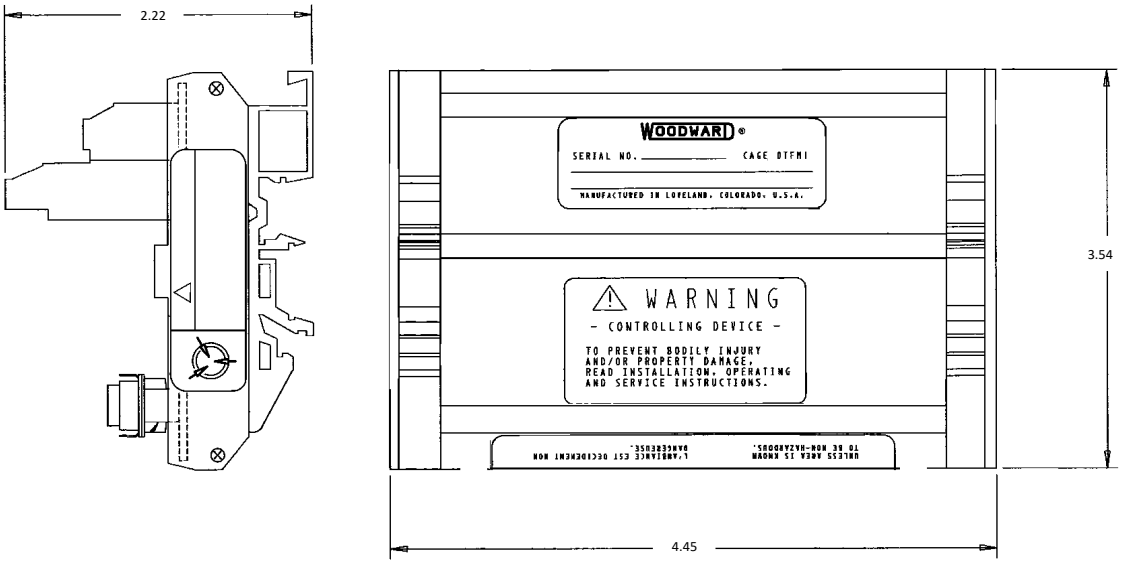


Figure 12-20. Analog Input FTM Outline Dimensions

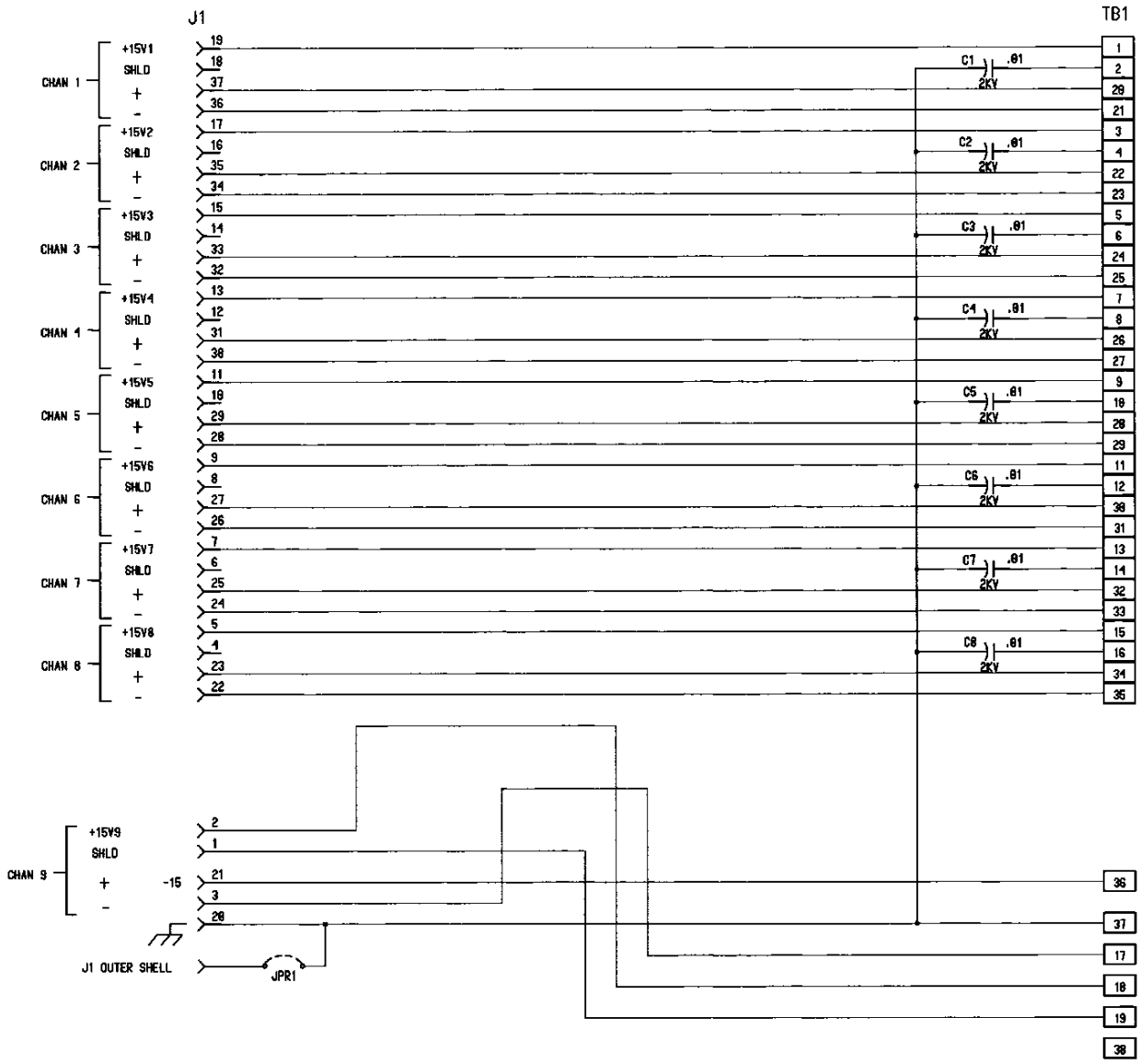


Figure 12-21. Analog Input FTM Schematic

12.2.9 TC Input FTM

The TC Input FTM is used with 8Ch TC Fail Low, Fail High, and Non-standard modules. (See Chapter 8 MicroNet module information and Appendix A for FTM part number). One MicroNet Low Density Analog cable is use to connect the FTM with the 8Ch TC modules (see Appendix A for part numbers). Each FTM utilizes an AD590 Temperature sensor to measure the thermocouple junction temperature. This temperature is used as the reference junction temperature in correcting for the thermocouple wire to copper/copper junction error. Channel 9 is used for this purpose.

Figure 12-22. TC Input FTM

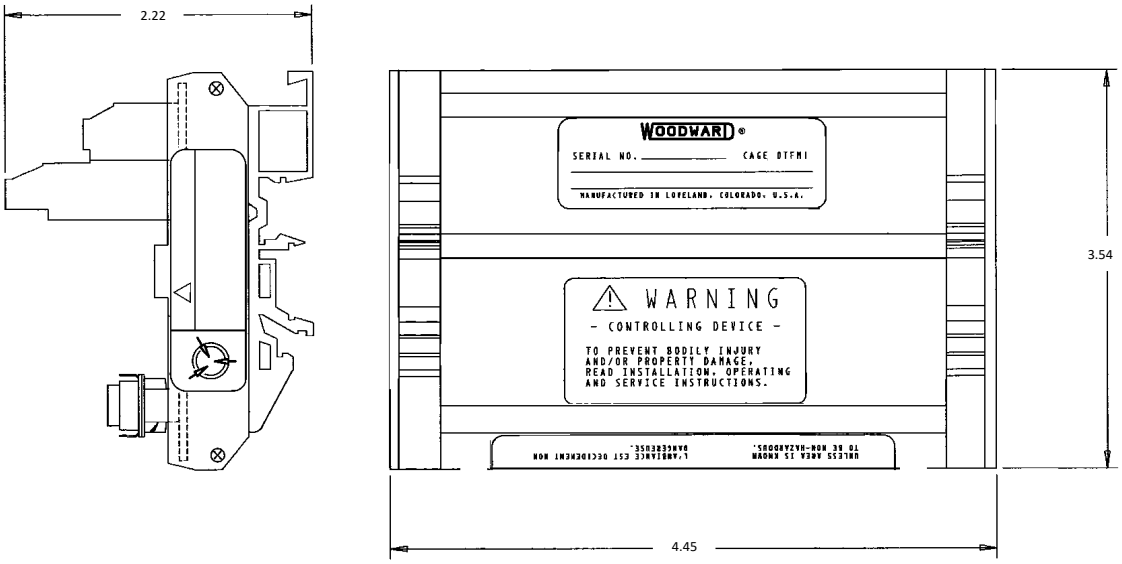


Figure 12-23. TC Input FTM Outline Dimensions

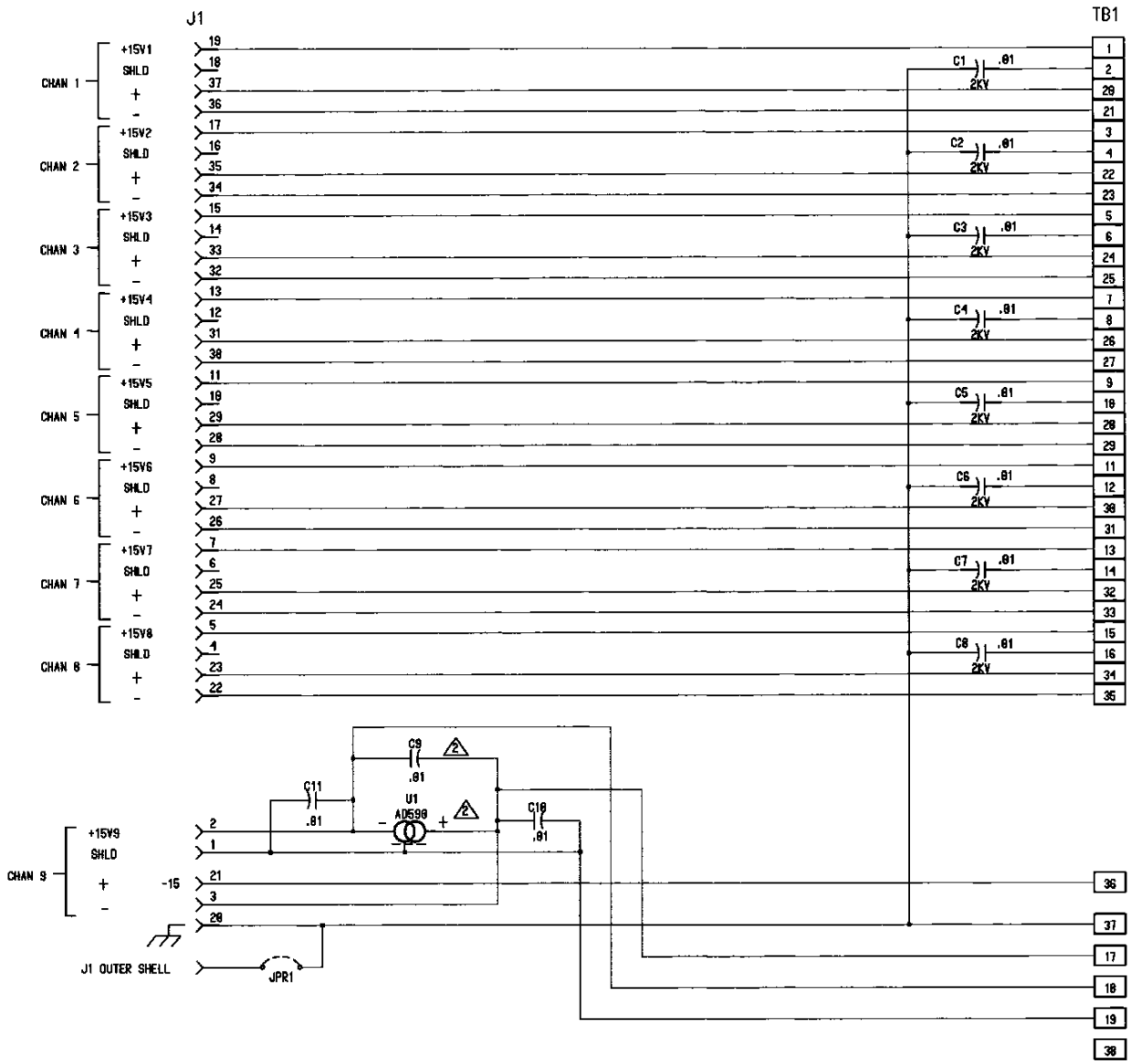


Figure 12-24. TC Input FTM Schematic

12.2.10 Analog Combo I/O

The Analog Combo FTM is used with Analog Combo module (see Chapter 8 MicroNet module information and Appendix A for FTM part number). The FTM can connect to four speed sensor inputs, eight analog inputs, four analog outputs, and two proportional actuator driver outputs. Two MicroNet Low Density Analog cable are used to connect the FTM with the Analog Combo module (see Appendix A for part numbers). There are eight +24 Vdc connections available for sourcing 4–20 mA inputs. Each connection is protected with a 0.1 A fuse (F1-F8). There are four +24/12 Vdc output connections available for powering four proximity sensors. Each of these connections are protected with a 0.1 A fuse (F9-F12).

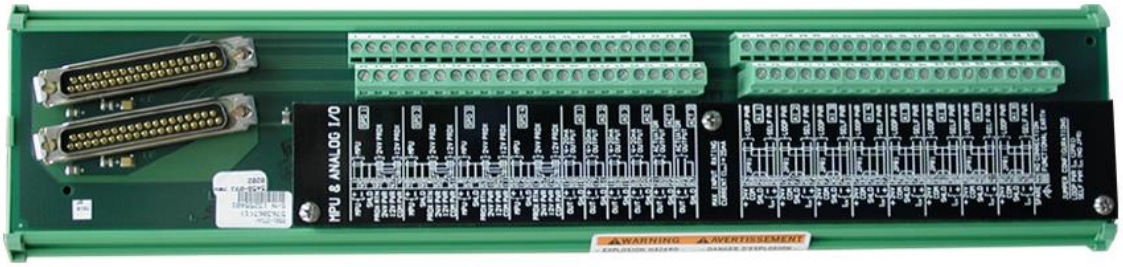


Figure 12-25. Analog Combo FTM

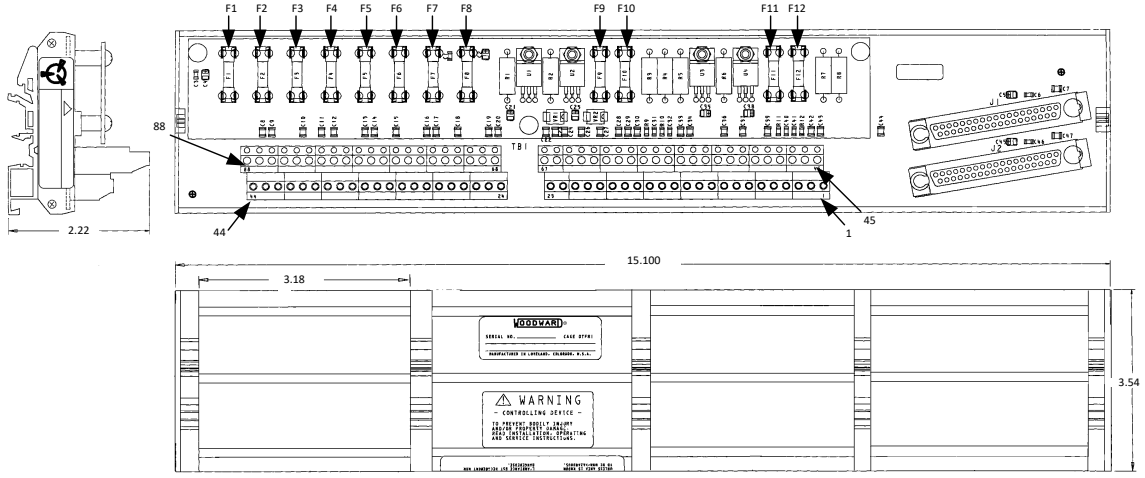


Figure 12-26. Analog Combo FTM Outline Dimensions

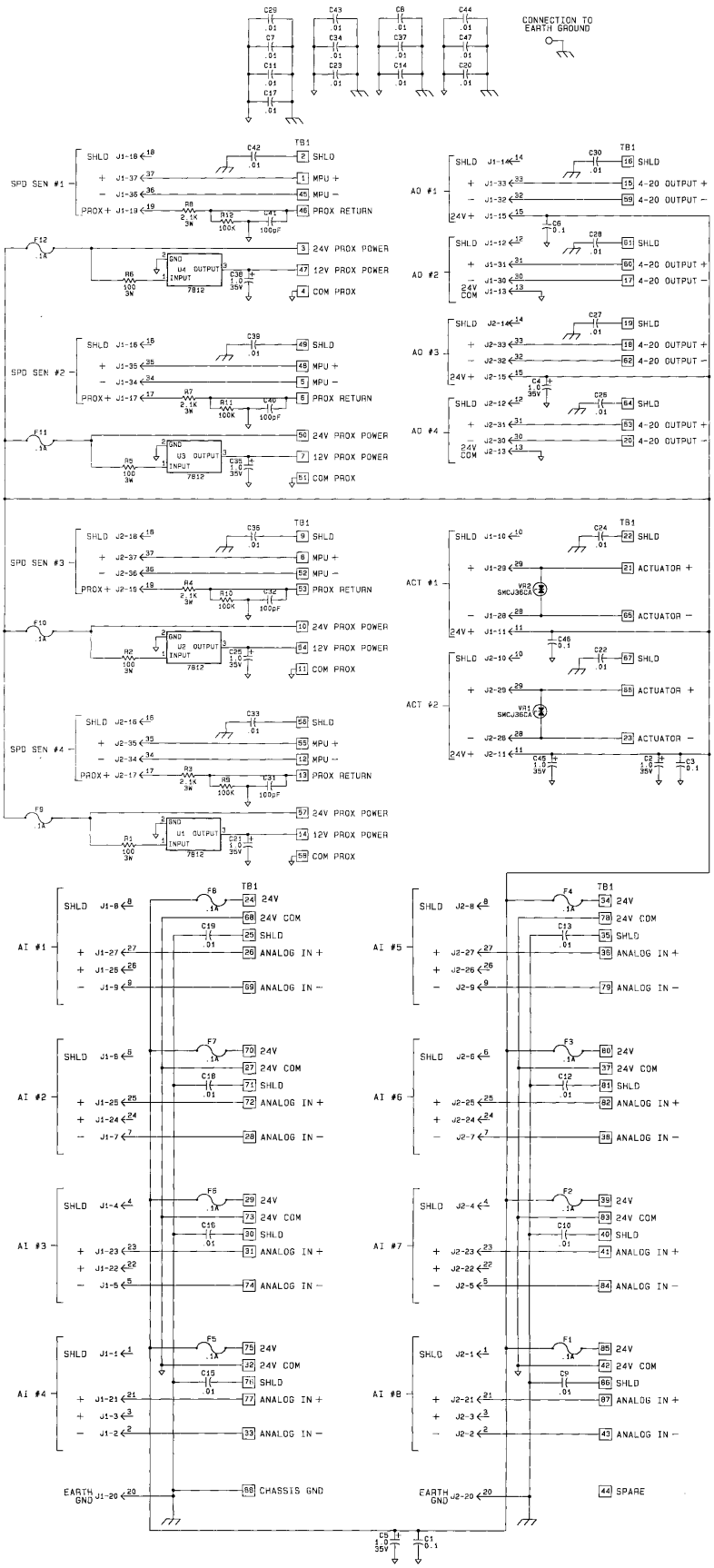


Figure 12-27. Analog Combo FTM Schematic

12.2.11 Non-Standard Analog Input FTM

The Non-Standard Analog Input FTM is used with Non-Standard 8Ch Current Input module (see Chapter 8 MicroNet module information and Appendix A for FTM part number). The FTM has eight current input channels with the output of channel 7 feeding a derivative circuit which in-turn is fed back into channel 8's input. Originally, this derivative signal was used for detection of Combustor Discharge stall Pressures in turbines, but can be used for monitoring other rate of changes in the channel 7 input transducer. The first seven channels may be connected to current transducers. Channels 1 through 6 are standard 0–25 mA inputs with standard frequency response. The derivative circuit consists of two adjustable potentiometers that are factor set. Do not adjust these potentiometers. One MicroNet Low Density Analog cable is used to connect the FTM with the Non-Standard 8Ch Current Input module (see Appendix A for part numbers).

Figure 12-28. Non-Standard Analog Input FTM

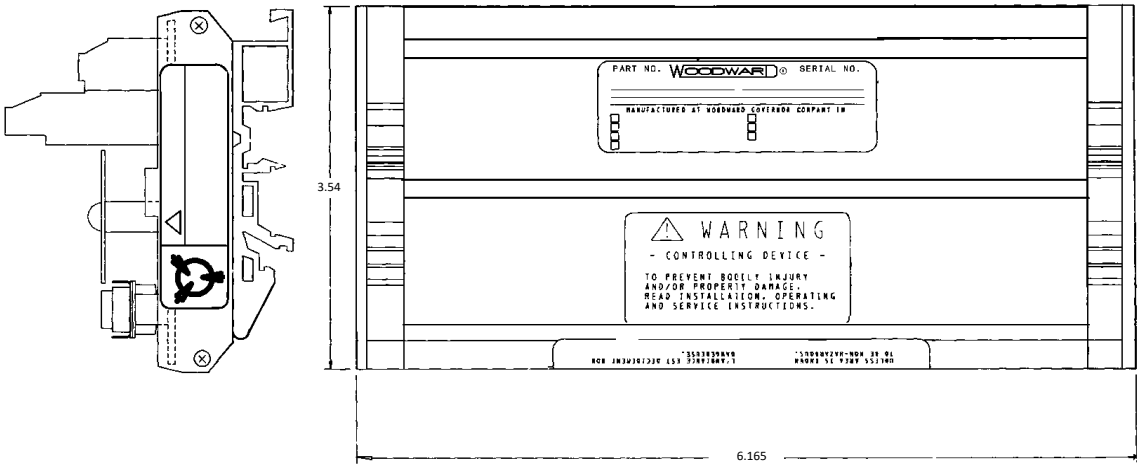


Figure 12-29. Non-Standard Analog Input FTM Outline Dimensions

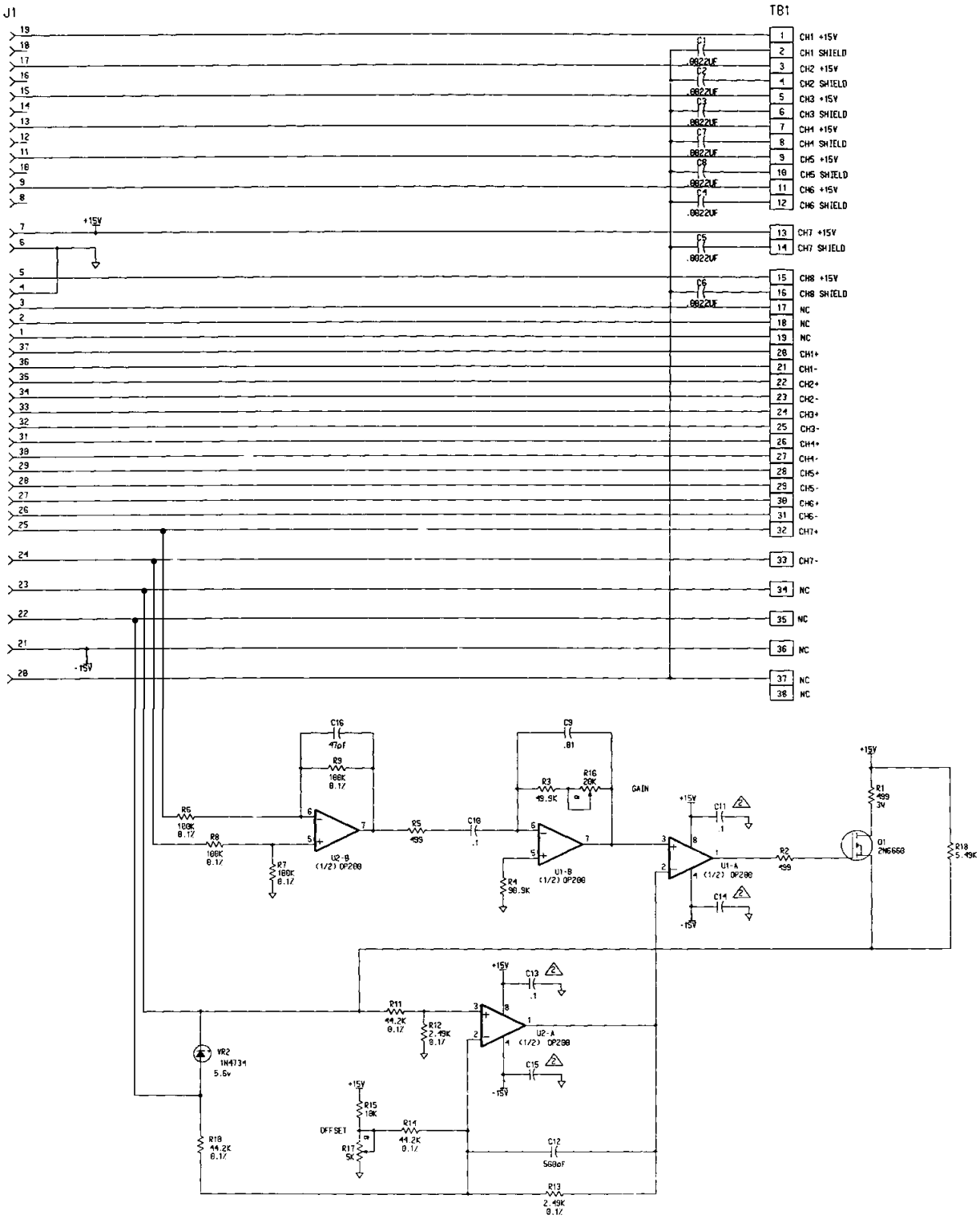


Figure 12-30. Non-Standard Analog Input FTM Schematic

12.2.12 TMR SPEED INPUT FTM

The TMR Speed Input FTM is used with MPU, PROX and Eddy sensors in TMR systems. (See Chapter 8 MicroNet module information and Appendix A for FTM part number). Three MicroNet Low Density Analog cables are used to connect the FTM with the Analog modules (see Appendix A for part numbers).

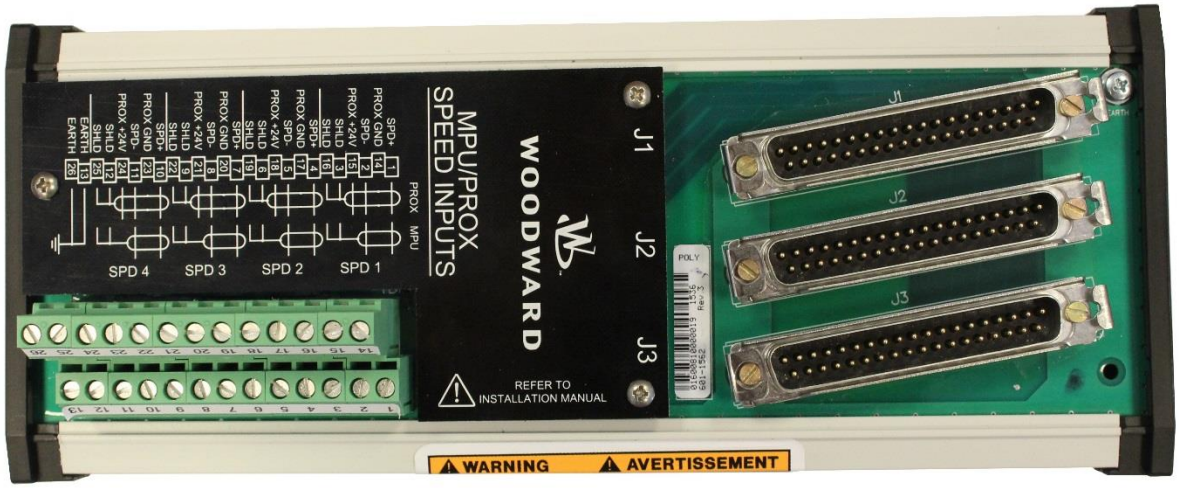


Figure 12-31. TMR Speed Input FTM

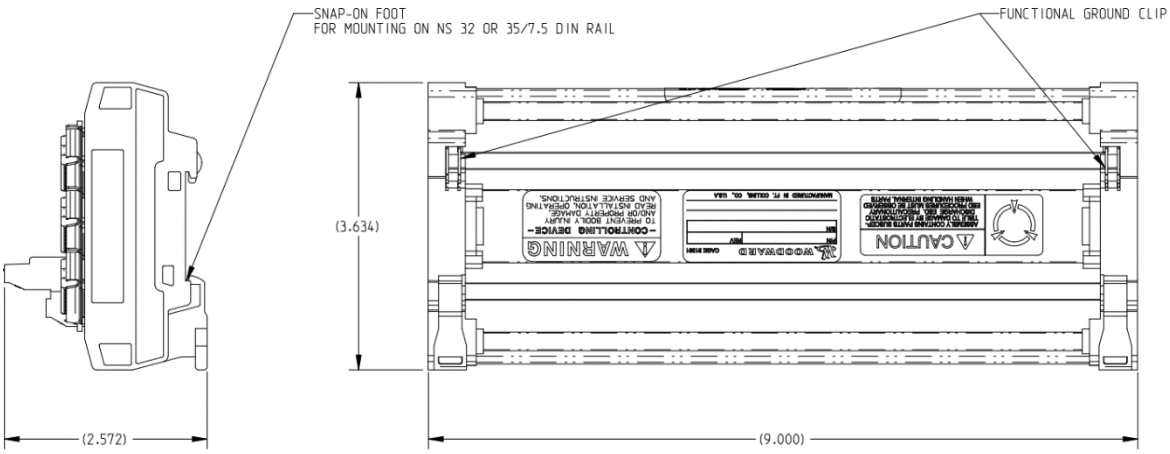


Figure 12-32. Analog Input FTM Outline Dimensions

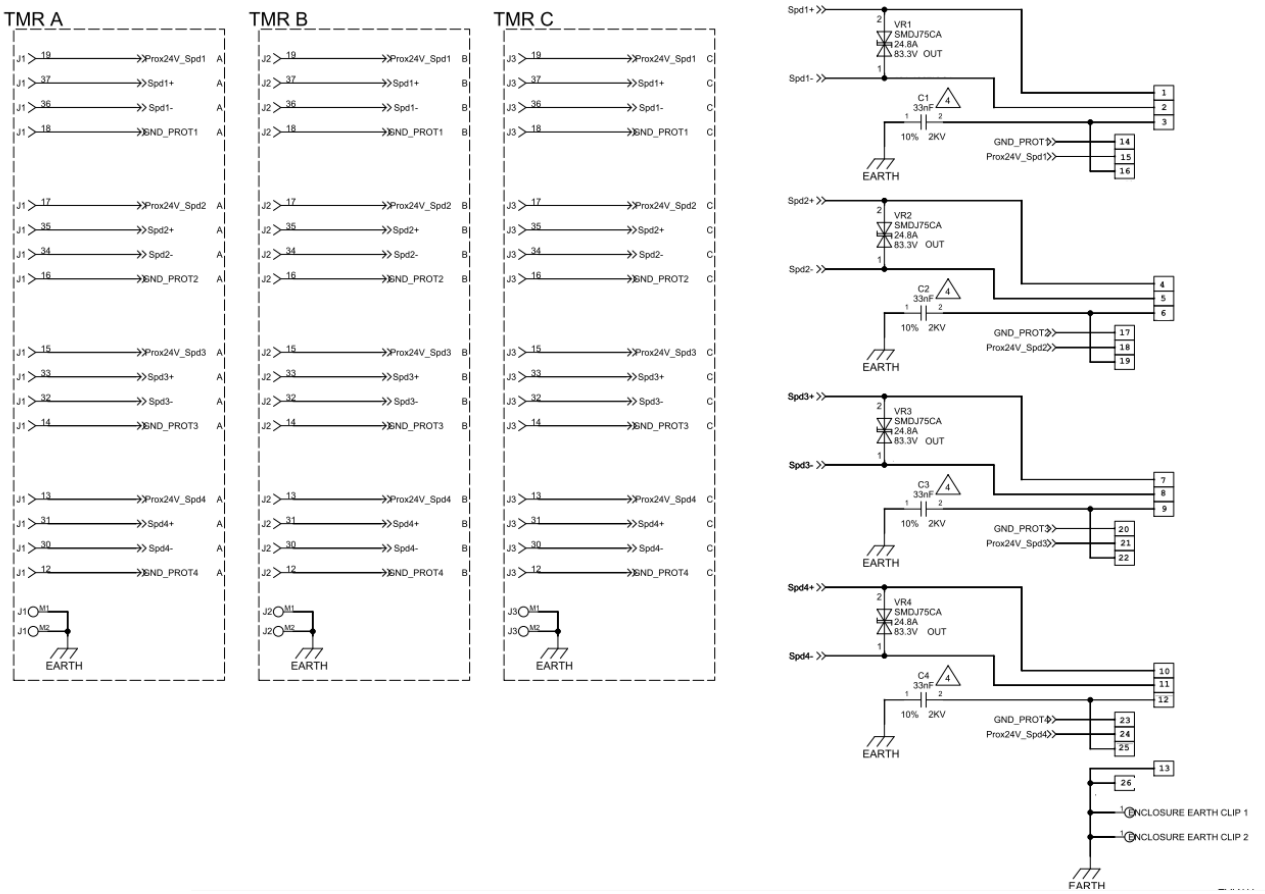


Figure 12-33. TMR Speed Input FTM Schematic

12.3 Discrete I/O FTM

12.3.1 24 Vdc Discrete Input/Output FTM

The 24 Vdc Discrete Input/Output FTM is used with 48Ch DI, the 32Ch DO, and the 64Ch DO Modules (see Chapter 7, MicroNet module information and Appendix A for FTM part number). The FTM has 24 discrete input or output channels per module. The 48Ch DI modules utilizes two FTMs, the 32Ch DO module utilizes two FTMs, and the 64Ch DO module utilizes four FTMs for their I/O connections. Two MicroNet Low Density Discrete cables are used to connect the 48Ch DI and 32Ch DO modules with their FTMs. Four MicroNet Low Density Discrete cables are used to connect the 64Ch DO Module with its four FTMs (see Appendix A for part numbers).

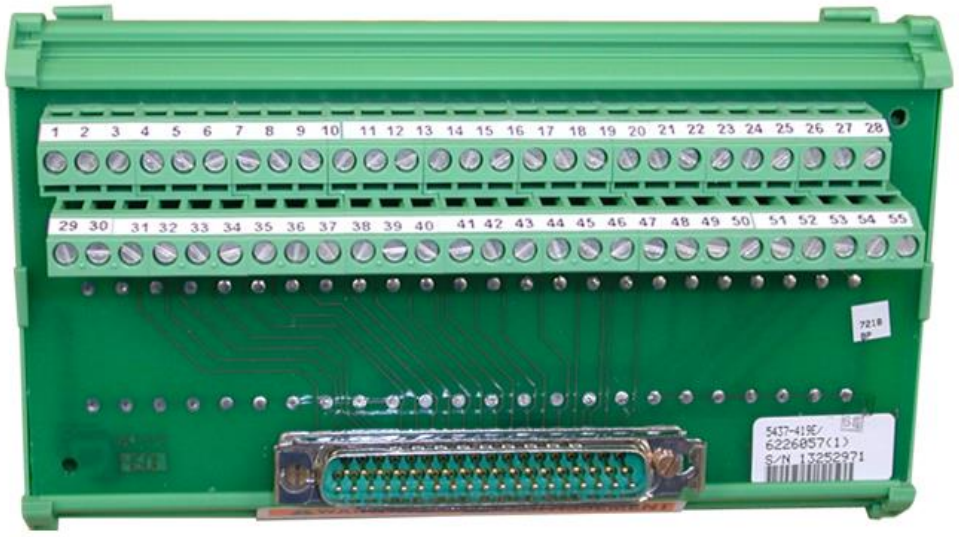


Figure 12-34. 24 Vdc Discrete Input/Output FTM

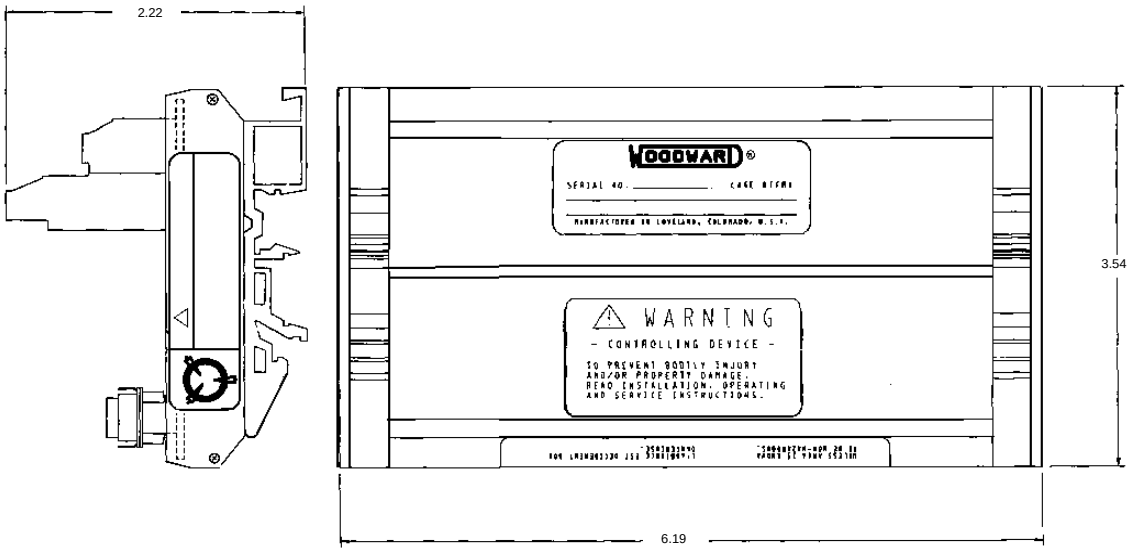


Figure 12-35. 24 Vdc Discrete Input/Output FTM Outline Dimensions

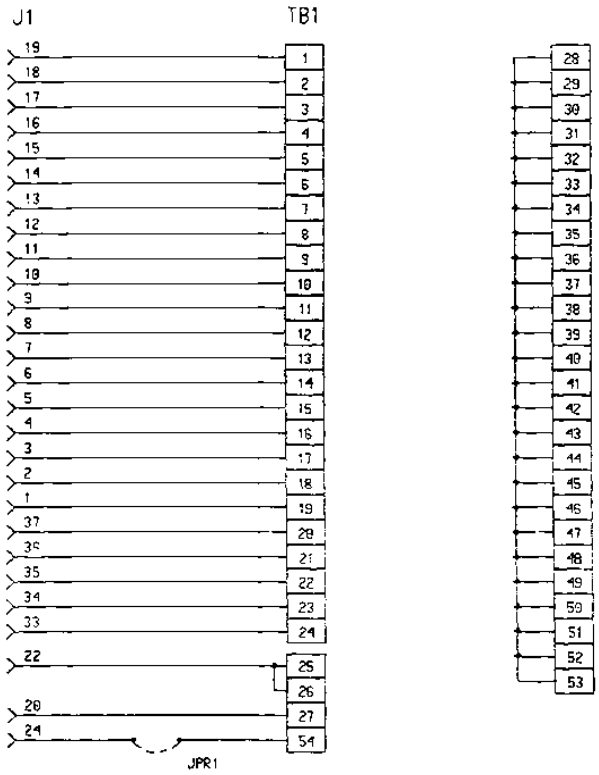


Figure 12-36. 24 Vdc Discrete Input/Output FTM Schematic

12.3.2 Position Controller FTM

The Position Controller FTM is used with 2Ch TM100 Modules, and the 2Ch EM-35 Modules (see Chapter 9 for MicroNet module information and Appendix A for FTM part number). One MicroNet Low Density Discrete cable is used to connect each of the 2Ch TM100 Modules, and the 2Ch EM-35 Modules with their FTMs (see Appendix A for part numbers).

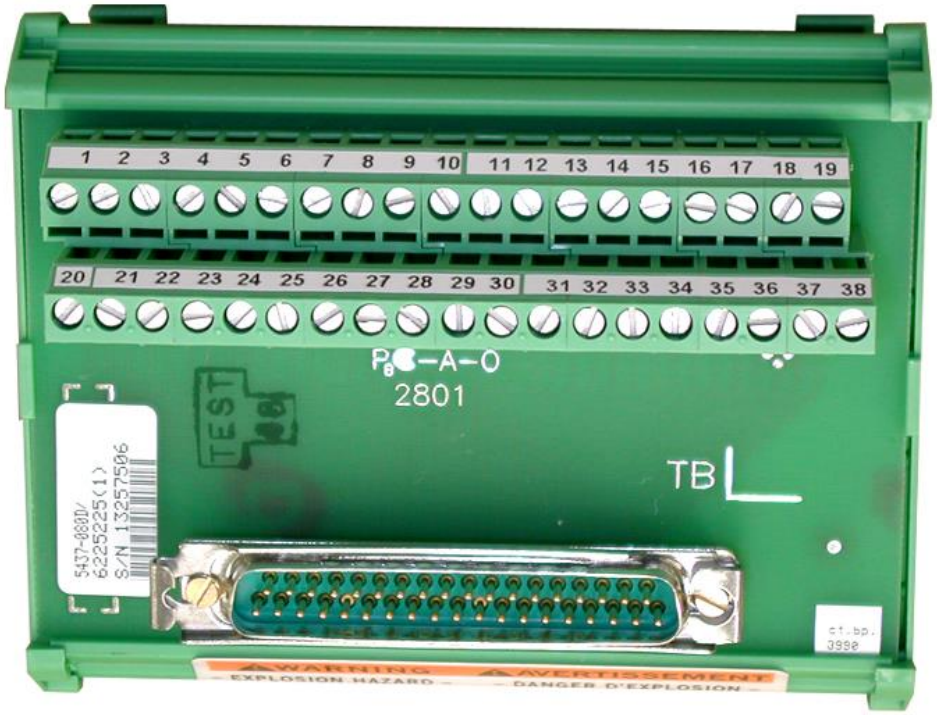


Figure 12-37. Position Controller FTM

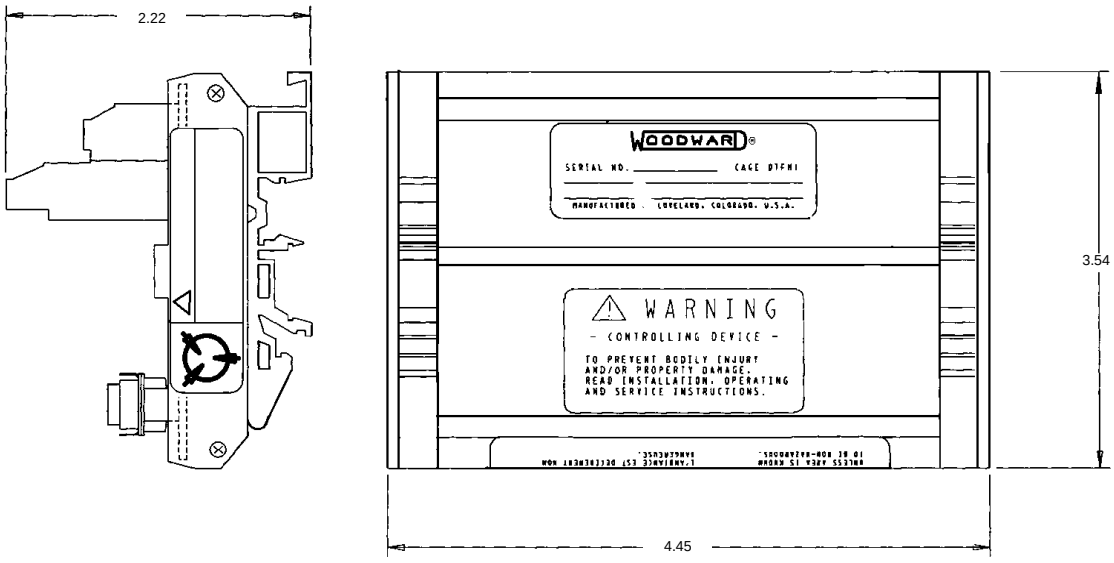


Figure 12-38. Position Controller FTM Outline Dimensions

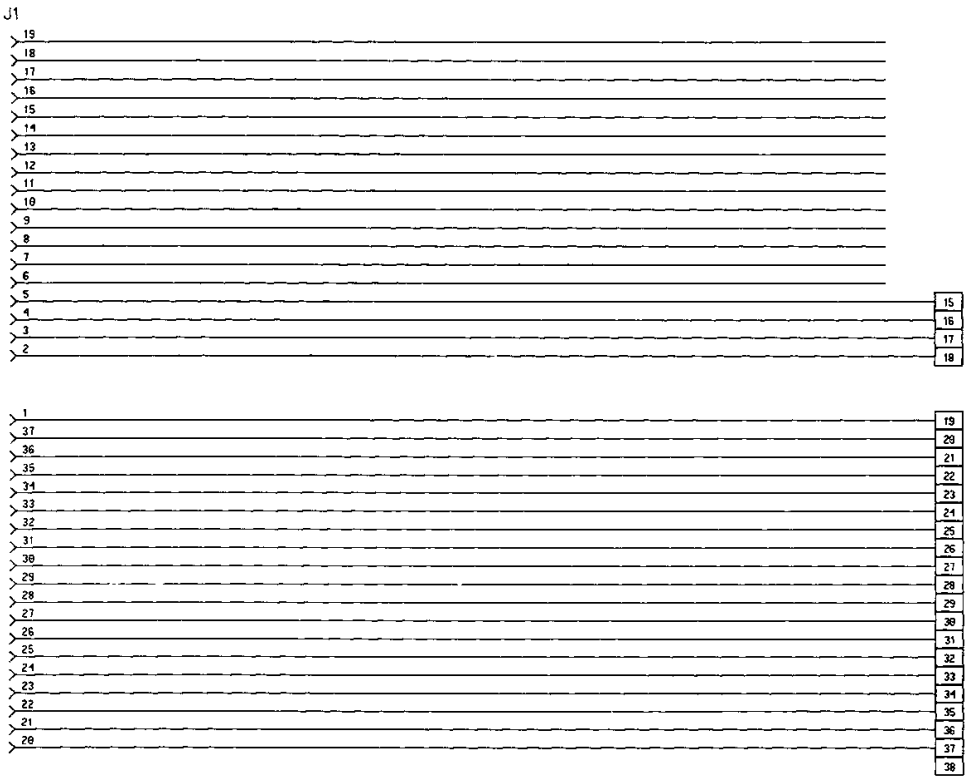


Figure 12-39. Position Controller FTM Schematic

12.3.3 24/12 Discrete Module (Phoenix Contact)

WARNING

This relay module is for use in ordinary or non-hazardous locations only.

The 24/12 Discrete Module is used with 48/24 Discrete Combo Module (see Chapter 7 MicroNet module information and Appendix A for FTM part number). The 24/12 Discrete Module has 24 discrete inputs connections and 12 SPDT relay outputs. Two relay modules connect to one 48/24 Discrete Combo Module. Each FTM uses one MicroNet High Density Analog/Discrete cable to connect it with the 48/24 Discrete Combo Module (see Appendix A for part numbers). This relay module incorporates an I/O lockout relay that will de-energize all of the relays if de-activated by the I/O lock signal from the DO module. All field connections use removable connectors for ease in replacing module in the field. All relays are field replaceable.

Relays (see Appendix A)
Output Rating:
10 A @ 28 Vdc Resistive
3 A @ 150 Vdc Resistive
10 A @ 115 Vac Resistive
10 A @ 240 Vac Resistive
3 A @ 28 Vdc Inductive
1.2 A @ 150 Vdc Inductive
6 A @ 115 Vac Inductive
3 A @ 240 Vac Inductive

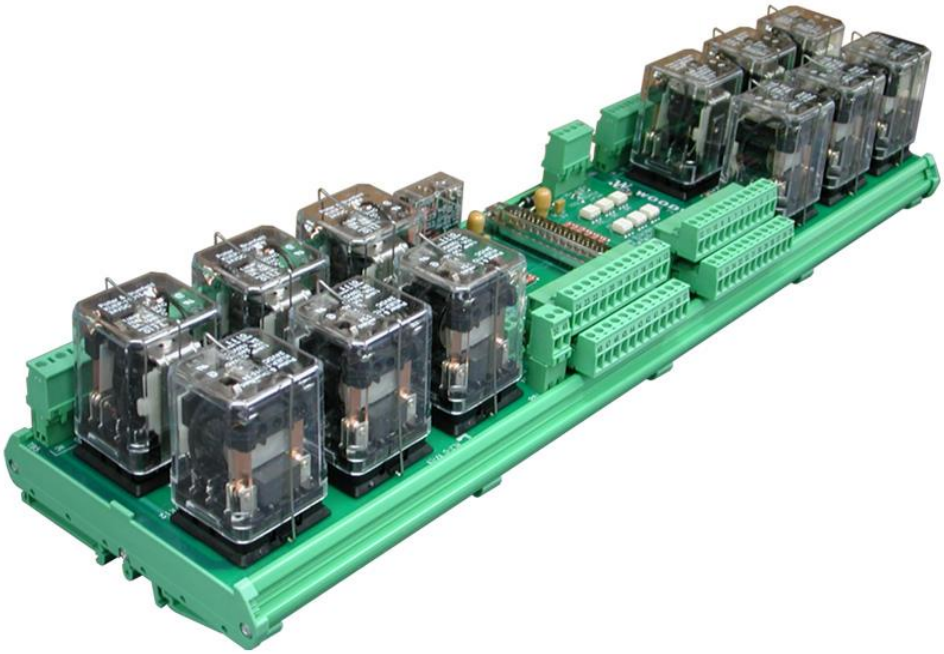


Figure 12-40. 24/12 Discrete Module (Phoenix Contact)

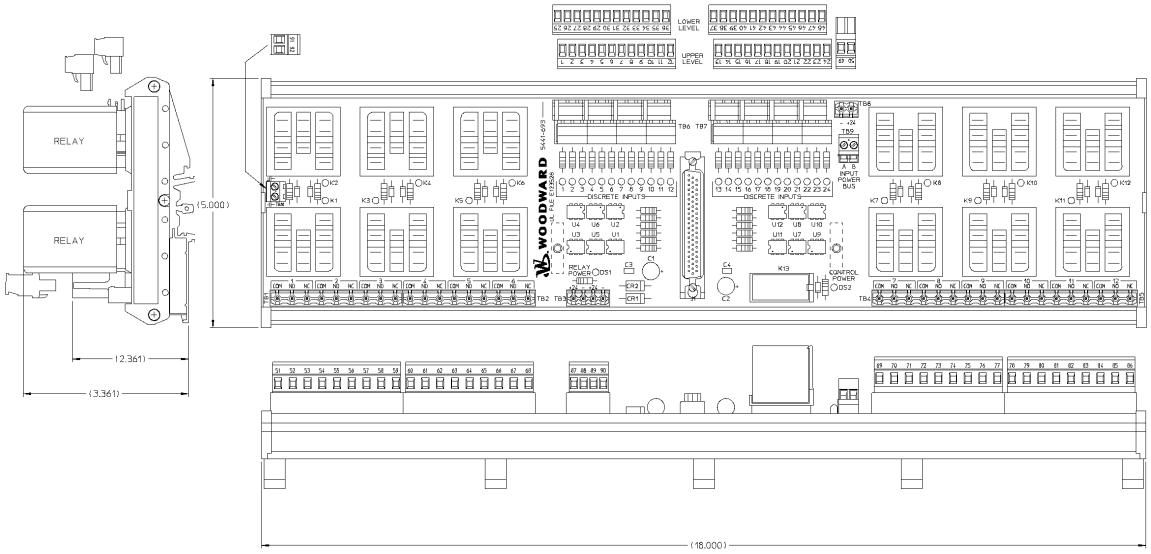


Figure 12-41. 24/12 Discrete Module Outline Dimensions

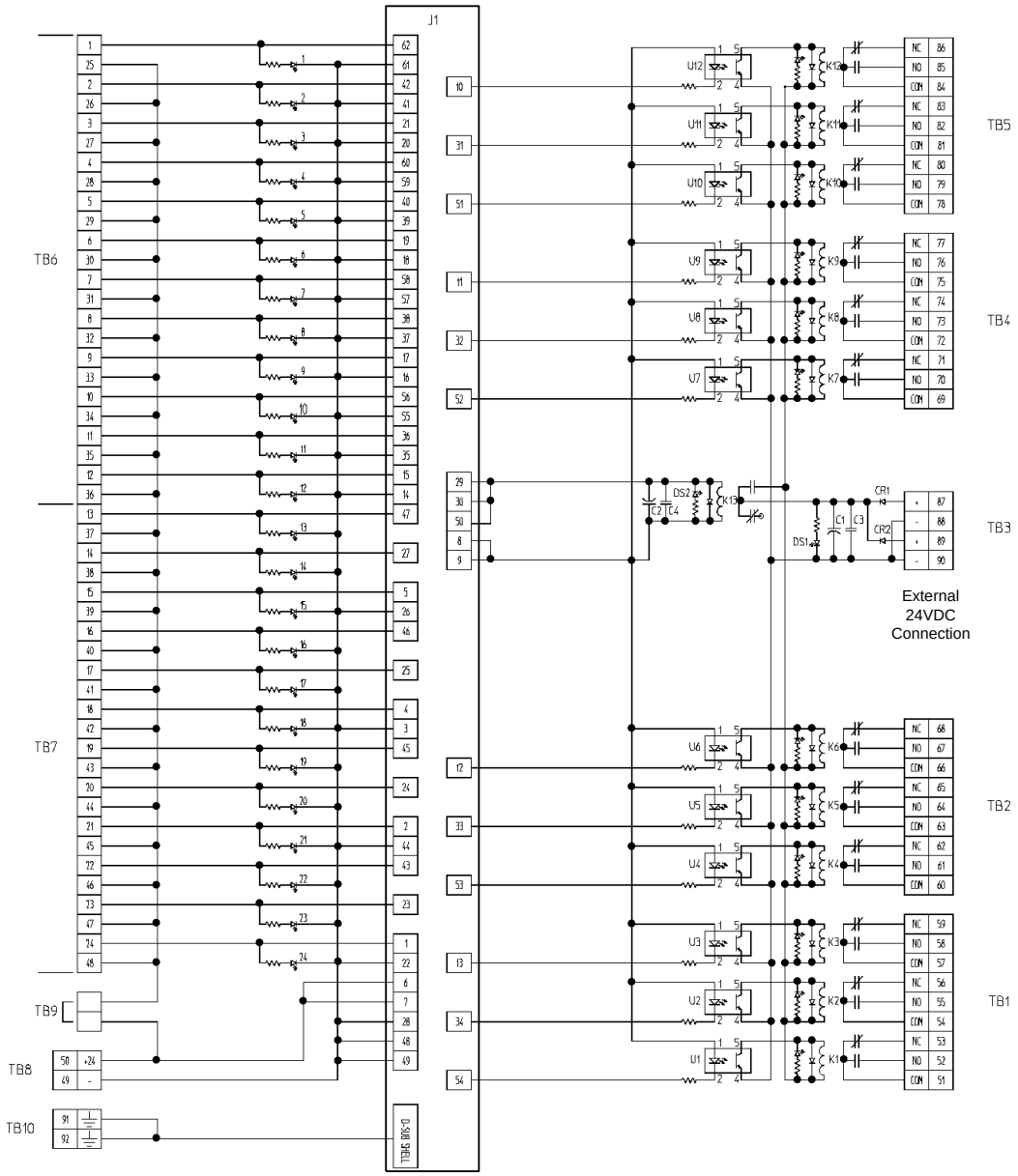


Figure 12-42. 24/12 Discrete Module Schematic

12.3.4 24 Vdc 48/24 Discrete FTM

This 24 Vdc 48/24 Discrete FTM is used with the 48/24 Discrete Combo Module and one of three relay boxes (see Chapter 7 for MicroNet module information and Appendix A for FTM part number). Two MicroNet High Density Analog/Discrete cables are used to connect the FTM with the 48/24 Discrete Combo Module (see Appendix A for part numbers). 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) (See Appendix A for part numbers).

All discrete Input wiring is through the 48/24 Discrete I/O FTM. Contact wetting voltage may be supplied by the 48/24 Discrete FTM. Optionally, an external
18–32 Vdc power (LV) source can be used to source the circuit wetting voltage. If the 24 Vdc internal power source is used for contact wetting, a jumper is required between FTM terminals 98 and 99. If an external power source is used for contact wetting, the external sources common must be connected to the FTM's discrete input common, terminal 49.

If an external 24 Vdc is used, 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).

The discrete input isolation voltage is 500 Vdc to earth ground and 1000 Vdc to control common.

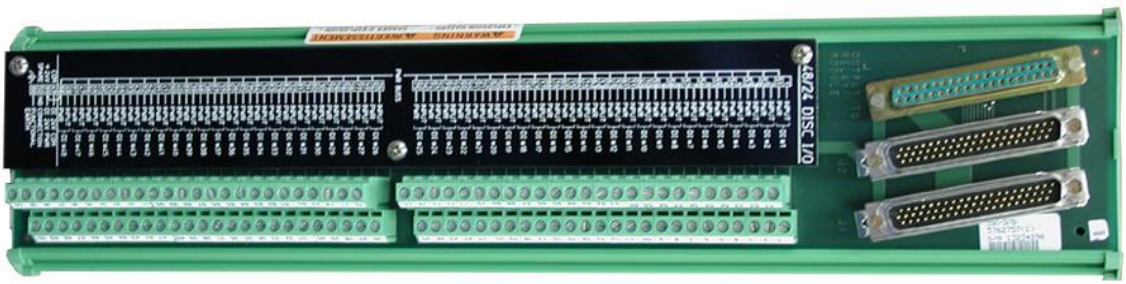


Figure 12-43. 24 Vdc 48/24 Discrete FTM

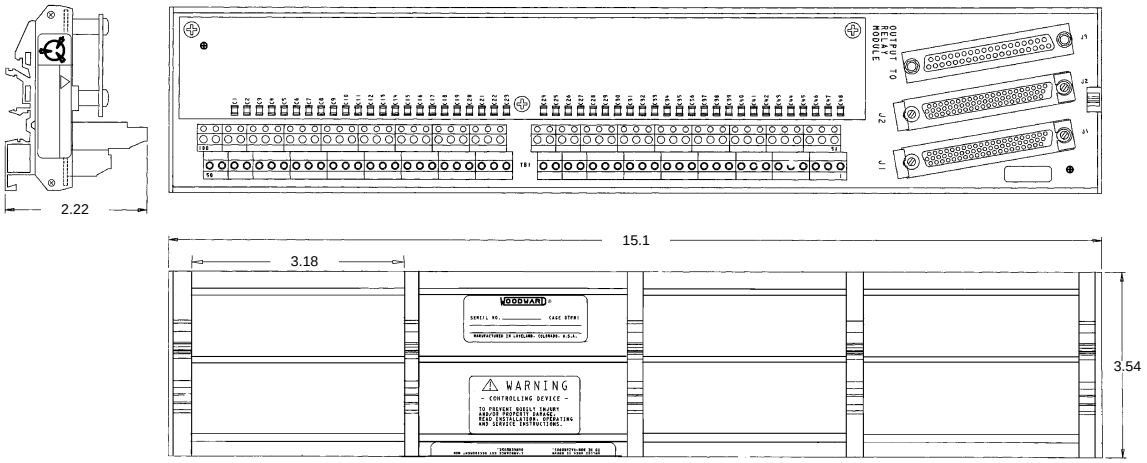


Figure 12-44. 24 Vdc 48/24 Discrete FTM Outline Dimensions

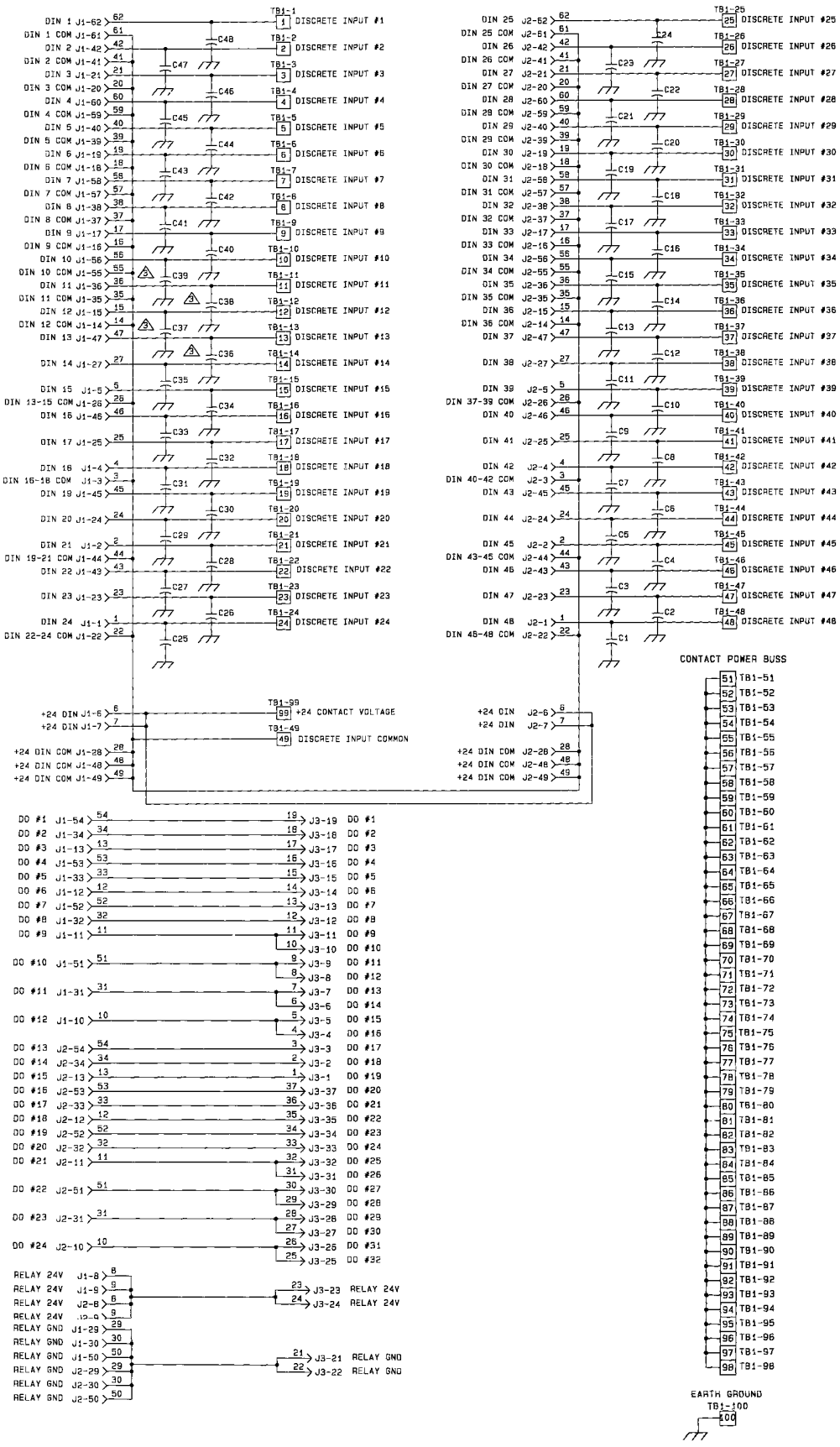


Figure 12-45. 24 Vdc 48/24 Discrete FTM Schematic

12.3.5 125 Vdc 48/24 Discrete FTM

WARNING

HIGH VOLTAGE—If the high voltage FTM is being used, and there is 125 Vdc on the FTM terminal blocks, there will be 125 Vdc on the FTM sub D connectors and on the cable when it is connected to the FTM. For this reason, any power should be removed from the FTM terminal blocks before installing the 24/8 Analog I/O module or the FTM.

This 125 Vdc 48/24 Discrete FTM is used with the 48/24 Discrete Combo Module (see Chapter 7 for MicroNet module information and Appendix A for FTM part number). Two MicroNet High Density Analog/Discrete cables are used to connect the FTM with the 48/24 Discrete Combo Module (see Appendix A for part numbers). 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) (See Appendix A for part numbers).

All discrete Input wiring is through the 48/24 Discrete FTM. Contact wetting voltage must be supplied by an external 100-150 Vdc power (HV) source. The common for the 125 Vdc must be tied to the discrete input common.

The discrete input isolation voltage is 500 Vdc to earth ground and 1000 Vdc to control common.

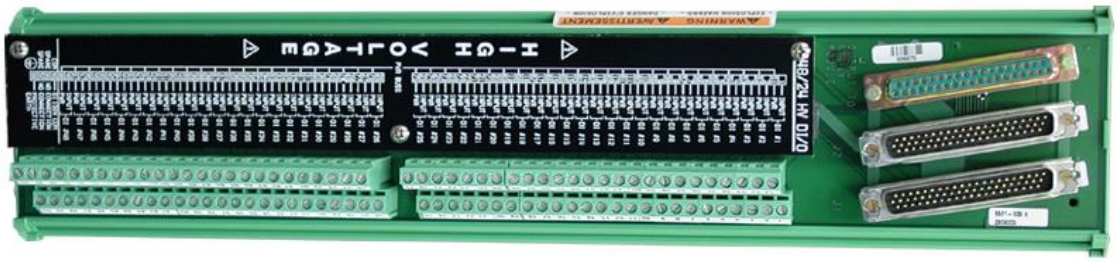


Figure 12-46. 125 Vdc 48/24 Discrete FTM

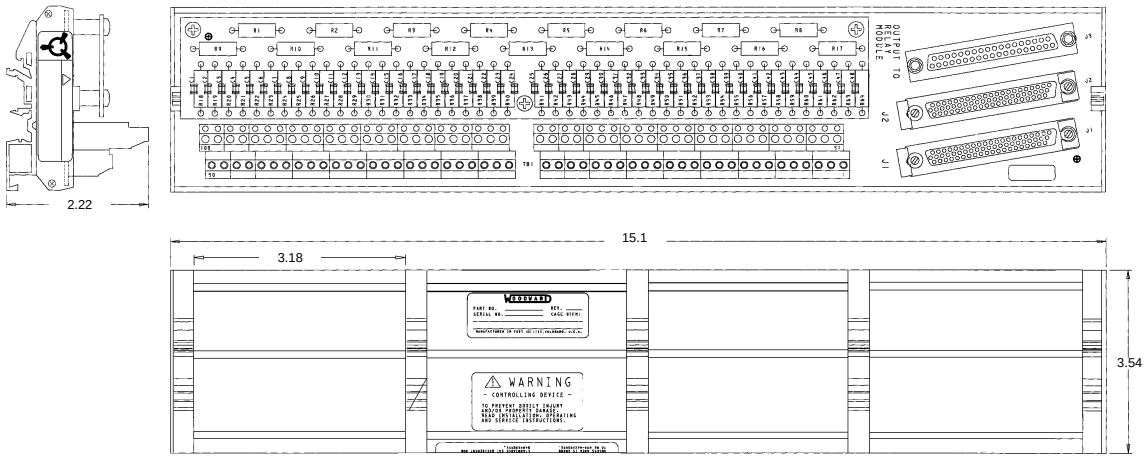


Figure 12-47. 125 Vdc 48/24 Discrete FTM Outline Dimensions

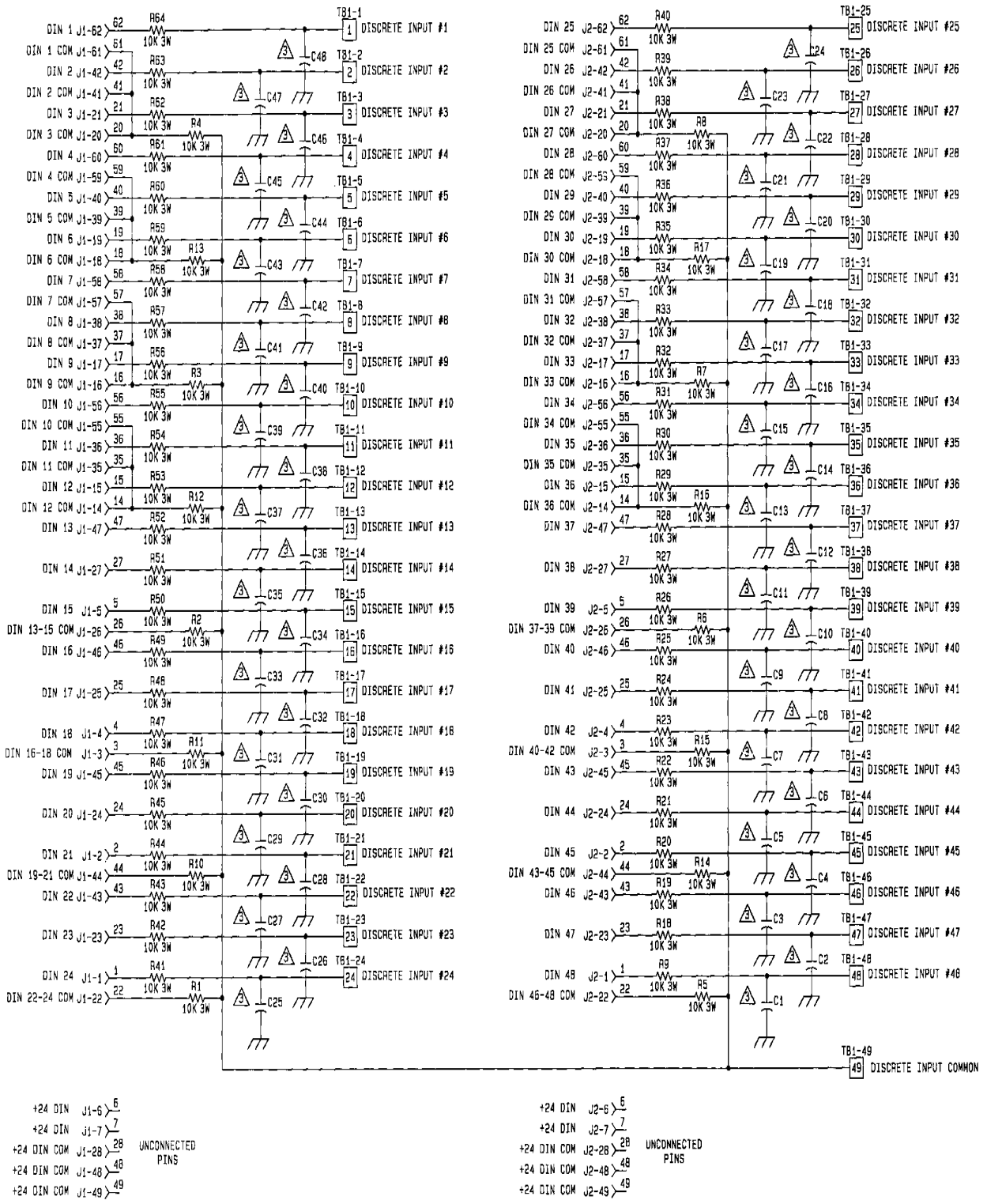


Figure 12-48a. 125 Vdc 48/24 Discrete FTM Schematic (part 1)

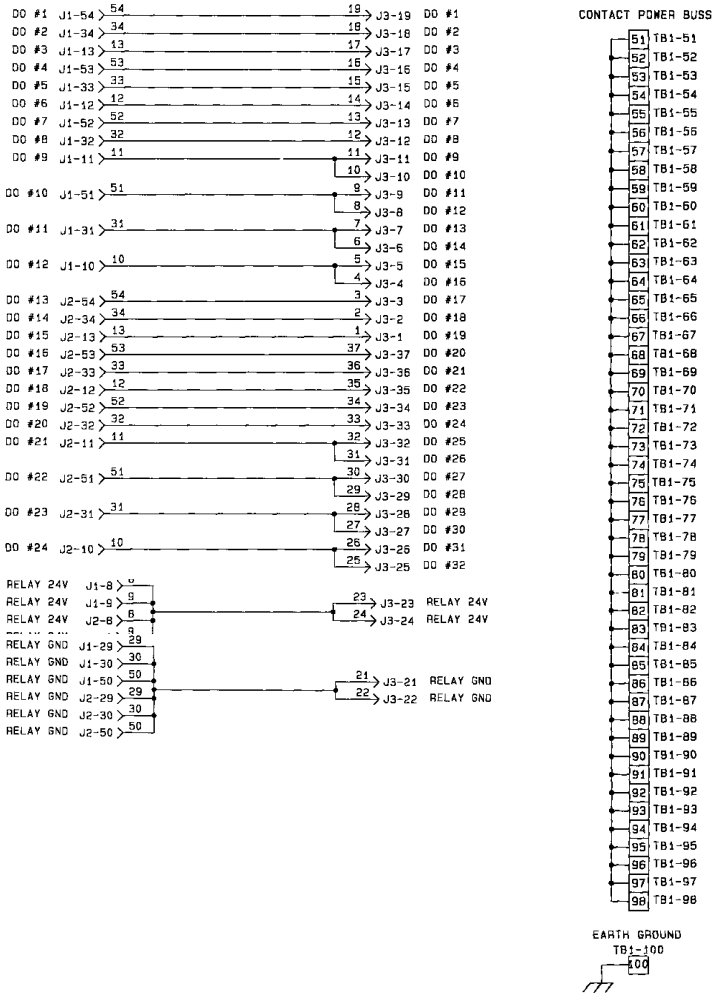


Figure 12-48b. 125 Vdc 48/24 Discrete FTM Schematic (part 2)

12.3.6 Discrete Input (with LEDs) FTM

IMPORTANT

Do not use internal 24 Vdc power (TB1-54) to power inputs. Use external 24 Vdc power source as shown in Chapter 7. Internal 24 Vdc does not have sufficient current capability to power all LEDs at one time.

This Discrete Input (with LEDs) FTM is used with the 48Ch Discrete Input Module (see Chapter 7 for MicroNet module information and Appendix A for FTM part number). One MicroNet Low Density Discrete cable is used to connect the FTM with the 48Ch Discrete Input Module (see Appendix A for part numbers). Always use an external 24 Vdc power source for energizing the inputs (See Chapter 7 for external power connection). The internal 24 Vdc power is not sufficient to power all LEDs.

Figure 12-49. Discrete Input (with LEDs) FTM

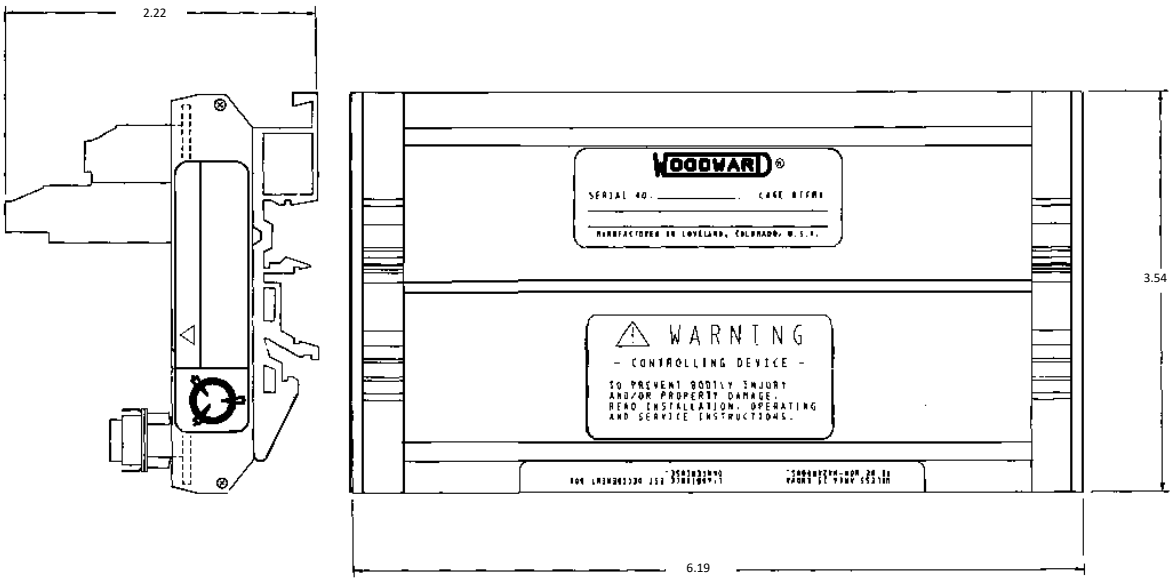


Figure 12-50. Discrete Input (with LEDs) FTM Outline Dimensions

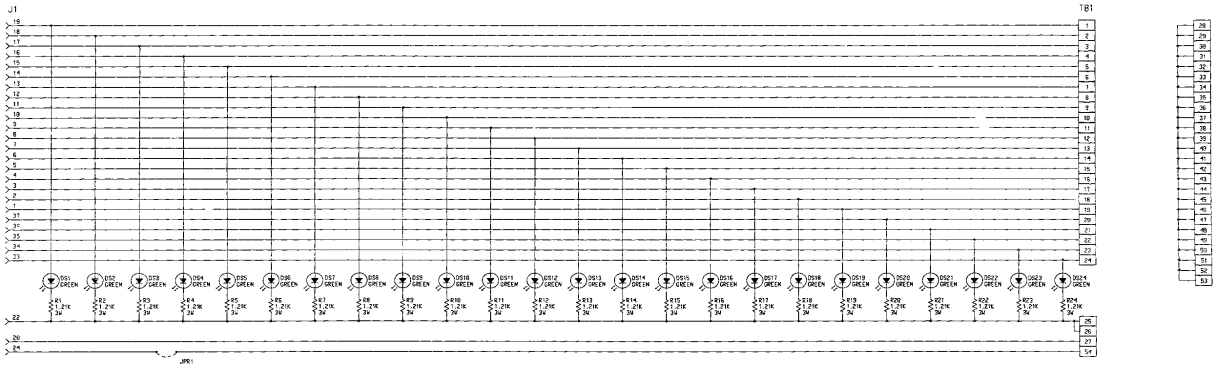


Figure 12-51. Discrete Input (with LEDs) FTM Schematic

12.3.7 24/12 Discrete I/O (with LEDs) FTM

The 24/12 Discrete Module is used with MicroNet Discrete I/O Smart-Plus Module (see Chapter 8 MicroNet module information and Appendix A for FTM part number). The 24/12 Discrete I/O FTM has 24 discrete inputs connections and 2 groups isolated from each other of 6 relay drivers. Two FTMs connect to one MicroNet Discrete I/O Smart-Plus Module. Each FTM uses one MicroNet High Density Analog/Discrete cable to connect it with the MicroNet Discrete I/O Smart-Plus Module (see Appendix A for part numbers). All field connections use removable connectors for ease in replacing module in the field.

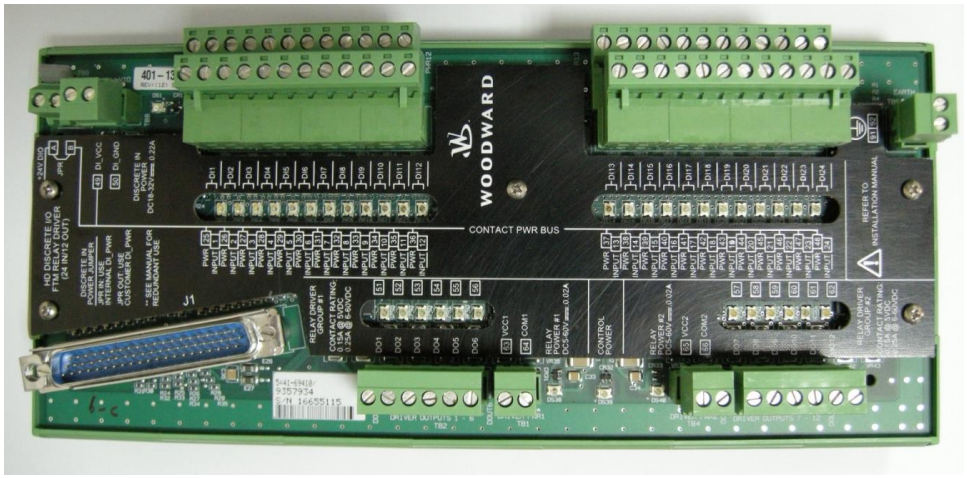


Figure 12-52. 24/12 Discrete I/O FTM

All discrete Input wiring is through the 48/24 Discrete I/O FTM. Contact wetting voltage may be supplied by the 48/24 Discrete FTM. Optionally, an external
18–32 Vdc power (LV) 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 in terminal block TB9.

If an external power source is used for contact wetting, the external sources common must be connected to the FTM's discrete input common, terminal 49. If the external power supply to be used with voltage < 24 Vdc, jumper from TB9 is required to be removed. If the external power supply voltage >= 24 Vdc jumper from terminal block TB9 may stay – in this case power supply redundancy option can be used.

Each of two groups of relay drivers (Discrete Outputs) require own external power supply. External Power Supply voltage: 5–60 Vdc, the same as for relays driven by the relay driver.

Relay Driver Ratings:
150 mA MAX @ Ext. Power supply voltage: 5 Vdc
250 mA MAX @ Ext. Power supply voltage: 6–60 Vdc

Relay driver power supply input rating:
20 mA MAX @ 60 Vdc

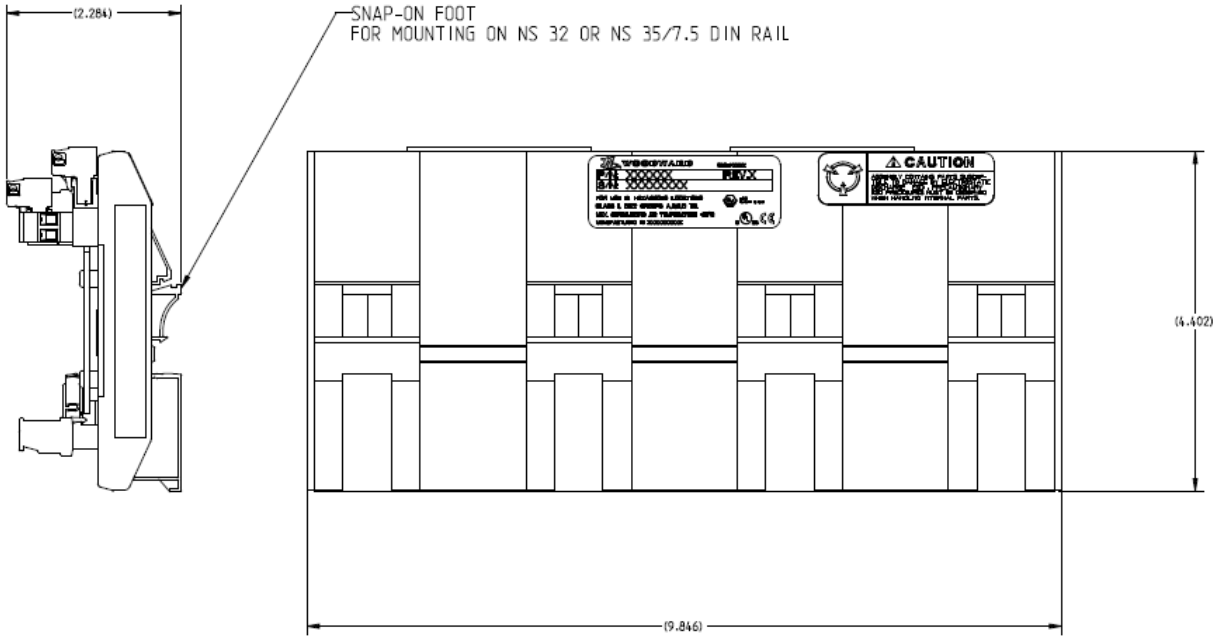


Figure 12-53. Discrete I/O (with LEDs) FTM Outline Drawings

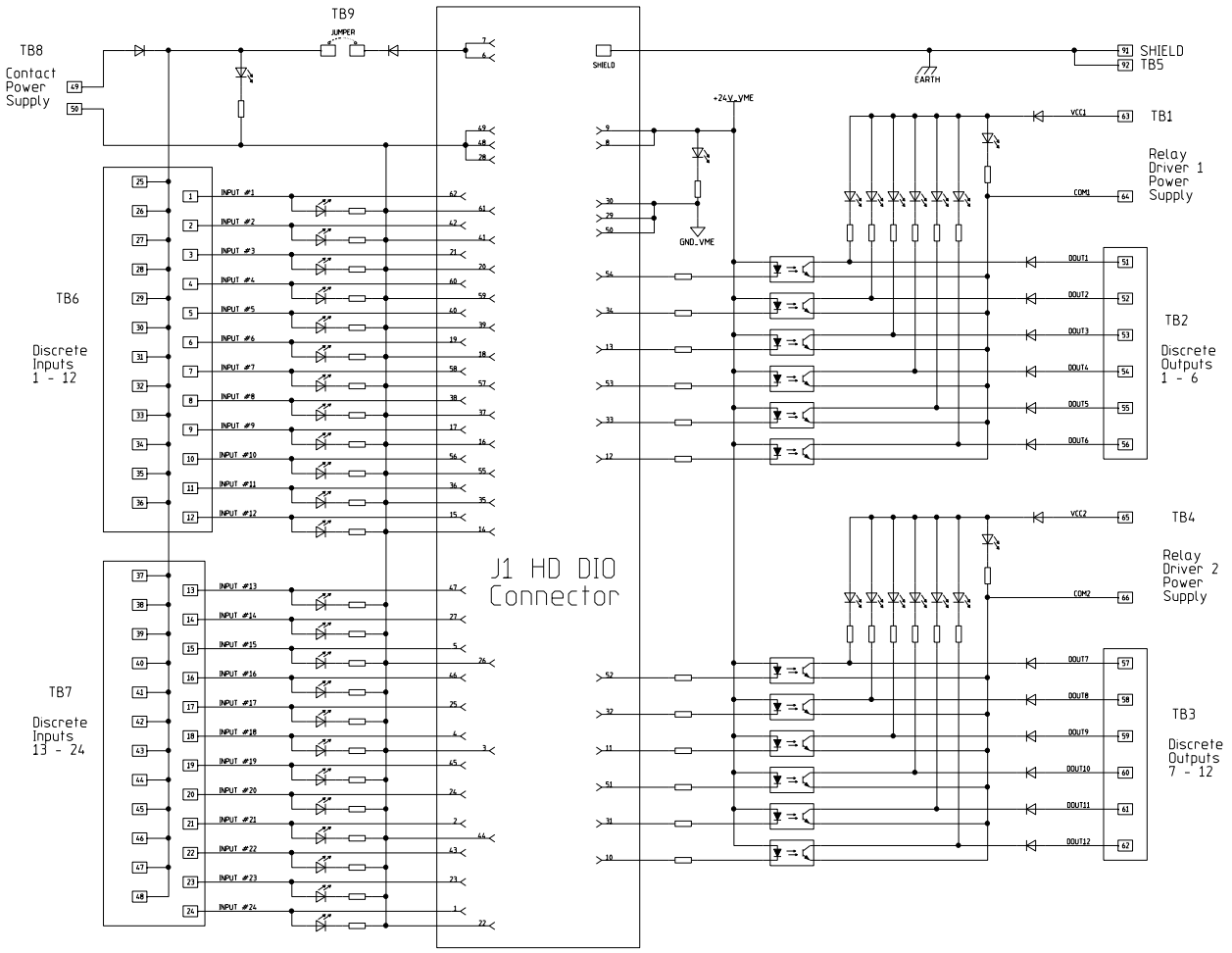


Figure 12-54. Discrete I/O (with LEDs) FTM Block Diagram

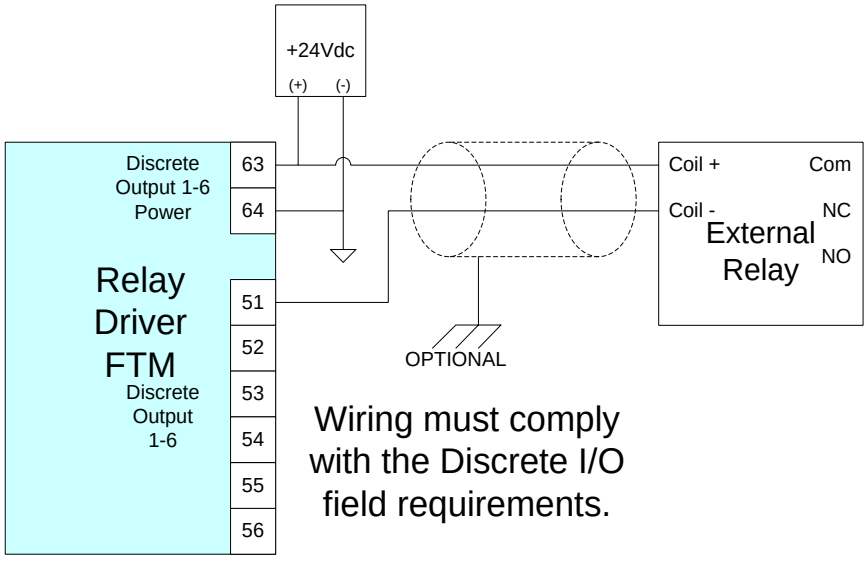


Figure 12-55. Discrete Output Relay Connection Example

IMPORTANT

The Internal or External Discrete Input contact wetting power source is protected via short circuit current limiting on-board the FTM. Because of this protection, the module cannot detect a power fault condition out at the FTM. The module does monitor its power source to the FTM, but the fault coverage only detects internal module faults. If the discrete input power is used for critical I/O, Woodward advises monitoring the voltage with one of the discrete inputs. This is accomplished by dedicating one discrete input for this monitoring purpose. Jumper that input so that it always reads logic high (TRUE). If the dedicated discrete input signal shows a logic level low (FALSE), the GAP application can flag that condition, and take appropriate action, as a power fault on the Discrete I/O FTM.

12.4 Relays

12.4.1 16 Channel Relay Module (Phoenix Contact)

⚠WARNING

This relay module is for use in ordinary or non-hazardous locations only.

This 16 Channel Relay Module (Phoenix Contact) can be used with several different discrete output modules (see Appendix A for the 16 channel Relay Module (Phoenix Contact) part number and applicable discrete output (DO) module part numbers). The 16 Channel Relay Module (Phoenix Contact) is connected to the DO Module via a Low Density Discrete Cable (See Appendix A for part numbers). It can then be daisy-chained to another relay module using another Low Density Discrete Cable if desired. The J1 connector connects to the DO module and the J2 connector connects to the J1 on the next relay module. This relay module incorporates an I/O lockout relay that will de-energize all of the relays if de-activated by the I/O lock signal from the DO module. All field connections use removable connectors for ease in replacing module in the field. All relays are field replaceable.

Figure 12-56. 16 Channel Relay Module (Phoenix Contact)

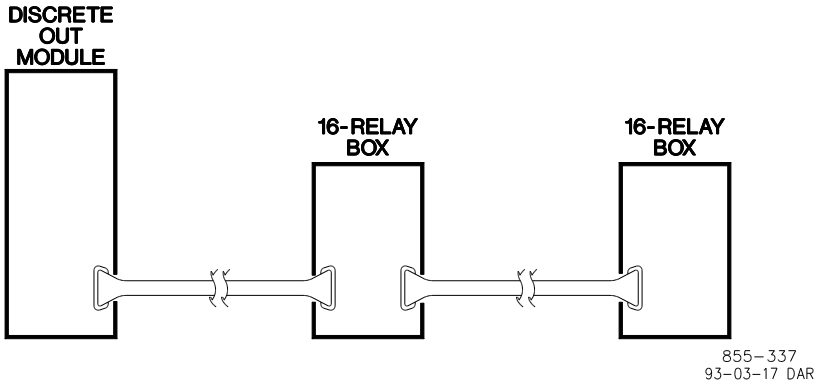


Figure 12-57. 16 Channel Relay Module (Phoenix Contact) Configuration

Replacement Relays (see Appendix A)

16 relays, DPDT, and draws 1.5 A @ 24 Vdc ±10% from its external power supply (with all 16 relays energized). It also has redundant power input capability.

Relay type:	Dust-tight with magnetic blow-out
Coil rating:	80 mA @ 24 Vdc, suppressor located on circuit board
Isolation:	1000 Vrms
Relay response time:	15 ms (operate and release)
Relay life expectancy:	50 000 operations @ rated load
Replaceability:	Relays are socket mounted and retained by a wire bail
Status indication:	Yellow LED - Relay energized
	Green LED - Relay power on
	Green LED - Control power on

The external power source connected to the relay contacts should be limited to 10 A to protect the circuit board.

Contact ratings:
5.0 A @ 240 Vac, 50/60 Hz (resistive) (meets UL ratings only)
3.0 A @ 240 Vac, 50/60 Hz (inductive) (meets UL ratings only)
10.0 A @ 120 Vac, 50/60 Hz (resistive) (meets UL ratings only)
6.0 A @ 120 Vac, 50/60 Hz (inductive) (meets UL ratings only)
600 watt @ 120 Vac, 50/60 Hz (lamp) (meets UL ratings only)
3.0 A @ 150 Vdc (resistive) (meets UL ratings only)
A @ 150 Vdc (inductive) (meets UL ratings only)
10.0 A @ 28 Vdc (resistive) (meets LVD and UL ratings)
3.0 A @ 28 Vdc (inductive) (meets LVD and UL ratings)

IMPORTANT

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.

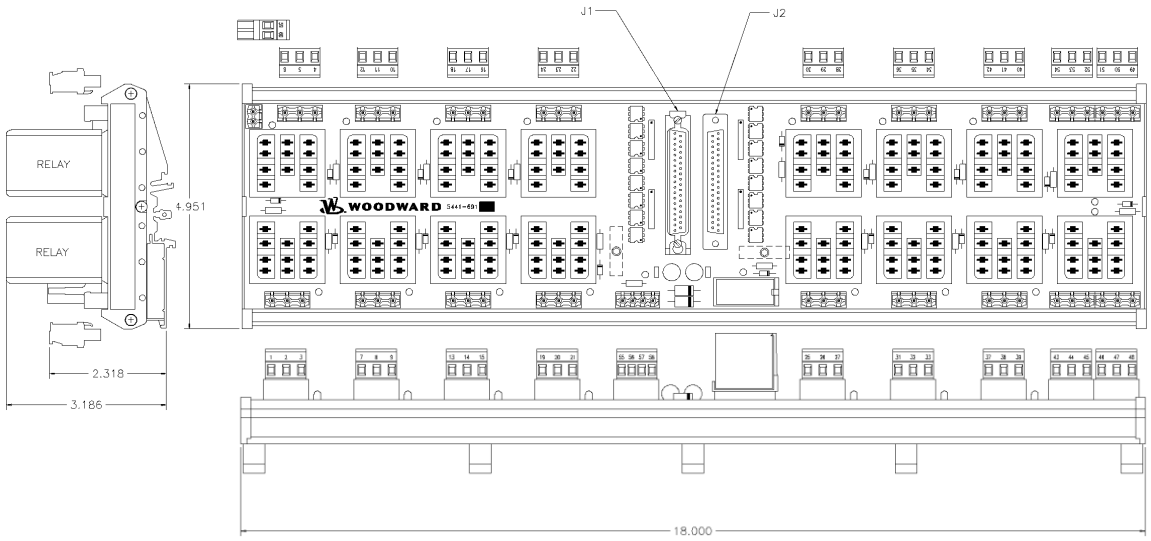


Figure 12-58. 16 Channel Relay Module (Phoenix Contact) Outline Dimensions

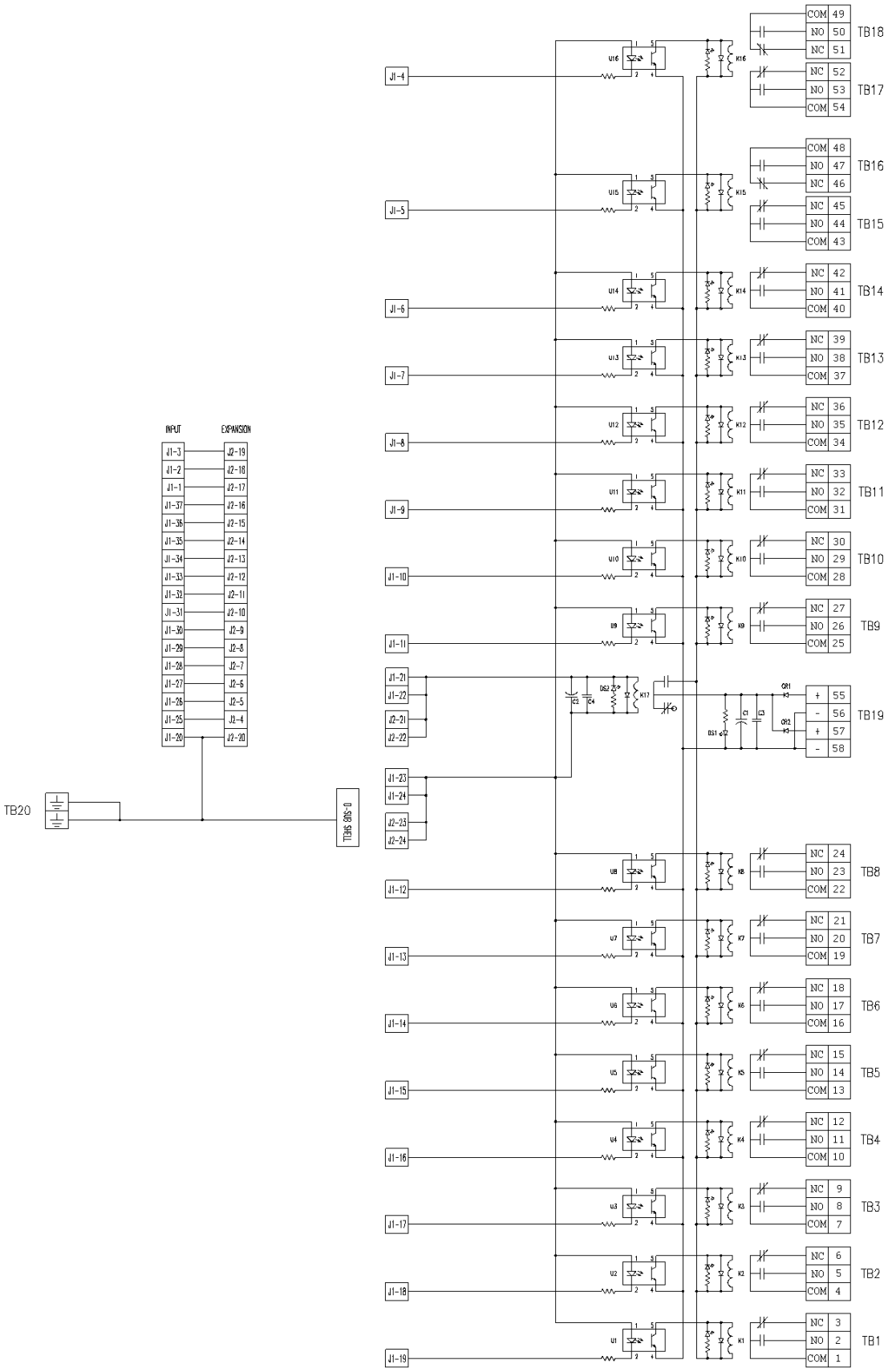


Figure 12-59. 16 Channel Relay Module (Phoenix Contact) Schematic

12.4.2 16 Channel Relay Module

WARNING

This relay module is for use in ordinary or non-hazardous locations only.

This relay module contains 16 field-replaceable relays (16 channels DPDT). It can be used with several different discrete output modules (see Appendix A for the 16 Channel Relay Module part number and applicable discrete output (DO) module part numbers). The 16 Channel Relay Module is connected to the DO Module via a Low Density Discrete Cable (See Appendix A for part numbers). If 32 relays are needed, the module can be daisy-chained to another relay module using another Low Density Discrete Cable. The J1 connector connects to the DO module and the J2 connector connects to the J1 on the next relay module. This relay module incorporates an I/O lockout relay that will de-energize all of the relays if de-activated by the I/O lock signal from the DO module.

Figure 12-60. 16 Channel Relay Module

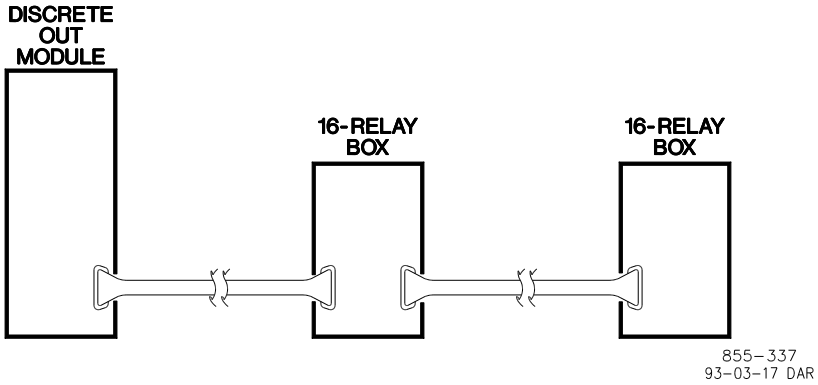


Figure 12-61. 16 Channel Relay Module Configuration

16 relays, DPDT, and draws 1.5 A @ 24 Vdc from its external power supply (with all 16 relays energized). It also has redundant power input capability.

Relay type:	Dust-tight with magnetic blowout
Coil rating:	80 mA @ 24 Vdc, suppressor located on circuit board
Isolation:	1000 Vrms
Relay response time:	15 ms (operate and release)
Relay life expectancy:	50 000 operations @ rated load
Replaceability:	Relays are socket mounted and retained by a wire bail
Status indication:	Yellow LED - Relay energized
	Green LED - Relay power on
	Green LED - Control power on

The external power source connected to the relay contacts should be limited to 10 A to protect the circuit board.

Contact ratings:
5.0 A @ 240 Vac, 50/60 Hz (resistive) (meets UL ratings only)
3.0 A @ 240 Vac, 50/60 Hz (inductive) (meets UL ratings only)
10.0 A @ 120 Vac, 50/60 Hz (resistive) (meets UL ratings only)
6.0 A @ 120 Vac, 50/60 Hz (inductive) (meets UL ratings only)
600 watt @ 120 Vac, 50/60 Hz (lamp) (meets UL ratings only)
3.0 A @ 150 Vdc (resistive) (meets UL ratings only)
A @ 150 Vdc (inductive) (meets UL ratings only)
10.0 A @ 28 Vdc (resistive) (meets LVD and UL ratings)
3.0 A @ 28 Vdc (inductive) (meets LVD and UL ratings)

IMPORTANT

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.

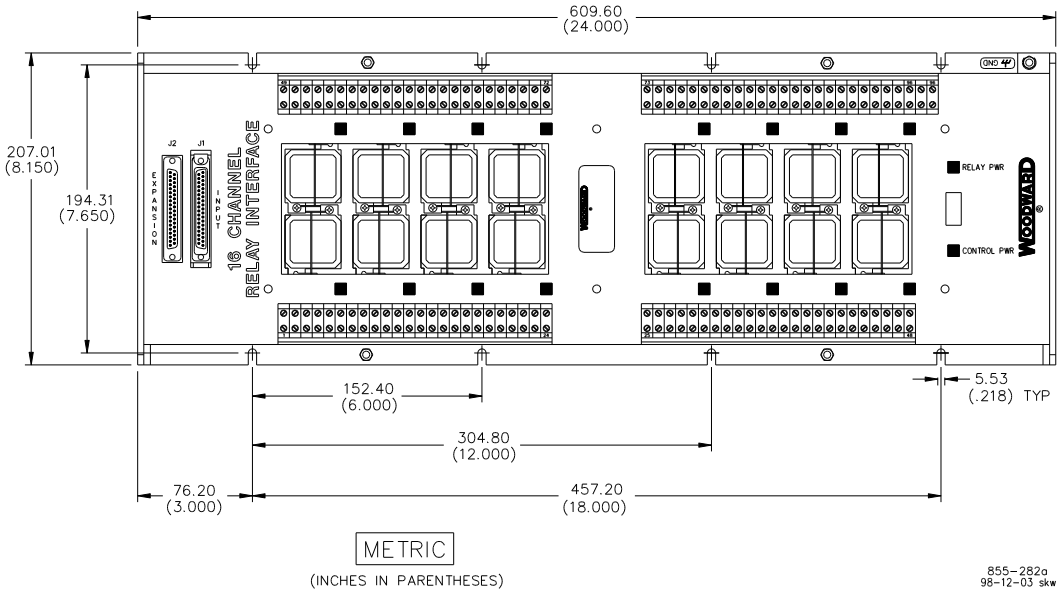


Figure 12-62. 16 Channel Relay Module Outline Dimensions

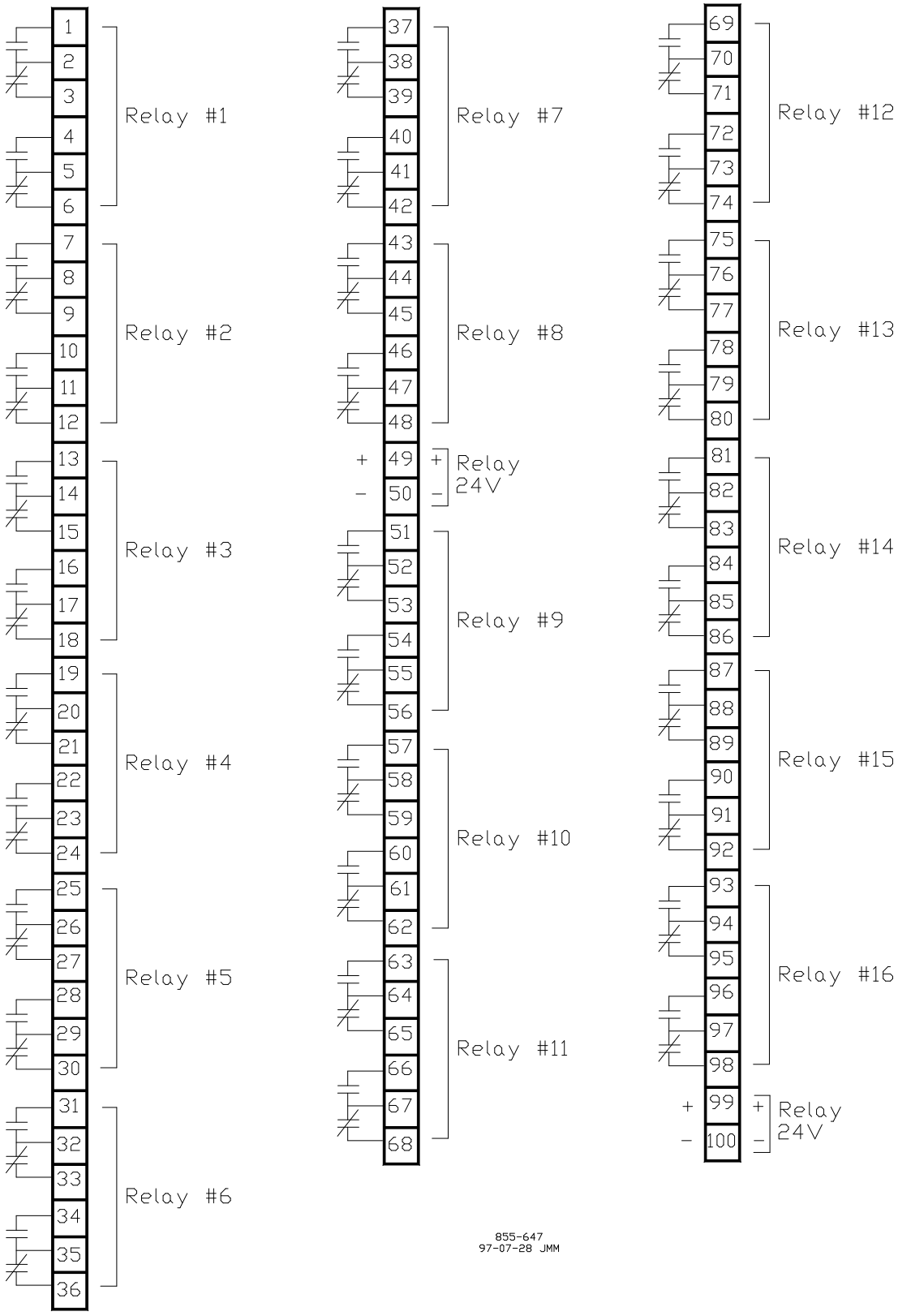


Figure 12-63. Relay Contact Connections for a 16 Channel Relay Box

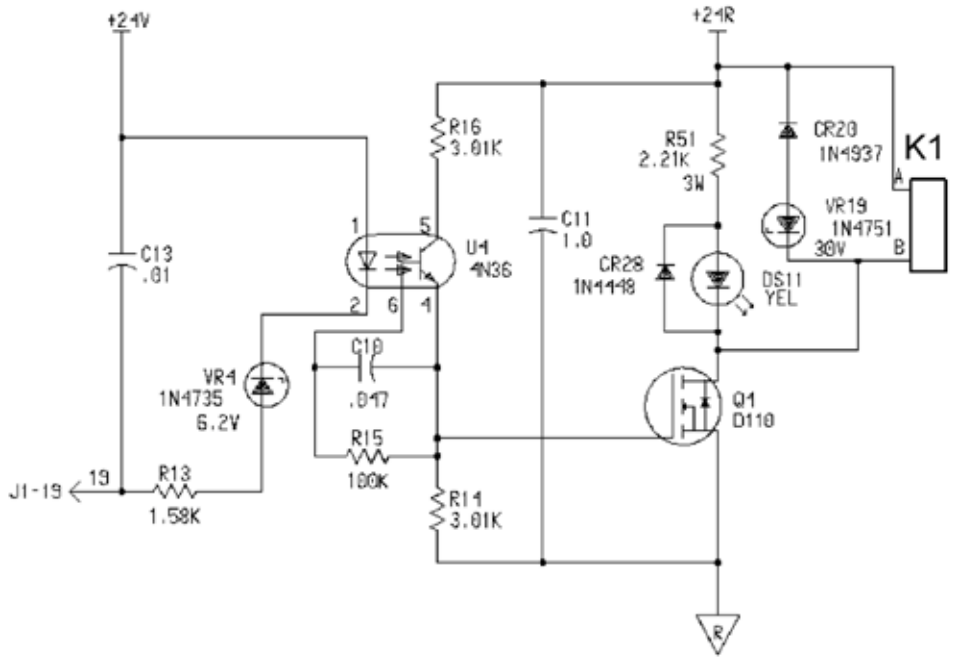


Figure 12-64. Typical 16 Channel Relay Module Relay Driver Circuit (K1)

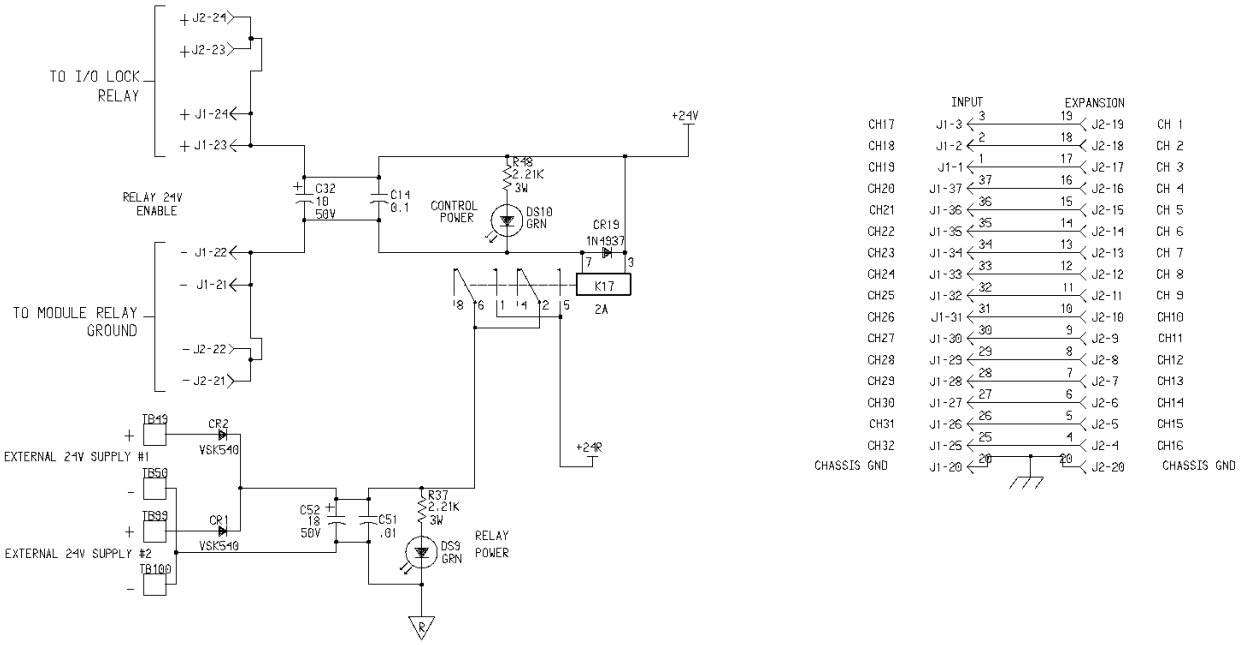


Figure 12-65. 16 Channel Relay Module I/O Lock and Second Relay Module Feedthrough Circuits

12.4.3 32 Channel Relay Module (with 2 amp DPDT relays)

IMPORTANT

This 32 Channel Relay Module is approved for use in MicroNet applications for hazardous locations: Class I, Division 2, Groups A, B, C, and D.

This 32 Channel Relay Module contains 32 relays (32 channels SPDT) that are not field-replaceable. There are two types of relays offered depending on the part number of the module. Consult Woodward for additional information regarding the 2 amp relay version.

This relay module can be used with several different discrete output modules (see Appendix A for the 32 Channel Relay Module part number and applicable discrete output (DO) module part numbers). The 32 Channel Relay Module is connected to the DO Module via a Low Density Discrete Cable (See Appendix A for part numbers). This relay module incorporates an I/O lockout relay that will de-energize all of the relays if de-activated by the I/O lock signal from the DO module.

The 32-relay module draws 3.9 A @ 24 Vdc from its power supply (with all 32 relays energized). De-rating curves must be applied in applications using the 32 Channel Relay Module.

Input Power Rating:	18–32 Vdc, 3.9 A
Relay type:	Hermetically sealed
Coil rating:	80 mA @ 24 Vdc, suppressor located on circuit board
Isolation:	1000 Vrms
Relay response time:	15 ms (operate and release)
Relay life expectancy:	50 000 operations @ rated load
Replaceability:	Individual relays not field replaceable
Status indication:	Yellow LED - Relay energized
	Green LED - Relay power on
	Green LED - Control power on

Contact ratings:
3.0 A @ 120 Vac, 50/60 Hz (resistive) (meets UL ratings only)
2.0 A @ 120 Vac, 50/60 Hz (inductive) (meets UL ratings only)
60 Watt @ 120 Vac, 50/60 Hz (lamp) (meets UL ratings only)
10.0 A @ 28 Vdc (resistive) (meets LVD and UL ratings)
3.0 A @ 28 Vdc (inductive) (meets LVD and UL ratings)

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

The device(s) must be wired in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.

⚠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.

⚠ 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.

Relay Interface De-rating

The relays must be prevented from exceeding their maximum operating temperature specification of 125 °C that can happen under certain conditions of ambient temperature, coil voltage, and contact current. No de-rating is necessary at coil voltages of 24 Vdc and ambient temperatures below 47.5 °C. At higher coil voltages, fewer relays can be energized or contact current must be reduced (or combination thereof). All relays can be energized at 24 Vdc and carry 7 A at ambient temperatures up to 55 °C outside the interface enclosure. The accompanying de-rating curves (Figure 12-45) can be used to help determine if your relay application is within operating limits. The left vertical axis is the ambient temperature. The family of curves is made up of lines of constant coil voltage at various contact currents. The family of diagonal bold lines is for a given numbers of relays energized. The horizontal line marked "55 °C ambient..." is the limit line. Your operating point should be less than 55 °C.

To establish an operating point for your applications, determine the maximum number of relays that will be energized simultaneously for more than a few minutes. Find the diagonal bold lines on the de-rating chart corresponding to number of relays "ON" above and below your number. Interpolate horizontally between lines and sketch in your own line. You may also round up the number to correspond to a line. Next, determine the supply voltage to the relay coils and an average contact current. Find the curves corresponding to your coil voltage and estimate a curve for your average contact current. The intersection of the estimated curve and the diagonal line for the number of energized relays must be less than 55 °C.

If the intersection is above the 55 °C limit the ambient must be de-rated to the indicated temperature.

Example: What would the maximum ambient rating be for the following characteristics? (15) relays "ON", Average contact current of 5 A, Coil voltage of 32 Vdc.

Answer: Approximately 37 °C. The ambient must be limited to a maximum of 37 °C, or the Relay Interface power must be reduced by decreasing the number of relays "ON", coil voltage, contact current, or combination of these.

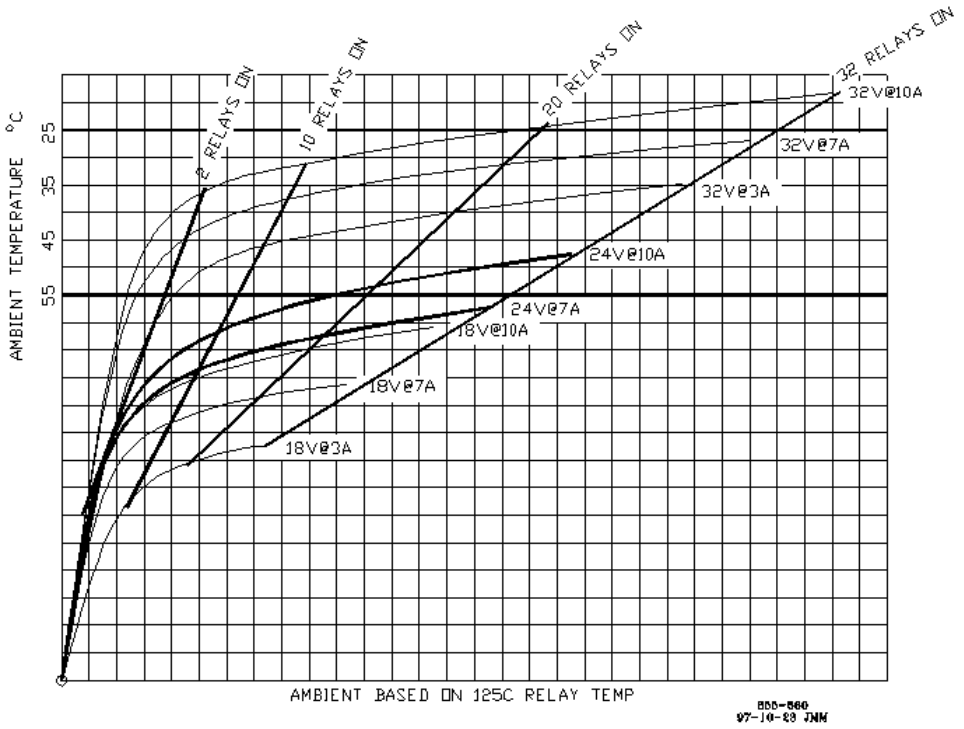


Figure 12-66. 32 Channel Relay Module De-rating Curves

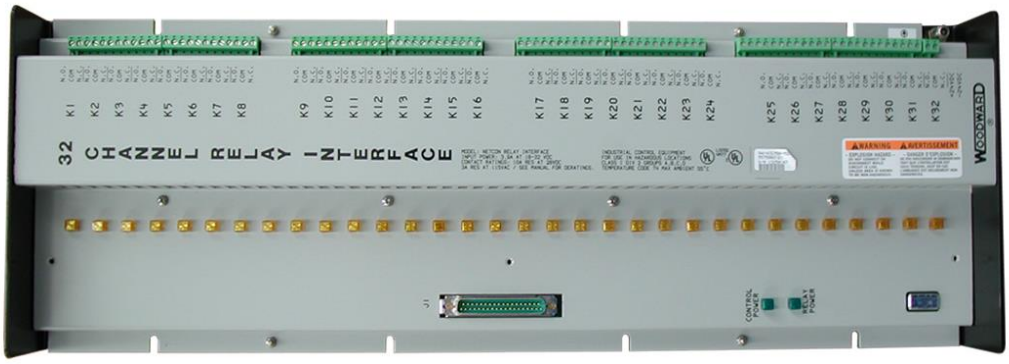


Figure 12-67. 32 Channel Relay Module

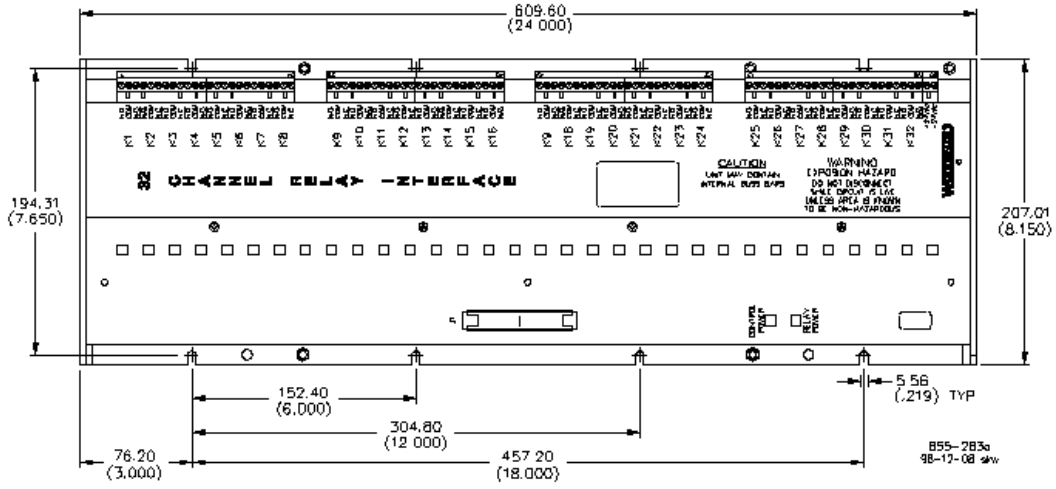


Figure 12-68. 32 Channel Relay Module Outline Dimensions

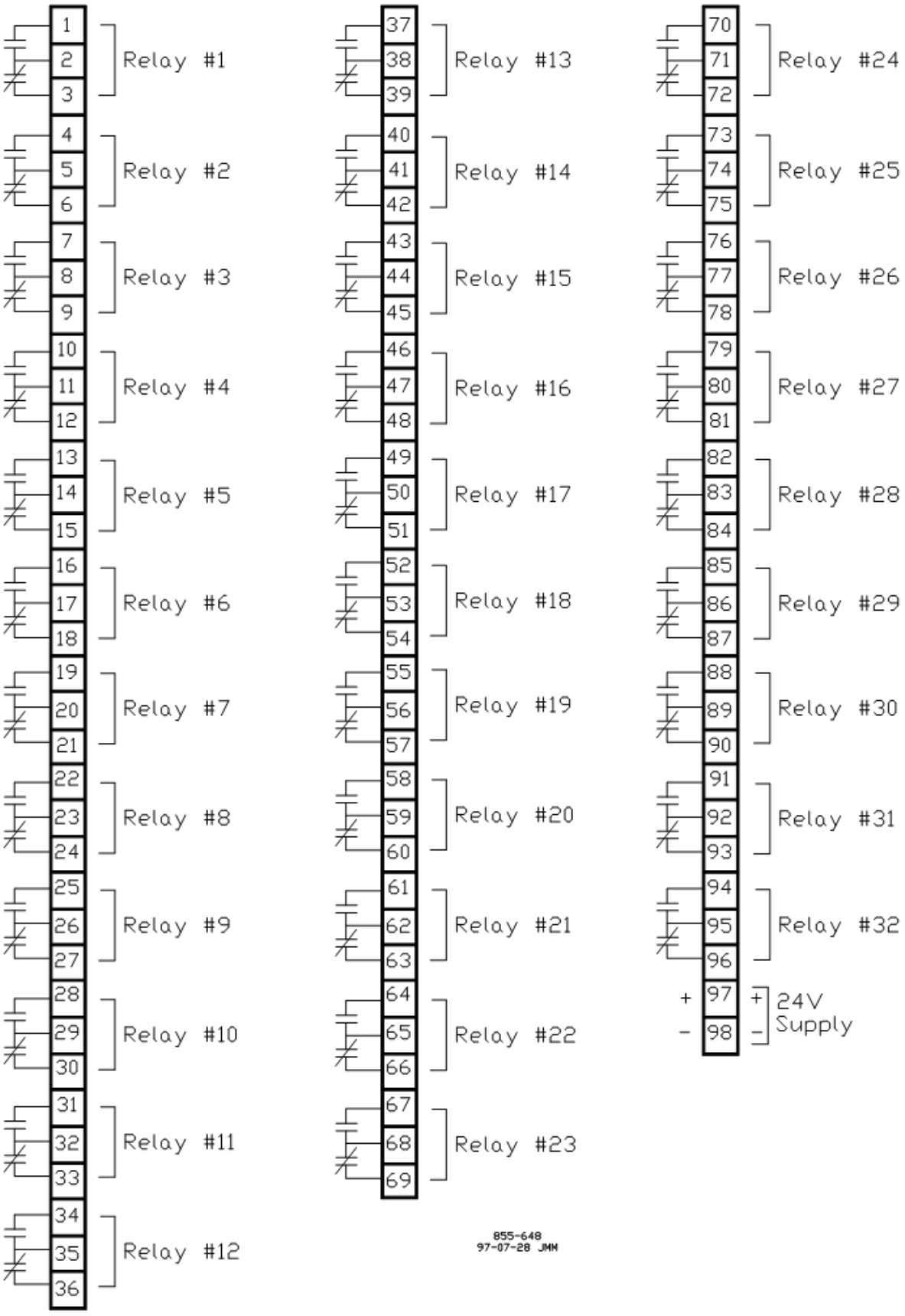


Figure 12-69. Relay Contact Connections for a 32 Channel Relay Module

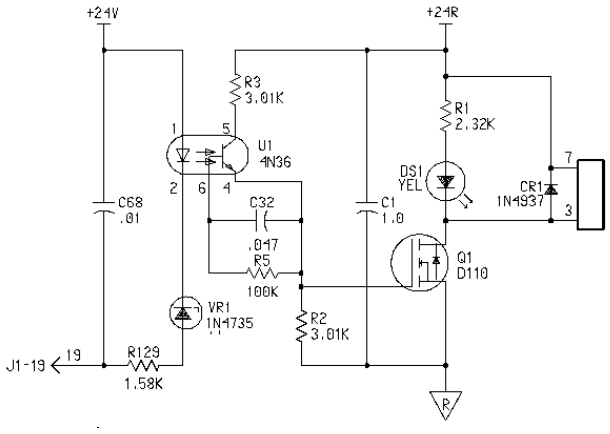


Figure 12-70. Typical 32 Channel Relay Module Driver Circuit (K1).

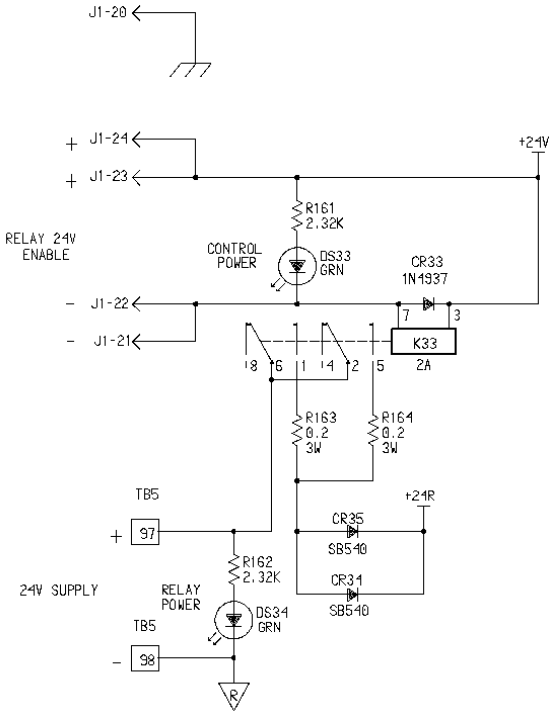


Figure 12-71. 32 Channel Relay Module I/O Lock Circuit.

12.5 Service Panel

Information on this section is in Volume 3, Chapter 7.

12.6 CPU Interfaces

Information on this section is in Volume 3, Chapter 7.

Chapter 13.
Distributed I/O Network

See Woodward manual 26640 for detailed information on the RTCnet and LINKnet HT distributed I/O modules.

Chapter 14.
Installation Procedures

14.1 Pre-Installation Information

14.1.1 Storage

Store MicroNet controls and associated parts between –20 and +70 °C (–4 and +158 °F) at a maximum relative humidity of 90% non-condensing. If modules (especially power supplies) are to be stored for a long time, apply operating power to them at least once every 18 months. This is done to re-form the aluminum electrolytic capacitors, and will prevent them from overheating upon initial power up after extended storage.

14.1.2 Unpacking

Unpack each part of the system carefully. Check the units for signs of damage, such as bent or dented panels, scratches, or loose or broken parts. If any damage is found, notify the shipper immediately.

14.1.3 Unit Location

Consider the following when selecting a cabinet location for mounting the MicroNet:

- Make sure the MicroNet unit(s) are mounted in a dry location, protected from water and condensation.
- Make sure the ambient temperature of the system location is not lower than 0 °C (32 °F) or higher than 55 °C (131 °F) and that the relative humidity is not over 90%, non-condensing. (**NOTE**—For NTCPU 0–50 °C)
- Provide adequate ventilation for cooling the units. If the units must be mounted near heat-producing devices, shield them from the heat.
- Do not install the units or their connecting wires near high-voltage, high-current devices or inductive devices. If this is not possible, shield both the system connecting wires and the interfering devices and wires.
- If the selected location does not already have a conductor to a good earth ground, provide one.
- This equipment is suitable for Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only. The 24/12 and 16 channel relay modules are for use in ordinary or non-hazardous locations only.

14.2. Installation Procedures

⚠WARNING

EXPLOSION HAZARD—Do not remove or install modules while circuit is energized unless area is known to be non-hazardous.

⚠AVERTISSEMENT

RISQUE D'EXPLOSION—Ne pas enlever ni installer les cartes pendant que le circuit est sous tension sans s'assurer que la zone est non dangereuse.

14.2.1 Installing a VME I/O Module into an Unpowered Chassis

IMPORTANT

Before installing a module, check for broken connectors and bent pins.

1. Be sure that each module is installed in the correct slot. There are no keys to keep a module from being installed in the wrong slot. To aid in proper module placement, the module slots are labeled with the slot number. Prior to installing, verify that all VME connector pins on the rear of the module are parallel and straight.

2. Align the circuit board edges in the card guides and re-position the two captive-screw fasteners as necessary to prevent interference when the module is inserted. Install the module by aligning the circuit board edges inside the card guides and pushing the module straight in until it is approximately 25 mm (1 inch) from the motherboard. (**Do not make contact with the chassis motherboard mating connectors**.)

3. With even pressure exerted at the top and bottom of the module, in one continuous motion, fully seat the module into the motherboard.

IMPORTANT

If resistance is encountered when installing a module, do not force the module. Remove the module and check the connectors for bent contacts or foreign objects. Also check to ensure that the module screws are fully retracted. Forcing a module into place may break the connector or bend the securing screws.

4. Tighten the two screws that secure the module in place (one at the top and one at the bottom).

5. See “section 15.8—Replacing a VME I/O Module” below for replacing a module previously installed into functional a system.

14.2.2 MicroNet Simplex Installation Notes and Warnings

⚠WARNING

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

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

The 24/12 and 16 channel relay modules are for use in ordinary 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.

14.2.3 Installing a MicroNet Simplex Power Supply Module

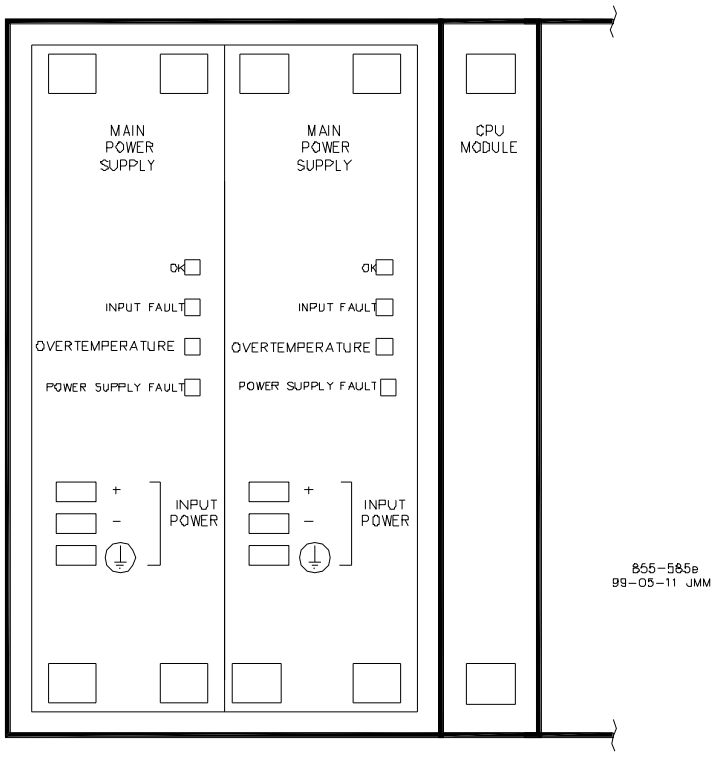


Figure 14-1. MicroNet Power Supply

Installing a Power Supply (PA1, PA2)

1. Be certain power to the supply being installed is disconnected. Verify that all pins in the module connectors are parallel and straight.
2. Install a new power supply by aligning the circuit board edges in the card guides, then pushing the unit into the slots until the connectors on the modules and the connectors on the motherboard make contact.
3. With even pressure exerted at the top and bottom of the supply's front panel, firmly push the unit into place.
4. Tighten the screws that secure the module in place.

IMPORTANT

If resistance is encountered when installing a module, do not force the module. Remove the module and check the connectors for bent contacts or foreign objects. Also check to ensure that the module screws are fully retracted. Forcing a module into place may break the connector or bend the securing screws.

14.2.4 Installing the 16/32 Channel Relay Boxes

The system's relay boxes mount on a panel (not provided). Mount the relay boxes within the length of the provided cable from the control's main chassis, leaving adequate service loop.

1. Mark the location of the relay box and the locations of the holes to be drilled to mount it. Figures 14-2 and 14-3 are outline drawings of the relay boxes.
2. Drill and tap holes for appropriately sized hardware.
3. Place the relay box in position. Place the mounting screws into the holes that were drilled and tapped, and tighten them securely.

4. The mounting panel should be well grounded to protective earth via the cabinet structure or ground straps that are low RF impedance. Low RF impedance: length not greater than 4 times the cross-sectional circumference of the ground strap.
5. Additionally, the insulation on the cable between the FTM or relay box and the VME Module may have the insulation removed and a metal “P-clip” used around the cable to ground it within approximately 300 mm (12 inches) of the relay box connector.
6. If your system includes a second relay box, repeat the above steps for the second relay box.
7. After the FTM, the VME module, and the relay box(es) are installed, the cables that connect them may be installed.

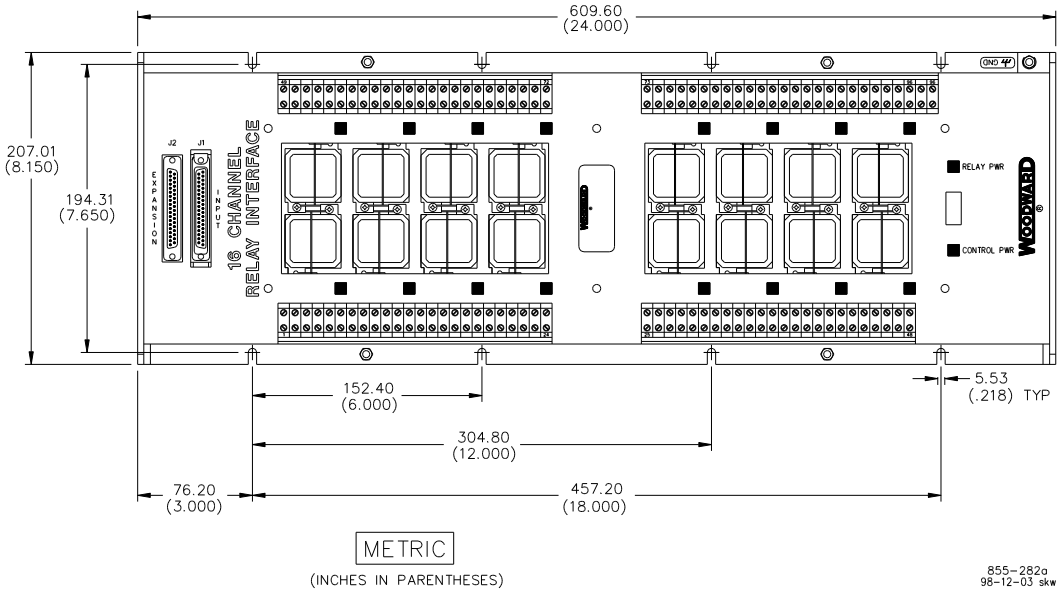


Figure 14-2. 16 Channel Relay Box Outline Drawing

Note: For use in ordinary or non-hazardous locations only.

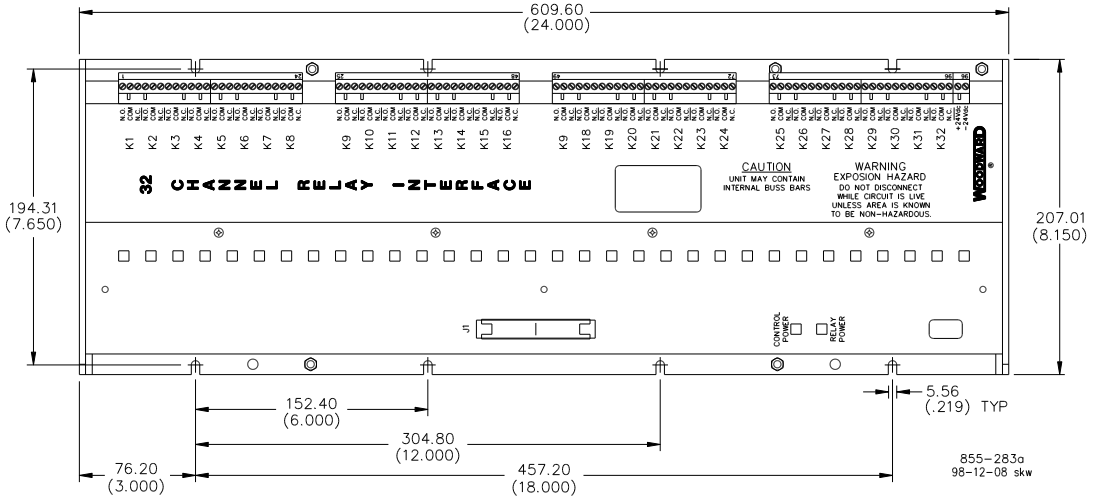


Figure 14-3. 32 Channel Relay Box Outline Drawing

Note—Listed for use in hazardous locations (Class I, Division 2, Groups A, B, C, D)

Conditions of UL Acceptability for 32 Channel Relay Box:

1. The devices must be installed in compliance with the enclosure, mounting, spacing, and segregation requirements of the ultimate application.
2. The device(s) must be wired in accordance with Class I, Division 2 wiring methods and in accordance with the authority having jurisdiction.

14.2.5 Installing the FTMs

The system's Field Terminal modules (FTMs) mount on a standard DIN (35 x 7.5) rail (not provided). Mount FTMs within the length of the provided cable from the control's main chassis, leaving an adequate service loop.

1. Cut a DIN rail strip to the desired length and mount it to a panel. Leave sufficient space between the DIN rail and other objects for accessibility.
2. Drill and tap at least two holes per 300 mm (12 in) for appropriately sized hardware, and secure the DIN rail using screws and washers.
3. The mounting panel should be well grounded to protective earth via the cabinet structure or ground straps that are low RF impedance. Similarly the DIN rail should be well grounded to the panel. Low RF impedance: length not greater than 4 times the cross-sectional circumference of the ground strap.
4. Verify that the DIN rail is at earth ground potential (connected to a panel that is at earth ground potential). If the DIN rail is not at earth ground potential, connect it to earth ground via a 4 mm² (12 AWG) green/yellow wire or braid, keeping the wire or braid as short as possible.
5. Snap the FTMs onto the DIN rail.
6. Snap ground terminals onto the DIN rail next to the FTMs. See Figure 19-7.
7. Connect a 4 mm² (12 AWG) wire between each ground terminal and the FTM earth ground terminal. Torque to 0.5 to 0.8 N·m (0.37 to 0.59 ft. lb.). This wire should be kept short for optimum high frequency grounding. It must be no longer than 150 mm (6 in) in length.
8. Additionally in some cases, the insulation on the cable between the FTM or relay box and the VME Module may have the insulation removed and a metal "P-clip" used around the cable to ground it within approximately 300 mm (12 inches) of the relay box connector. (When not required, it is also an option to have both 7 and 8 implemented.)
9. After both the FTM and the module are installed, the cables that connect them may be installed.

Wiring Notes

It is recommended that 0.5 mm² (20 AWG) or larger twisted, shielded wire be used between each external device and FTM.

- Shields inside the Cabinet housing the MicroNet should be connected to earth ground at all intermediate terminal blocks, as well as terminated at the control terminal block. The length of exposed wire extending beyond the shield should be limited to 25.4 mm (1 in).
- Cable shields must be electrically continuous from the signal source to the point the signal wire enters the FTM.
- FTM terminals accept wires from 0.25–2.5 mm² (24–12 AWG) wire. Two 0.75 mm² (18 AWG) or three 0.5 mm² (20 AWG) wires can be installed in each terminal. Torque 0.5 to 0.8 N·m (0.37 to 0.59 lb-ft).
- Take care to prevent ground loop wiring when interfacing to other devices.
- Shields should be terminated to the cabinet at the entrance/exit point with a grounding bar or similar low impedance ground. The ground bar may be either a direct connection to the cabinet frame protective earth or an AC (capacitor ~0.01 µF) connection where 0.01 µF capacitors are between the bar and cabinet frame/panel every 150–200 mm (6–8 inches) of bar length. Shield terminations should only be directly grounded to chassis at one end, preferably the MicroNet Cabinet end.
- Do not place shielded wires in the same conduit as high voltage or large current-carrying cables.

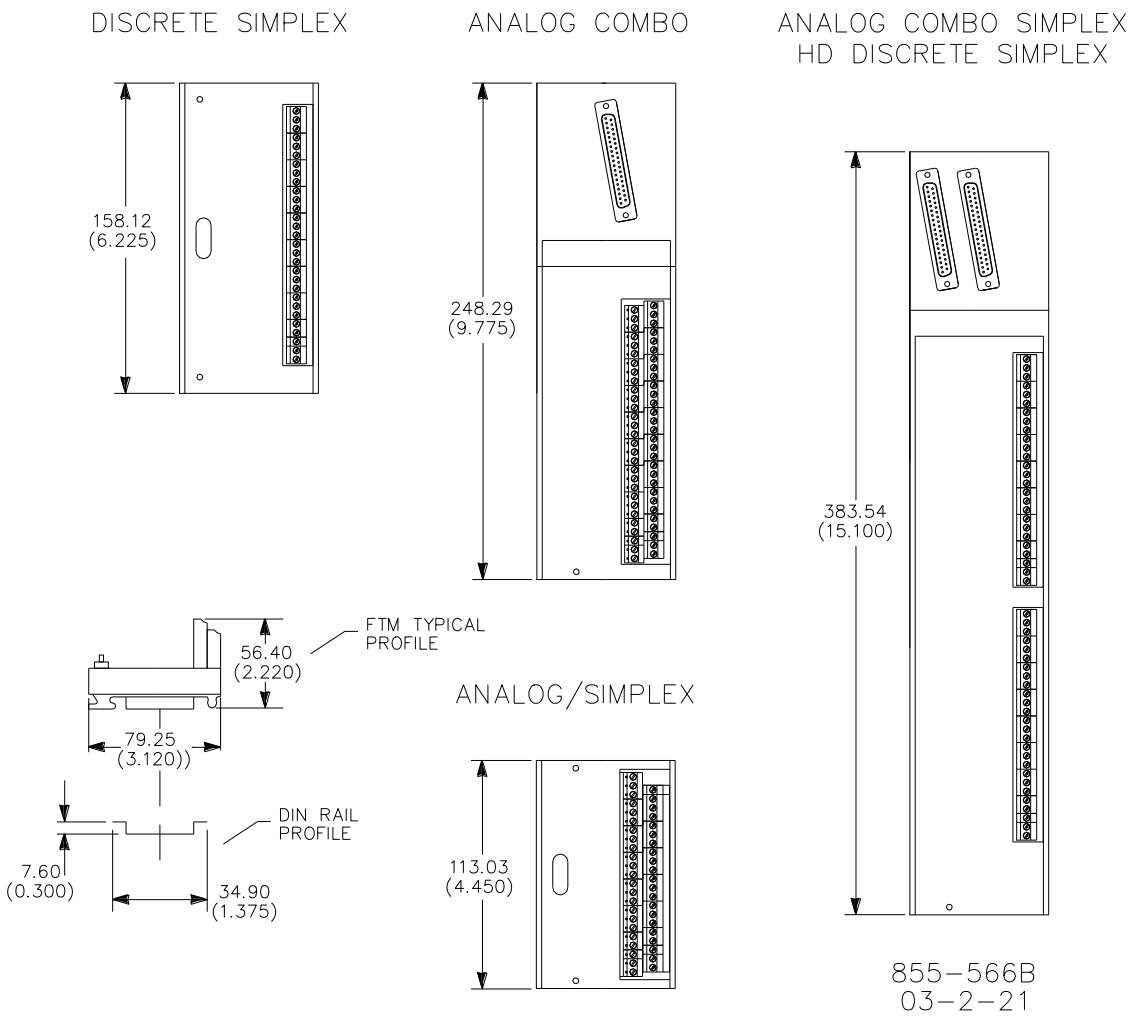


Figure 14-4. FTM Grounding and Outlines

14.2.6 Shields and Grounding

WARNING

Do not connect chassis ground or PE ground to signal common.

An individual shield termination is provided at the terminal block for each of the analog inputs and analog outputs. All of the analog inputs and outputs should be wired using shielded, twisted-pair wiring. The shields should be connected to earth ground at all intermediate terminal blocks, as well as terminated at the FTM terminal block; which will typically AC couple the shield to earth ground. The length of exposed wire extending beyond the shield should be limited to 25 mm (1 inch).

Discrete Input wiring leaving the cabinet housing the MicroNet should be grouped together based on field signal source location and be shielded as a group. The shield termination should be to the chassis ground on the cabinet housing the MicroNet system; the shield termination should only be to the MicroNet's cabinet. The Discrete Inputs should also have a common wire (Wetting voltage common), grouped with them inside the shield. The field end of the common wire should be un-terminated, unless wetting voltage is provided remotely in the field.

Relay Driver/Discrete Output wiring leaving the cabinet housing the MicroNet should also be grouped together based on field relay coil or input location and be shielded as a group. The shield termination should be to the chassis ground on the cabinet housing the MicroNet system; the shield termination should only be to the MicroNet's Cabinet. The Discrete Output wires should also have a common wire (coil voltage common), grouped with them inside the shield. The field end of the common wire should be un-terminated, unless coil voltage is provided remotely in the field.

DI & DO 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.

Unshielded field I/O cables may only be used inside the cabinet 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.

If the panel that the control chassis and FTMs are mounted on is not at earth ground potential, connect it to earth ground via a 4 mm² (12 AWG) green/yellow wire or braid, keeping the wire or braid as short as possible. The mounting panel should be well grounded to protective earth via the cabinet structure or ground straps that are low RF impedance. Low RF impedance: length not greater than 4 times the cross-sectional circumference of the ground strap.

For compliance with EMC standards, it is required that all analog and discrete input/ output wiring be separated from all power wiring. Power wiring leaving the cabinet housing the MicroNet may couple noise if not segregated and routed directly against the grounded metal of the cabinet & mounting plates. If segregation is not possible, a line filter of at least 20 dB attenuation is needed.

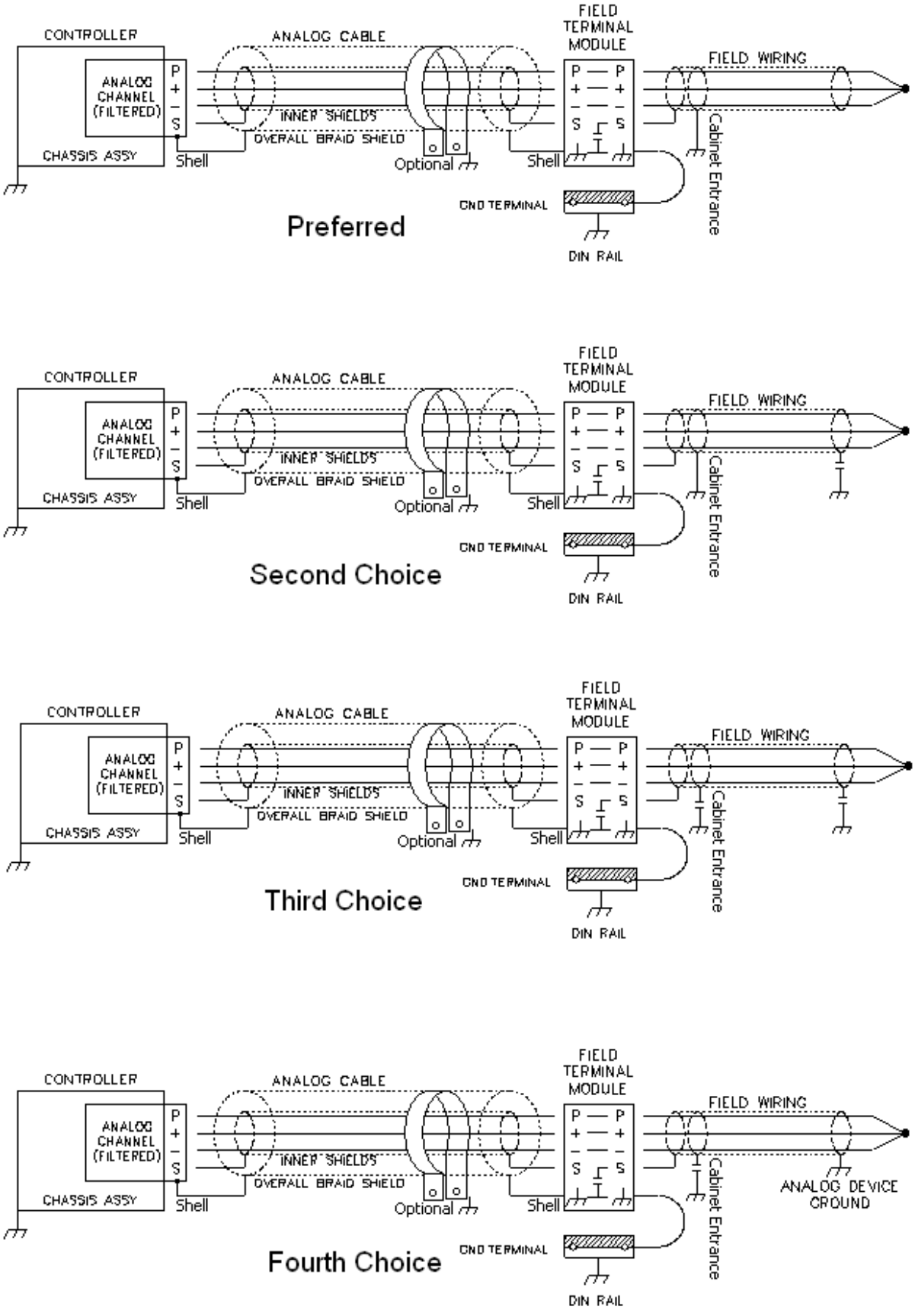


Figure 14-5. Analog Shield Termination Diagram Example

Some ways DGND to Protective Earth referencing happens are as follows:

- Connecting DGND to Protective Earth directly in the field device.
- Connecting multiple cable shields directly to protective earth at the field devices, with cable runs and device to control separation longer than 30 m (99 feet).
- Connecting DGND to Protective Earth indirectly, AC coupling, via intentional filter capacitance.
- Connecting the field device's power or its power reference to Protective Earth with transient limiting devices like a Metal Oxide Varistor or Transient Voltage Suppression Diode.
- Stray Coil capacitance from the actuator coil to the shaft or housing on multiple actuators and grounding the shaft or housing due to the attachment mechanisms.

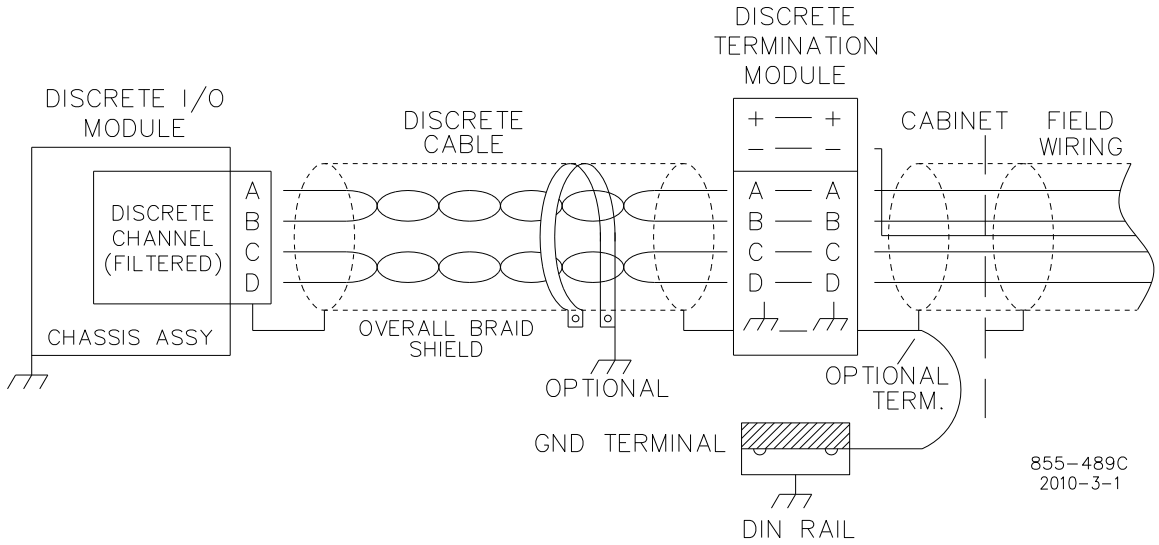


Figure 14-6. Discrete Cable Grounding Diagram Example

14.2.7 Cabinet Structural Grounding

Non-EMC Enclosure Application Information

- The cabinet needs to be a six-sided metal enclosure.
  - Do not use cabinet doors with unshielded windows—doors should be solid metal.
- If a window in the cabinet door is needed, the window must provide >20 dB of RF attenuation from 10 kHz to 1 GHz.
- The enclosure floor and/or top must provide holes for cable entry, only the floor or top panels may be used.
- Cable entry aperture areas must be restricted in size. The largest dimension of any cable entry aperture (hole) is no greater than 152 mm (6 inches). This is particularly important when RF transmitters, like push to talk radios or cell phones, can be located near the cable access areas.
- When RF transmitters (hand-held radios) can be located below the plane of the floor, in the metal cableway area, floor entry areas shall be restricted in size, with largest dimension no greater than 152 mm (6 inches).
- When RF transmitters (hand-held radios) cannot be located below the plane of the floor, in the metal cableway area, no floor entry areas restrictions are required.
- An enclosed metal cable area or cable way joining to the cabinet may be thought of as part of the enclosure; if it has no holes larger than 152 mm
  (6 inches) and no RF transmitters can be present within it. This allows larger holes in the enclosure cable access plate. The enclosed cableway effectively becomes part of the enclosure.
- The cabinet enclosure frame and mounting areas must be bonded (grounded) together.
- Frame shall be electrically connected at each structural interface (<2.5 mΩ).
- Mounting plates shall be electrically connected to structural frame
  (<2.5 mΩ).
  - Four places minimum, six places preferred — four corners + two mid-points preferred.

- Cabinet doors must be electrically connected to the main structural frame (<2.5 mΩ).
  - Two places minimum, three places preferred, use of 25 mm (1 inch) wide bond straps is preferred.
  - Install bond straps at the locations that I/O cables cross the door hinge. If no cables cross the hinge point, locate bond straps to break up the size of gaps/openings in the metal structure to door interface.
- Cover panels shall be electrically connected to structural frame (<10 mΩ).
  - One place minimum, two places preferred (placed at opposite sides).
- Floor and top panels must be electrically connected to structural frame (<2.5 mΩ).
  - Two places minimum, four places at the corners preferred.
- DIN rail must be electrically connected to structural frame (<2.5 mΩ).
  - Once every 300 mm (12 inches), use a minimum of two screws to bond a DIN rail to cabinet frame.
- The cabinet must provide a shield termination point for cables as they enter the enclosure. Shielded I/O shields must be either AC or DC terminated directly to the cabinet (earth ground) at the entry to the cabinet, as well as connected to the FTM shield pins.

EMC Enclosure Application Information

- The cabinet needs to be a six-sided EMI shielded metal enclosure. The interior surfaces must be conductive and coated with corrosion protection treatments.
- Do not use cabinet doors with windows—doors should be solid metal.
- The enclosure floor and/or top must provide holes for cable entry; only the floor or top panels may be used.
- Cable entry aperture areas must be restricted in size. The largest dimension of any cable entry aperture (hole) is no greater than 152 mm (6 inches). This is particularly important when RF transmitters, like push to talk radios or cell phones, can be located near the cable access areas.
- When RF transmitters (hand-held radios) can be located below the plane of the floor, in the metal cableway area, floor entry areas shall be restricted in size, with largest dimension no greater than 152 mm (6 inches).
- When RF transmitters (hand-held radios) cannot be located below the plane of the floor, in the metal cableway area, no floor entry areas restrictions are required.
- The cabinet enclosure frame and mounting areas must be bonded (grounded) together.
- Frame shall be electrically connected at each structural interface (<2.5 mΩ).
- Mounting plates shall be electrically connected to structural frame (<2.5 mΩ).
  - Four places minimum — four corners + two mid-points preferred.
- Door must be electrically connected to the main structural frame (<2.5 mΩ) and must be mounted to contact an EMI gasket all the way around the perimeter when the door is closed.
- Cover panels shall be electrically connected to structural frame (<10 mΩ) and must be mounted to contact an EMI gasket all the way around the perimeter when the panel is mounted.
- Floor and top panels must be electrically connected to structural frame (<2.5 mΩ) and must be mounted to contact an EMI gasket all the way around the perimeter when the panel is mounted.
- DIN rail must be electrically connected to structural frame (<2.5 mΩ).
  - Once every 300 mm (12 inches), use a minimum of 2 screws to bond a DIN rail to cabinet frame.
- The cabinet must provide a shield termination point for cables as they enter the enclosure. Shielded I/O shields must be either AC or DC terminated directly to the cabinet (earth ground) at the entry to the cabinet, as well as connected to the FTM shield pins.

14.2.8 Cable Entry Locations

- Cable shield termination hardware must be installed at cable entry points.
- Cable shield terminations must be electrically connected to structural frame (<2.5 mΩ), and shall allow direct grounding or AC (capacitive) grounding of cable shields.

14.2.9 Equipment Zoning (Segregation)

Separate the equipment inside the cabinet into areas:

- Analog equipment area
- Discrete I/O equipment areas
- Shielded I/O area
- Un-shielded I/O area
- Power area
- Light Industrial compliant equipment area
- Monitor/keyboard/pointing device (HMI if applicable)
- Other equipment area

Maintain a minimum of 152 mm (6 inches) of separation between areas

14.2.10 Input Power Routing and Filtering

- Input power must enter the cabinet and be routed separately from all other circuits.
- Route power in middle at back of cabinet. All other I/O and internal cabling must be kept more than 152 mm (6 inches) away.
- Input power must route directly to controls that are Industrial compliant.
- Input power that must route to controls that are Light Industrial compliant must be filtered with a minimum of 20 dB filtering.
- Input power that must be routed near other cabling will be filtered prior to the point they are on a common path and before leaving the cabinet. Filter with a 20 dB filter.

IMPORTANT

Light Industrial equipment is defined as equipment that is designed and tested to comply with European Union (EU) directives (e.g. EN61000-6-1 or EN61000-6-3) for Light Industrial environments. Industrial compliant equipment is designed and tested for the EU directives for Heavy Industrial environments.

14.2.11 Analog I/O Routing and Shield Termination

Field I/O Module (FTM & Similar, Analog Driver, etc.) in Cabinet

- Use shielded cable from MicroNet module to I/O module.
- Locate I/O module as close to I/O cable entry point as possible.
- Locate I/O module away from unshielded discrete areas (> 152 mm / 6 inches).

Field I/O Cable with Field I/O Module (FTM & Similar, Analog Driver, etc.) in Cabinet

- Route I/O cable against cabinet metal wall from entry point to I/O module.
- Ground I/O cable shield, direct, to cabinet at entry point
  - If over braid shielded, ground over braid shield to cabinet - connect inner braid shields at I/O module termination point. The inner braid must still be directly grounded to earth at one point.
  - If single shield, ground shield to cabinet.
- If field I/O cable is grounded direct (DC coupled) at remote end of cable, ground the I/O cable shield capacitively at I/O module in cabinet and at the cable entry point into the cabinet.

I/O Module (FTM & Similar, Analog Driver, etc.) not in Cabinet

- Route cable from MicroNet module to I/O module with cable against cabinet metal wall.
- DC Ground the cable shield at entry point to the cabinet and at the I/O module.

Field I/O Cable without I/O Module in Cabinet

- Connect all shield braids at I/O module termination point

14.2.12 Discrete I/O Routing and Shield Termination

I/O Module (FTM & Similar, Relay Driver, etc.) in Cabinet

- Use shielded cable from MicroNet module to I/O module.
- DC Ground the cable shield at entry point to the cabinet and at the I/O module.
- Locate as close to field I/O cable entry point as possible
- Locate I/O module away from analog I/O areas (> 152 mm / 6 inches)
- Locate I/O module away from areas with unshielded discrete I/O (> 152 mm / 6 inches)

Field I/O Cable with I/O Module (FTM & Similar, Relay Driver, etc.) in Cabinet

- Route I/O cable against cabinet metal wall/structure from cabinet entry point to I/O module;
- If field I/O cable is shielded, ground I/O cable shield, direct, to cabinet at entry point
  - If over braid shielded, ground over braid shield to cabinet - connect inner braid shields at I/O module termination point. The Inner braid must still be directly grounded to earth at one point.
  - If single shield, ground shield to cabinet
  - If field I/O cable is grounded direct (DC coupled) at remote end of cable, ground the I/O cable shield, capacitively at the I/O module.
- I/O cable shield ground at the I/O module must be the same type as at cable entry point into cabinet, and it should be direct connected.

I/O Module (FTM & Similar, Relay Driver, etc.) not in Cabinet

- Route cable from MicroNet module to I/O module with cable against cabinet metal wall
- Ground “MicroNet module to I/O module” cable at entry point to cabinet, at MicroNet module and the I/O module

Field I/O Cable without I/O Module in Cabinet

- Ground I/O cable shield, direct, at the I/O module
  - If over braid shielded, ground over braid shields to cabinet - connect inner braid shields at I/O module termination point. The Inner braid must still be directly grounded to earth at one point.
  - If single shield, ground shield to earth at the I/O module
- If field I/O cable is grounded direct (DC coupled) at remote end of cable, ground the I/O cable shield capacitively at the I/O module.
- I/O cable shield ground at the I/O module must be the same type as at cable entry point into cabinet, and it should be direct connected.

14.2.13 Unshielded I/O

Unshielded field I/O cables may only be used inside the cabinet or for very short distances near the control cabinet. Also short on engine sections of discrete Input & Output cables may be use on the engine/turbine.

Discrete I/O is the only I/O type that may be unshielded, for more details on this requirement please see the Discrete I/O MicroNet Module section.

I/O Module (FTM & Similar, Relay Driver, etc.) in Cabinet

- Use Shielded cable from MicroNet module to I/O module.
- Ground cable direct at MicroNet module and I/O module.
- Locate I/O module as close to field I/O cable entry point as possible.
- Locate I/O module away from sensitive analog areas (> 152 mm / 6 inches) or other types of unshielded I/O.

Field I/O Cable with I/O Module (FTM & Similar, Relay Driver, etc.) in Cabinet

- Route I/O cable against cabinet metal wall from entry point to I/O module.
- Do not let other cable types within 300 mm (12 inches) of unshielded discrete I/O cables if they are parallel for > 61 cm (2 feet).
- Do not let other cable types within 152 mm (6 inches) of unshielded discrete I/O cables if they are parallel for less than 61 cm (2 feet).
- Limit length of unshielded I/O cable inside the cabinet. Any length over 61 cm (2 feet) is too long.

- If lengths greater than 61 cm (2 feet) are required, special considerations should be used to separate unshielded wiring from other circuits and minimize electromagnetic RF emissions.

I/O Module (FTM & Similar, Relay Driver, etc.) not in Cabinet

- Route cable from MicroNet module to I/O module with cable against cabinet metal wall
- Ground “MicroNet module to I/O module” cable at entry point of the cabinet at MicroNet Module and to the I/O module

14.2.14 Third Party Hardware

CE Compliant to Light Industrial Levels

- Locate inside the cabinet, away from all I/O cables that enter or exit the cabinet by >300 mm (12 inches)
- Locate from all other cables > 152 mm (6 inches) away
- Use only CE compliant devices

CE Complaint to Industrial Levels

- Locate based on Zoning restrictions

14.2.15 Ethernet I/O Connections

- Use Shielded Twisted Pair (STP) category 5 Ethernet cable
- Route Ethernet cable away from all other Internal cabling and external I/O cabling
- Ground internal Ethernet cable at the CPU card and at the entry point to the cabinet
- If external Ethernet cable is grounded direct at remote end of cable, ground the external Ethernet cable shield capacitively. See Ethernet FTM in Figure 12-51.

14.2.16 CAN I/O Connections

- A shielded CAN cable as defined in section 5.1.10 of volume 1 of this manual.
- Route the CAN cable away from all other Internal cabling and external I/O cabling.
- Ground the internal CAN cable shield at the entry point to the cabinet.
- AC couple the CAN cable shield to earth at each of the CAN devices external to the MicroNet cabinet.
- AC couple the CAN cable shield to earth at each of the CAN devices internal to the MicroNet cabinet.

14.2.17 Connection of Cabinet to Installation Ground

- Ensure the cabinet enclosure is electrically grounded to the plant ground system. Use as large a conductor as is possible. Use plant guidelines.

14.2.18 DIN Rail Grounding

- Provide Chassis ground to FTMs using a DIN rail ground clip.
- Install one each of these clips at the FTM end closest to the Earth ground connection point.
- Use largest gauge wire allowed by Clip and FTM.
- Maximum length of ground wire shall not exceed 5 cm (2 inches)

14.2.19 Equipment Bonding

- DIN rail shall be electrically connected to structural frame (<2.5 mΩ) once every 30 cm (12 inches).
- Use a minimum of 2 screws to bond a DIN rail to cabinet frame.
- Equipment chassis shall be electrically connected to structural frame (<2.5 mΩ).

14.2.20 Safety Ground Wire Installation

- A dedicated cabinet safety wire shall be routed against the grounded cabinet structure. Locate safety ground wire 152 mm (6 inches) from unshielded cabling, 76 mm (3 inches) from internal shielded cabling, and 15 cm (6 inches) from any I/O cabling exiting the cabinet.
- Safety ground/Protective earth wire should be routed from power input connections to the source of power. These wires should be routed with the power wires. Optimally power wires should be twisted; minimally they should be routed in direct contact with each other & bundled per input connector group.

14.2.21 Installation of other Equipment, Fans, Meters, etc.

Shield Termination Schemes

See Application Note B51204 for this information.

14.2.22 Shielded I/O Cable

Note: Copper tape is not reliable for shield termination.

Figure 14-7. Bottom Cable Entry Area

Figure 14-8. Door Bonding

Figure 14-9a. Cable Entry # 1

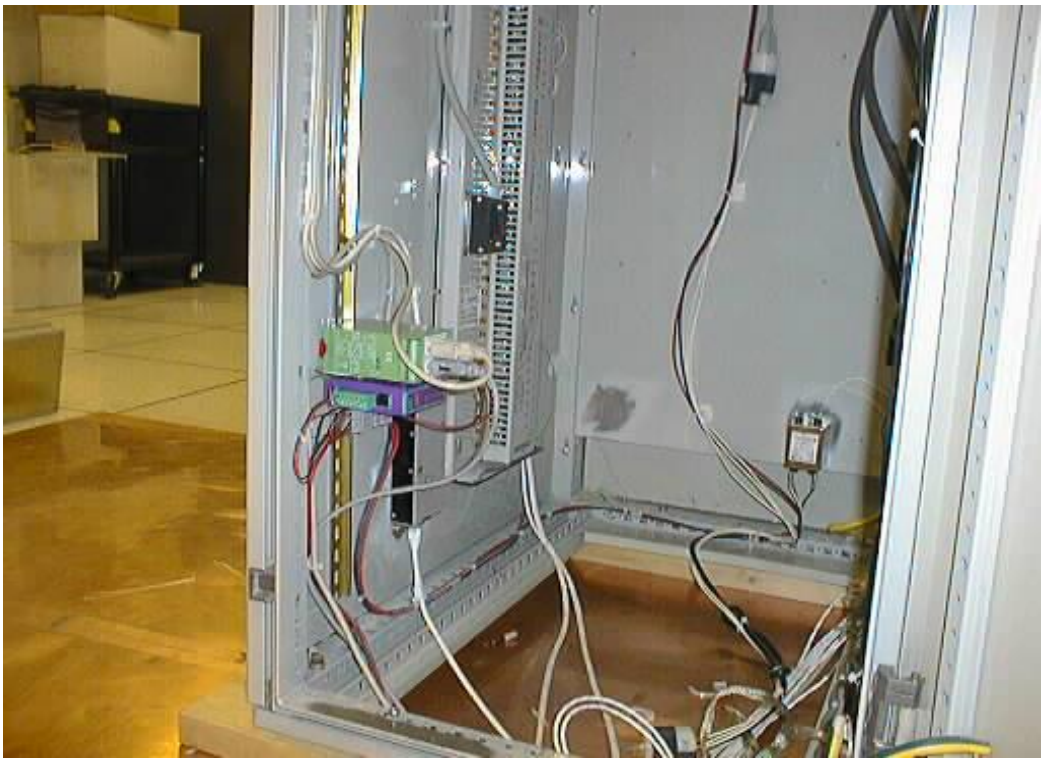


Figure 14-9b. Cable Entry # 2

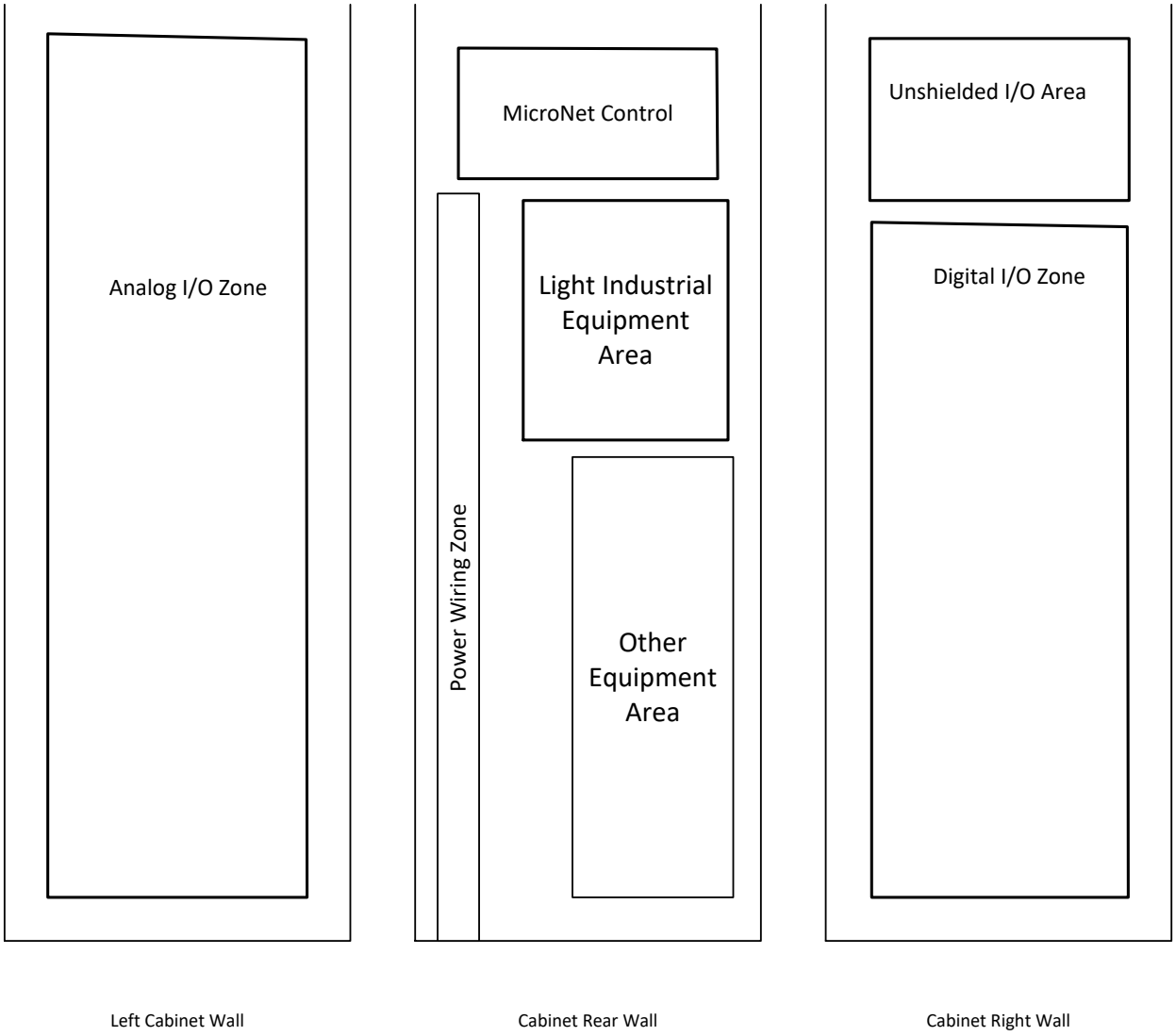


Figure 14-10. Zoning

Chapter 15.
Troubleshooting and Module Replacement

15.1 Introduction

This chapter provides detailed information on system hardware, gives tips to assist in solving hardware related issues, and includes module replacement instructions. Once a system problem is annunciated, this chapter can be utilized as a troubleshooting guide to assist problem finding and if necessary module replacement.

Because testing all functions of an individual module is beyond the scope of this manual, when the results of the procedures indicate that a module may be faulty, replace the suspected module with a module known to be good. This will help verify that the cause of the problem actually is in the suspected module.

If after following this chapter's guidance the cause of a problem cannot be found, contact the Woodward technical assistance group.

NOTICE

Only qualified service personnel should perform the following module replacement procedures.

15.2 Diagnostics

The MicroNet CPU module runs off-line and on-line diagnostics that display troubleshooting messages through the debug Service Port and AppManager. Offline 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 Software manual #26336 Additional fault information may be found in the CPU5200 section of volume 1 of this manual.

Table 15-1. CPU5200 Module, Fault LED Flash Codes

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

Table 15-2. AppManager Diagnostic Codes / Message ID Values

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

15.3 System Troubleshooting Guide

The following is a troubleshooting guide for areas to check which may present potential difficulties. By making these checks prior to contacting Woodward for technical assistance your system problems can be more quickly and accurately assessed.

MECHANICAL SYSTEM

ACTUATORS

- Is the oil clean?
- Does the actuator have the correct hydraulic pressure (if required)?
- Does the actuator have the correct pneumatic pressure (if required)?
- Does the drive shaft rotate (if required)?
- Is the actuator wiring correct?
- Is the direction of the stroke correct?
- Has the compensation (if so equipped) been adjusted correctly?
- Is the hydraulic return line free and not clogged?
- Is there backpressure on the hydraulic return line?
- Is the feedback (if any) adjusted correctly and sending the correct signal?

LINKAGE

- Is there slop or lost motion?
- Is there misalignment, binding, or side loading?
- Is there visible wear or scarring?
- Does the linkage move smoothly?

VALVES

- Does the valve move through its proper stroke smoothly?
- Does the valve travel its full stroke?
- Can mid-stroke be obtained and held?
- Does the valve fully seat (close) before the governor reaches full minimum stroke?
- Does the valve fully open before the governor reaches maximum stroke?
- Is the bypass valve(s) (if any) in the proper position?
- Are there nicks or contamination which allow steam to pass when the valve is closed?

OIL/HYDRAULIC SYSTEM

- Is the oil at the proper operating pressure?
- Is the oil temperature too high for the type of oil being used?
- Is the oil contaminated?
- Does the actuator have sufficient flow of oil?
- Are the accumulators (if any) charged to the correct pressure?
- Are the filters plugged?
- Is the oil pump operating properly?

STEAM CONDITIONS

- Is the turbine inlet pressure at design specification?
- Is the steam pressure in the proper operating range?
- Are pressure transducers (if any) located close to the turbine?
- Are there any pressure regulating devices or valves which may interfere with governor operation or proper steam flow?

CONTROL, ALARM, AND FAULT INDICATIONS

- Does the governor indicate it is in the correct control mode?
- Is the governor issuing any alarms?
- Are any of the components of the governor indicating hardware faults?
- Does the actuator demand agree with the actual valve position?
- Are any shut\ down conditions present?
- Have the control dynamics been tuned to match the system response?

COMMUNICATIONS

- Are the LAN switches powered and operable?
- Are the Ethernet (or Serial) cables all securely connected at both ends?
- Are the IP addresses on the same network domain (within subnet mask)?
- Are any IP addresses duplicated? (LAN will prevent second one from joining)
- Is the MicroNet configured correctly for desired port/protocol/slave #?
- Are there status LED’s that can be checked for activity (on Ethernet)?

INPUT SIGNALS

- Are all input signals properly scaled?
- Are the inputs free of electrical noise and properly shielded?
- Is the wiring correct?
- Have all field input signals to the control been verified?
- Is the polarity of the signals correct?

OUTPUT SIGNALS

- Are the outputs calibrated?
- Have the actuator drivers been calibrated to the stroke of the turbine valves?
- Are the output signals free of noise and properly shielded?
- Is the wiring correct?

TRANSDUCERS

- Is the transducer calibrated for the proper range?
- Has it been tested by simulating its input and measuring its output signal?
- Does the transducer have power?
- Are the sensing lines feeding the transducer clear of obstructions?

MAGNETIC PICKUPS AND OTHER SPEED SENSING DEVICES

- Is the wiring between the speed sensing pickup and the control correct?
- Are there any grounding problems or worn shields?
- Is the signal sufficient (at least 1.5 Vrms)?
- Is the signal a clean sine wave or square wave with no spikes or distortions?
- Is the MPU head clean and free of oil or metallic particles?
- Is the MPU head free of any nicks or chips?
- Is the MPU or proximity probe correctly aligned with the gear?
- Is the speed sensing probe adjusted to the correct gap?
- Is the speed sensing probe head the correct size for the toothed wheel it is being used with?
- Are the proper jumpers installed on the FTM?

INPUT VOLTAGE/POWER SUPPLIES

- 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?

ELECTRICAL CONNECTIONS

- Are all electrical connections tight and clean?
- Are all signal wires shielded?
- Are shields continuous from the device to the control?
- Are the shields terminated according to Woodward specifications?
- Are there low voltage signal wires running in the same wiring trays as high voltage wiring?
- Are the governor's signal common or grounds not tied to any other devices?
- Have the signals been checked for electrical noise?

VOLTAGE REGULATOR

- Is the voltage regulator working properly?

EXTERNAL DEVICES

- Are there external devices the control is dependent on for input signals?
- Are these devices providing the correct signal to the control?
- Is the external device configured or programmed to be compatible with the control?

15.4 Replacing Hardware & Safety Considerations

⚠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 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.** **Ne pas enlever ni installer l'alimentation électrique pendant que le circuit est sous tension avant de s'assurer que la zone est non dangereuse.** **Ne pas enlever ni installer les cartes pendant que le circuit est sous tension sans s'assurer que la zone non dangereuse.**

15.5 Replacing a Main Power Supply (PSM1, PSM2)

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

Main Power Supply LED descriptions:

OK LED—This green LED turns on to indicate that the power supply is operating and 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 Table 4-1 for power supply input specifications.

OVERTEMPERATURE LED—This red LED gives an early warning of a thermal shutdown. The LED turns on to indicate when the internal power supply temperature reaches approximately 80 °C. If the internal supply temperature rises further to approximately 90 °C the supply will shutdown. 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 or 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 supply temperature decreases below approximately 75 °C.

POWER SUPPLY FAULT—This red LED turns on when one of the supply's three 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. Once the short circuit is removed, the supply may resume normal operation. If no short circuit is found, try resetting the supply by removing input power for one minute. Once input power has been restored, if the power supply is still not functioning, verify that the supply is properly seated to the motherboard connector, if still not functioning, replace the supply.

Each main power supply must have its own branch circuit rated fuse or circuit breaker. A main power supply module has internal fuses, however these fuses do not protect the supply's input circuitry, and will only open in the event of a component failure internal to the power supply. If any of the supply's internal fuses are open, replace the supply.

Main Power Supply Replacement Procedure:

1. Read all warnings on pages v and vi of this Volume before replacing any module.
2. Remove input power from the power supply being replaced.
3. Unscrew front panel mounting screws, and release the module from the motherboard connectors by pressing the top handles up and the bottom handles down.
4. Remove module by pulling straight out.
5. Install a new power supply by aligning the circuit board edges in the card guides and push the unit into the slots until the connectors on the modules and the connectors on the motherboard make contact.
6. With even pressure exerted at the top and bottom of the supply's front panel, firmly push the unit into place.
7. Tighten the screws that secure the module in place (two at the top and two at the bottom).
8. Re-apply power to the input of the power supply.

15.6 Replacing a Kernel Power Supply

Each kernel section of the MicroNet TMR control contains one kernel power supply module located in the first slot (A1) of the kernel. This module receives 24 Vdc from the main TMR supply and regulates it to 5 Vdc, 10 A for the rest of the kernel section. The kernel power supply also creates a 5 V pre-charge voltage. There are no switches on this module. A Fault LED is on the front panel of the power supply. It will illuminate if a problem occurs with the 5 V or 5 V precharge.

The kernel power supply module also assists in CPU to CPU communications. If the control reports a CPU to CPU communication fault, the affected kernel power supply module may need to be replaced.

⚠WARNING

With this control, the removal of any single kernel will not cause a shutdown. However, if other faults are present within other kernels, those faults combined with any faults created by the removal of this kernel power supply may cause a system shutdown.

Kernel Power Supply Replacement Procedure:

1. If the control is running and on-line, use the Engineering Workstation to verify that the other CPUs are running without faults. Correct all other CPU faults within the other kernel sections before replacing a kernel's power supply.
2. Remove the cable clamp at the top of the chassis section. The clamp can be lifted off by removing the two screws which hold it in place.
3. **Reset the CPU:** Press the CPU Reset button to momentarily reset the CPU.
4. **Fully remove the Kernel PS.** Unscrew the Kernel PS module's captive-screw fasteners, and release the module from the motherboard connectors by pressing the top handles up and the bottom handles down. Remove the module by pulling straight out and place it into a conductive plastic bag (Woodward P/N 4951-041).
5. Inspect the connector pins on the new replacement module and verify that all pins are parallel, straight, and un-damaged.
6. **Partially insert the replacement Kernel PS** module by aligning the board edge in the card guides and pushing the module *partially* into the slot *without contacting the motherboard*.
7. **Fully insert the replacement Kernel PS.** With even pressure at the top and bottom of the front panel, firmly push the module into place until fully seated. Tighten the top and bottom faceplate screws to secure the module.
8. Re-insert all kernel modules one at a time. With even pressure exerted at the top and bottom of each module's front panel, firmly push the module into place. Tighten the two screws that secure each module in place (one at the top and one at the bottom).
9. Reset the kernel CPU by pressing its reset switch. At this point the kernel CPU will perform off-line diagnostic tests for approximately 60 seconds, then re-synchronize with the other control CPUs.

15.7 Replacing a CPU Module

System diagnostic routines continuously monitor each CPU for proper operation. If a fault condition is detected, the fault is annunciated and the CPU is locked out of all voting. If necessary, use the CPU module's front panel LEDs to assist in diagnosing a related problem. If all CPU LEDs are turned off (not illuminated), it is probable that input power is not present and verification should be made. If only one CPU module has all of its LEDs off, it is probable that the kernel power supply is not functioning.

The CPU module has the following indicators and switch:

RESET (Recessed)—This momentary push-button resets the CPU and I/O modules (Kernel) when pressed. The CPU performs a boot-up sequence, then synchronizes to the other Kernels and functions normally.

RUN LED—This turns GREEN when the CPU is operating and no processor faults are present. If this is RED, the CPU is in Reset mode.

ETH G/Y (Link & TX/RX) LEDs—Link Active GREEN indicates a valid Ethernet connection to another device exists. Tx/Rx Active YELLOW when data is transmitted or received.

SYSCON LED—System Controller GREEN LED –on when the CPU is active and in control of the Kernel IO

LOW VCC LED—This red LED turns on when the Kernel power supply's +5 Vdc output is out of its specified limits. If this LED is on and remains on after a CPU reset, replace the Kernel power supply.

FAULT LED—This RED LED actively flashes CPU fault codes as necessary.

STANDBY LED—NOT USED FOR TMR SYSTEMS

I/OLOCK LED—This red LED turns on when a major CPU or I/O module hardware fault has been detected. When a major fault is detected, the fault is annunciated, all discrete outputs are locked in a de-energized state and all analog output signals locked to zero current. The reason for a hardware fault can be viewed through the engineering workstation. After the problem has been corrected, perform a CPU reset to unlatch the I/O lock logic.

WDOG LED—This RED LED turns on if the CPU stops executing the application program. After the problem has been corrected, perform a CPU reset to unlatch the Watchdog LED logic.

CAN LEDs—Active GREEN when data is transmitted or received through CAN Ports.
RED indicates a fault

CPU Module Replacement Procedure:

1. Read all warnings on pages v and vi of this Volume before replacing any module.

   Note: Replacing a CPU will disable all IO from this kernel. Live extraction/insertion of a CPU is not permitted in an operational TMR system. The kernel power supply must be extracted from the chassis to remove power from the CPU

2. Before CPU replacement, use AppManager and the following table to capture the customer-specific IP Address data from each CPU (A, B, C).

Table 15-3. Customer-Specific IP Addresses

	KERNEL A	KERNEL B	KERNEL C
ENET1			
	IP = _____	IP = _____	IP = _____
	Subnet = _____	Subnet = _____	Subnet = _____
ENET2			
	IP = _____	IP = _____	IP = _____
	Subnet = _____	Subnet = _____	Subnet = _____

**Refer to volume 1 of this manual (CPU5200 section) for factory defaults.

3. If the control is running and on-line, use the Engineering Workstation to verify that the other CPUs are running without faults. Review all system alarms to ensure that no IO channels in the selected Kernel are needed to operate.

4. Remove the cable clamp at the top of the chassis section. The clamp can be lifted off by removing the two screws which hold it in place.

5. **Reset the CPU:** Press the CPU Reset button to momentarily reset the CPU.

6. **Partially remove the Kernel PS:** Unscrew the **Kernel PS** module's captive-screw fasteners and release the module from the motherboard connectors by pressing the top handles up and the bottom handles down.

7. **Partially remove the CPU:** Unscrew the **CPU** module's captive-screw fasteners and release the module from the motherboard connectors by pressing the top handles up and the bottom handles down.

8. Remove CPU Cables: Disconnect any CPU communication cables.

9. **Fully remove the CPU:** Remove the CPU module by pulling straight out and place it into a conductive plastic bag (Woodward P/N 4951-041).

10. Inspect the connector pins on the new replacement module and verify that all pins are parallel, straight, and un-damaged.

11. **Partially insert the replacement CPU:** Install the replacement CPU module by aligning the board edge in the card guides and pushing the module partially into the slot *without contacting the motherboard*.

12. **Re-connect any communication cables** to the CPU.

13. **Fully insert the replacement CPU:** With even pressure at the top and bottom extraction tabs, firmly push the CPU into place until fully seated. Tighten the top and bottom faceplate screws to secure the module.

14. Re-engage the Kernel PS module by pushing the module into the slot. With even pressure exerted at the top and bottom of the Kernel PS module's extraction tabs, firmly push the module into place.

15. Tighten the two screws that secure the Kernel Power Supply module in place (one at the top and one at the bottom).

16. Using the Engineering Workstation, Launch AppManager to view the networked CPU modules.

17. AppManager will show 2 good CPU modules with the IP addresses listed above and a new CPU with the factory default settings of :
    ENET1 - IP = 172.16.100.1 with Subnet Mask 255.255.0.0
    ENET2 - IP = 192.168.128.20 with Subnet Mask 255.255.255.0

18. Use AppManager (Control/Network Settings) to change the IP addresses for **ETH1** and **ETH2** ports of the new CPU. Both the IP Address and the Subnet mask settings must be changed to the Customer Specific settings captured above in step 2.

    Note: The CPU module will require a case-sensitive Username = ServiceUser and Password=ServiceUser to login and perform this task.

19. The CPU will reboot to accept the new IP addresses. Once rebooted, it will show up on AppManager with the new IP address settings.

20. Using AppManager, select a running CPU and use the pull-down ‘Retrieve Files’ to retrieve ALL Application Program files (***.OUT, *.r1, *.r2, *.r3, etc.**) to a folder on the Engineering Workstation.

21. Verify that all kernel modules are tightly installed, screwed down, with cables properly connected and latched. Then select and RUN the application file (click on the ‘Start Application’ (pull-down or tool bar icon).

22. The CPU should start the application, clear all fault LEDs, and synchronize with the other kernels. It will obtain all current states and tunable values during synchronization with the other Kernels.

15.8 Replacing an I/O Module

IMPORTANT

For Simplex I/O configurations, this procedure will shut down the control system.

⚠WARNING

HIGH VOLTAGE—If power has not been removed from the control system, power will be active at the module and also at the cable connectors. It is recommended that the cables not be removed until after the module has been unseated. If cables are removed with power applied, use care to avoid shorting cable connector pins.

If the high voltage FTM is being used with the 48/24 Discrete I/O module, and there is 125 Vdc on the FTM terminal blocks, there will be 125 Vdc on the FTM sub D connectors and on the cable when it is connected to the FTM. For this reason, all power should be removed from the FTM terminal blocks before disconnecting any cables.

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

LED Diagnostics. If during normal control operation all Kernel I/O modules have their Fault LEDs on, check the Kernel CPU for a failure. If during normal control operation, only one module's Fault LED is turned on or flashing, replace this module. A flashing LED indicates that a certain module failure has occurred, and is used by factory technicians to locate module faults. When a module fault is detected, its outputs are disabled or de-energized.

I/O modules may have a fuse visible at the bottom rear edge of the module. If this fuse is blown, replace it with a fuse of the same type and size.

VME Module Replacement Procedure:

1. Read all warnings on pages v and vi of this Volume before replacing any module.

2. If the control is running and on-line, use the Engineering Workstation to verify that all three CPUs are running without faults.

3. Determine which TMR Kernel (A, B or C) requires the replacement module. (Hot Swapping of I/O modules is not allowed in a TMR chassis.)

4. **Reset the CPU:** Momentarily press the CPU Reset button to reset the CPU in the selected Kernel (A, B or C).

5. Partially remove the Kernel Power Supply (KPS) module in the selected Kernel (A, B or C) following step 7 below. This will remove power from the selected Kernel. Make sure that the module is withdrawn from the chassis motherboard an inch or two. Alternately the KPS module may be removed from the rack.

6. On the desired I/O module, remove the cable clamp at the top of the chassis section. The clamp can be lifted off by removing the two screws which hold it in place.

7. **Partially remove the module:** Unscrew the module's captive-screw fasteners, and release the module from the motherboard connectors by pressing the top handle up and the bottom handle down. At this point the module should be unseated from the motherboard connector, but still within the control rack.

8. **Disconnect cables:** The I/O cables use a slide latch (to disengage slide the latch up). To eliminate the possibility of causing a system trip when replacing a module always un-seat the module before disconnecting the I/O cables. (A system trip is possible if a number of the cable connector pins are shorted to chassis ground.)

9. **Fully remove the module:** Remove the module by pulling straight out and place it into conductive plastic bag (Woodward P/N 4951-041).

10. **Partially insert the replacement module:** Prior to installing a replacement module, verify that all connector pins are parallel and straight. Install the replacement module by aligning the circuit board edges inside the card guides and pushing the module straight in until it is approximately 25 mm (1 inch) from the motherboard. (**Do not make contact with the chassis motherboard mating connectors**.)

11. **Re-connect the cables:** The I/O cables use a slide latch (to secure cable, slide the latch down). To eliminate the possibility of causing a system trip when replacing a module always connect the I/O cables before seating the module to the motherboard. (A system trip is possible if a number of the cable connector pins are shorted to chassis ground.) Re-position the two captive-screw fasteners as necessary to prevent interference when the module is inserted.

12. **Fully insert the I/O module:** With even pressure at the top and bottom of the front panel, in one continuous motion, firmly push the module into place until fully seated. Tighten the top and bottom faceplate screws to secure the module.

IMPORTANT

If resistance is encountered when installing a module, do not force the module. Remove the module and check the connectors for bent contacts or foreign objects. Also check to ensure that the module screws are fully retracted. Forcing a module into place may break the connector or bend the securing screws.

13. Reinstall the Kernel Power supply in the selected Kernel (A, B or C) following step #10 and #12 above. This will re-apply power to the selected Kernel.

14. In most cases, the CPU in the selected Kernel will auto start and synchronize with the remaining two Kernel CPU's. Otherwise use the Engineering Workstation (or AppManager) to restart the application on the selected Kernel CPU.

15. Verify that the replacement MicroNet module is working correctly.

16. Reinstall the cable saddle.

Once the module is properly installed, the module Fault LED will be illuminated until the module is re-initialized by the control. The control performs module diagnostic tests for a few seconds, and if all test are passed, re-initializes the module (turning off the module Fault LED).

IMPORTANT

If the module's Fault LED does not turn off after the module has been installed for at least one minute, it may be necessary to re-seat the module more firmly. To re-seat a module follow step #4 of the above procedure to release the module from the motherboard, then re-install the module by following procedure steps #7 & #9.

15.9 Replacing a Field Termination Module (FTM)

The replacement of termination modules can be performed on-line (while the unit is operational) or off-line (while the unit is shut down).

IMPORTANT

If on-line replacement of the FTM's is required/desired, the user must consider this in the assignment of redundant input signals. For example use speed signals 1 & 3 (not 1 &2) and place redundant AI signals on channels 1 & 5 (not 1 & 2).

⚠WARNING

HIGH VOLTAGE—It is not possible to replace an FTM without shutting down the entire control system and the prime mover.

If power has not been removed from the control system, power will be active at the module and also at the cable connectors. It is recommended that the cables not be removed until after the module has been unseated. If cables are removed with power applied, take care to avoid shorting cable connector pins.

If the high voltage FTM is being used with the 48/24 Discrete I/O module, and there is 125 Vdc on the FTM terminal blocks, there will be 125 Vdc on the FTM sub D connectors and on the cable when it is connected to the FTM. For this reason, all power should be removed from the FTM terminal blocks before disconnecting any cables.

Caution must be taken whenever replacing a termination module on-line, or a unit trip could result. The procedure used in the replacement of termination modules on-line varies based on the control's configuration and system wiring configuration. Contact a Woodward representative to establish the correct termination procedure to use based on your configuration.

Replacing an Analog/Discrete Termination Module While the Unit is Off-line:

1. Read all warnings on pages v and vi of this Volume before replacing any module.
2. Shut down the control.
3. Remove all power from the system. Do not attempt to replace a termination module with the system powered.
4. Disconnect all FTM cables. Carefully—to avoid shorting cable pins—disconnect all I/O cables from the FTM, and secure cable ends to avoid damage or shorting of pins. The I/O cables use a slide latch (to disengage, slide the latch to the release position).
5. Disconnect all field wiring. Take care to avoid shorting the wires.
6. Remove the FTM by inserting a screwdriver into the mounting foot and prying each foot away from the DIN rail. Install the replacement FTM.
7. Reconnect all field wiring. Refer to the Wiring Notes for the appropriate module.
8. Re-connect all I/O cables to the FTM. Be careful to avoid shorting cable pins. Secure the connector by sliding the latch away from the cable end.
9. If power was removed, reapply power.
10. Put the CPU module back in run mode.
11. Verify that the new FTM is working correctly.

To Replace FTM Fuses:

1. Read all warnings on pages v and vi of this Volume before replacing any fuse. If the control is running and on-line, take care not to come in contact with any FTM circuitry.
2. Remove FTM cover.
3. Locate and replace fuse (see Chapter 12 for specific FTM fuse type and location) with one of the same size and rating.
4. Verify that the circuit problem has been corrected.
5. Replace FTM Cover.

To Replace FT Relays:

⚠WARNING

HIGH VOLTAGE—Relay circuit power is also present on an FTM's relay and cable connectors. When using high voltage relay circuit power, it is recommended that care be taken not to touch exposed connectors when replacing relays or cables. If possible remove relay circuit power from all FTM relays before replacing any FTM relay or cable.

1. Read all warnings on pages v and vi of this Volume before replacing any Relay.
2. Locate and replace faulty relay. Chapter 12 shows the relay locations for the specific FTMs that contain relays. Appendix A gives the part numbers for replacement relays.
3. Perform a system Reset to clear Alarm.

15.10 Replacing a Relay Box

⚠WARNING

HIGH VOLTAGE—If power has not been removed from the control system, power will be active at the module and also at the cable connectors. It is recommended that the cables not be removed until after the module has been unseated. If cables are removed with power applied, care must be used to avoid shorting cable connector pins.

If there is high voltage on the relay box terminal blocks, there will be high voltage on the relay box connectors. For this reason, all power should be removed from the relay box terminal blocks before disconnecting any cables.

1. **Reset the CPU:** Press the CPU Reset button to momentarily reset the CPU.
2. Carefully—to avoid shorting cable pins—disconnect all I/O cables from the relay box, and secure cable ends to avoid damage or shorting of pins. The I/O cables use a slide latch (to disengage, slide the latch to the release position).
3. Disconnect all field wiring. Care should be taken to avoid shorting the wires.
4. Install the replacement relay box.
5. Reconnect all field wiring.
6. Connect all I/O cables to the relay box, being careful to avoid shorting cable pins. Lock the connector in position by sliding the latch to the latched position.
7. If power was removed, reapply power.
8. Put the CPU module back in run mode.
9. Verify that the new relay box is working correctly.

15.11 Replacing a Receptacle-mounted Relay

WARNING

HIGH VOLTAGE—When there is high voltage on the relay contacts, there will be high voltage on and around the relay itself. For this reason, all power must be removed from the relay box before replacing the relay.

1. If possible, remove all power from the control system and the Relay module.
2. Identify the faulty relay.
3. Move the relay's hold down spring out of the way, and pull the relay out of its socket.
4. Insert a replacement relay with same manufacturer's part number into the vacated socket, and re-engage the hold down spring.
5. Restore all power if previously removed.
6. Verify that the new relay is functioning correctly.

15.12 Replacing an I/O Cable

IMPORTANT

This procedure will shut down the control system.

WARNING

HIGH VOLTAGE—If power has not been removed from the control system, power will be active at the module and also at the cable connectors. It is recommended that the cables not be removed until after the module has been unseated. If cables are removed with power applied, care must be used to avoid shorting cable connector pins.

If the high voltage FTM is being used with the 48/24 Discrete I/O module, and there is 125 Vdc on the FTM terminal blocks, there will be 125 Vdc on the FTM sub D connectors and on the cable when it is connected to the FTM. For this reason, all power should be removed from the FTM terminal blocks before disconnecting any cables.

1. **Reset the CPU:** Press the CPU Reset button to momentarily reset the CPU.
2. Remove the cable saddle at the top of the chassis section. The saddle can be lifted off by removing the two screws which hold it in place.
3. Unscrew the module's captive-screw fasteners (one at the top of the module and the other at the bottom), and release the module by simultaneously pressing the top module handle up and the bottom module handle down.
4. Unseat the module from the motherboard by pulling the module straight out along the card guide slots until it is approximately 1 inch from the motherboard.
5. Disconnect the I/O cable from the module, and secure the ends to avoid damage or shorting of pins. The I/O cable uses a slide latch (to disengage, slide the latch towards the top of the module).
6. Disconnect the I/O cable from the FTM or Relay/Discrete Input module.
7. Install the replacement I/O cable and connect it to the FTM or Relay/Discrete Input module, securing the end to avoid shorting or damage to pins.
8. Connect the I/O cable to the module. The I/O cable uses a slide latch (to engage, slide the latch towards the bottom of the module). Verify that the I/O cable is connected to the correct cable connector.

9. With even pressure exerted at the top and the bottom of the module, seat the module into the motherboard.
10. Tighten the two captive-screw fasteners (one at the top of the module and the other at the bottom).
11. If power was removed, reapply power.
12. Put the CPU module back in run mode.
13. Verify that the new MicroNet module is working correctly.
14. Reinstall the cable saddle.

15.13 Replacing Chassis Fans

Installation of MicroNet Power Supply:

Use the following procedure to remove faulty fan from chassis
1. Discharge ESD from your body by touching the main cabinet PE ground.
2. Use a stubby (approximately 9 cm/3.5 inches long) #2 Phillips screwdriver.
3. Loosen, but do not remove, the four retaining screws holding the fan assembly to the chassis.
4. Rotate fan to remove power by accessing wire quick connects.
5. Remove fan and guard assembly from chassis.
6. Remove guard from faulty fan, noting captive nut location.

IMPORTANT **Captive nuts should be rethreaded onto screws between fan mounting flanges to prevent loose hardware from contacting live circuits.**

7. Discharge ESD from your body by touching the main cabinet PE ground.
8. Install new fan.
9. Reinstall fan assembly (flow arrows should point "UP").
10. Connect RED wire to the + fan terminal and BLACK wire to – fan terminal.

IMPORTANT **Do not contact quick connect terminals with any metallic surface during reinstallation.**

MicroNet General Chassis/Power Supply Only
Installation of MicroNet Power Supply:

Locate power supply a minimum of 8 cm (3 inches) with a maximum distance of 11.4 cm (4.5 inches) directly below the TMR chassis.

Use the following procedure to remove faulty fan from chassis
1. Discharge ESD from your body by touching the main cabinet PE ground.
2. Use a stubby (approximately 9 cm/3.5 inches long) #2 Phillips screwdriver.
3. Loosen, but do not remove, the four retaining screws holding the fan assembly to the chassis.
4. Rotate fan to remove power by accessing wire quick connects.
5. Remove fan and guard assembly from chassis.
6. Remove guard from faulty fan.
7. Discharge ESD from your body by touching the main cabinet PE ground.
8. Install new fan.
9. Reinstall fan assembly (flow arrows should point "UP").
10. Connect RED wire to the + fan terminal and BLACK wire to - fan terminal.

IMPORTANT **Do not contact quick connect terminals with any metallic surface during reinstallation as they are powered.**

Chapter 16.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.

A current list of Woodward Business Partners is available at:
https://www.woodward.com/en/support/industrial/service-and-spare-parts/find-a-local-partner

Product Service Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (Woodward North American Terms and Conditions of Sale 5-09-0690) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is a flat-rate program and includes the full standard Woodward product warranty (Woodward North American Terms and Conditions of Sale 5-09-0690).

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

Flat Rate Repair: Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward North American Terms and Conditions of Sale 5-09-0690) on replaced parts and labor.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in “like-new” condition and carry with it the full standard Woodward product warranty (Woodward North American Terms and Conditions of Sale 5-09-0690). This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:

- Return authorization number
- Name and location where the control is installed
- Name and phone number of contact person
- Complete Woodward part number(s) and serial number(s)
- Description of the problem
- Instructions describing the desired type of repair

Packing a Control

Use the following materials when returning a complete control:

- Protective caps on any connectors
- Antistatic protective bags on all electronic modules
- Packing materials that will not damage the surface of the unit
- At least 100 mm (4 inches) of tightly packed, industry-approved packing material
- A packing carton with double walls
- A strong tape around the outside of the carton for increased strength

NOTICE

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*.

Replacement Parts

When ordering replacement parts for controls, include the following information:

- The part number(s) (XXXX-XXXX) that is on the enclosure nameplate
- The unit serial number, which is also on the nameplate

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

Product Training is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from many of our worldwide locations or from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at **https://www.woodward.com/en/support/industrial/service-and-spare-parts/find-a-local-partner**

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at **https://www.woodward.com/support**, which also contains the most current product support and contact information.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (32) 422-5551
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+ 82 (32) 422-5551
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+ 82 (32) 422-5551
The Netherlands	+31 (23) 5661111
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number

Prime Mover Information

Manufacturer _____

Turbine Model Number _____

Type of Fuel (gas, steam, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Symptoms

Description _____

_____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Appendix A.
Matrix of Modules with Compliance Information

The "X" indicates approval from the agency shown in the columns.
This Chart is for reference only. Woodward must be consulted for the latest compliance information.
Note: MicroNet TMR Controls do not have ATEX or Marine Type Approvals.

Part No	Status	Description	Extended Description	CSA	UL	ATEX	CE (LVD)	CE (EMC)	ABS	DNV	LRS
1604-801	A	BLOCK	SECTIONAL TERMINAL (UK 5, PHOENIX, 3004016)						x	x	x
1604-813	A	BLOCK	SECTIONAL EARTH/GRND TERM.				x	x	x	x	x
1606-519	A	CHANNEL	MOUNTING						x	x	x
1606-584	ANP	RAIL	MOUNTING 78 IN.						x	x	x
1611-003	A	CONVERTER	INTERFACE (RS-232 TO RS-422 AND RS-485)				n/a	x		x	
1711-1350	A	SWITCH	ETHERNET MODULE PHOENIX CONTACT FL SWITCH SFNT 8TX		x		n/a	x	x	x	x
1711-1349	INA	SWITCH	ETHERNET MODULE HIRSCHMANN SWITCH 7TX/2FX		X					X	
1711-1351	INA	SWITCH	ETHERNET MODULE PHOENIX CONTACT FL SWITCH SFNT 7TX/FX		x		n/a	x	x	x	x
1711-1410	A	SWITCH	ETHERNET MODULE PHOENIX CONTACT FL SWITCH 2206-7TX/2FX SM								
1711-1424	A	SWITCH	ETHERNET MODULE RED LION SWITCH SLX 4TX/2FX		x				x		
1740-217	A	LIGHT	CABINET, 24VDC 8W FLUORESCENT					x			
1751-147	A	MODULE	4 CH. MPU WITH 1:3 TRANSFORMER	x		x					
1751-6020	A	MODULE	ISOLATED ANALOG VOLTAGE INPUT, 0 TO 10 V INPUT (DATAFORTH)	x		x	n/a	x			
1751-6021	A	MODULE	ISOLATED ANALOG VOLTAGE INPUT, +/-10V INPUT (DATAFORTH)	x		x	n/a	x			
1751-6034	A	CONVERTER	RTD 100 OHM PT EUROPEAN CURVE (EXT RANGE)	x							
1751-6058	A	MODULE	TRANSFORMER	x		x					
1751-6091	A	RELAY	16 CHANNEL RELAY FTM (PHOENIX CONTACT) [Ordinary Locations Only]		x			x			
1752-357	A	HUB	RAIL RH1-TP (HIRSCHMANN 943 639-002)								
1755-111	A	FILTER	RFI POWER LINE						x	x	x
1784-573	A	CONVERTER	ISOLATED RS232-RS232, KD485, DIN RAIL Only for Marine				n/a	x	x	x	x
1784-575	A	CONVERTER	ISOLATED RS232-RS422/RS485, KD485, DIN RAIL Only for Marine				n/a	x	x	x	x
1784-577	A	CONVERTER	ISOLATED RS232-RS232, PHOENIX, DIN RAIL						x	x	x
1784-635	A	CONVERTER	INTERFACE ISOLATOR (RS-232 TO RS-232)				n/a	x		x	
1784-653	A	CONVERTER	K TYPE THERMOCOUPLE TO 0-5 VOLT, (DATAFORTH)	x		x	n/a	x		x	x
1784-655	A	CONVERTER	100 OHM RTD TO 0-5 VOLT, (DATAFORTH)	x		x	n/a	x		x	x

Part No	Status	Description	Extended Description	CSA	UL	ATEX	CE (LVD)	CE (EMC)	ABS	DNV	LRS
1784-657	A	CONVERTER	NON-ISOLATED PASS THROUGH, (DATAFORTH)	x		x	n/a	x			
1784-659	A	CONVERTER	NON-ISOLATED PASS THROUGH WITH 200 OHM (DATAFORTH)	x		x	n/a	x		x	x
1784-667	A	CONVERTER	100 OHM RTD, 0-600 DEG C SLOW TO 0-5 VOLT, (DATAFORTH)	x		x	n/a	x			
1784-675	A	CONVERTER	200 OHM RTD TO 0-5 VOLT, (DATAFORTH)	x		x	n/a	x			x
1784-695	A	THERMOC	THERMOCOUPLE - J TYPE THERMOCOUPLE 1-5 VOLT (DATFORTH)	x		x	n/a	x			
1784-1028	A	CONVERTER	ISOLATED LINEARIZED THERMOCOUPLE INPUT (DATAFORTH)	x		x	n/a	x			x
1784-1044	A	CONVERTER	ISOLATED ANALOG VOLTAGE INPUT MODULE (DATAFORTH)	x		x	n/a	x			
1784-1064	A	CONVERTER	E TYPE THERMOCOUPLE (DATAFORTH)	x		x	n/a	x			
1784-1069	A	CONVERTER	5K OHM ISOLATED POTENTIOMENTER INPUT (DATAFORTH)	x		x	n/a	x			
1784-1076	A	CONVERTER	ISOLATED ANALOG VOLTAGE INPUT MODULE (DATAFORTH)	x		x	n/a	x			
1784-1080	A	CONVERTER	10K OHM ISOLATED POTENTIOMENTER INPUT (DATAFORTH)	x		x	n/a	x			
1784-1115	A	CONVERTER	ISOLATED LINEARIZED T-TYPE THERMOCOUPLE INPUT (DATAFORTH)	x		x	n/a	x			
1790-039	A	KEYBOARD	NEMA 12 WITH HULAPOINT				n/a	x	x	x	x
1790-041	A	MONITOR	SCEPTRE LT12G 12.1" SVGA TFT FLAT PANEL				n/a	x	x	x	x
1790-043	A	KEYBOARD	UNICOMP SPACE SAVER W/TRACKPOINT (BLACK)				n/a	x	x	x	x
1790-885	A	MONITOR	T-521 CTC P31-212AR INTERACT 90/120 VAC								
1790-887	A	MONITOR	T-521 CTC P31-212DR INTERACT 20/36 VDC								
1790-889	A	MONITOR	T-521 CTC P2 INTERACT 100-240 VAC								
1790-891	A	MONITOR	T-521 CTC P2 INTERACT 20/36 VDC								
2006-379	A	WIRE	20 GA. 600V CRC WHITE (T-274)						x	x	x
2008-055	A	CABLE	20 GA. 2 COND. SHLD (T-274)						x	x	x
2008-057	A	CABLE	20 GA. 3 COND. SHLD (T-274)						x	x	x
2008-217	A	WIRE	10 GA. 600V CRC GRN/YEL (T-274)						x	x	x
2008-269	A	CABLE	50 OHM COAX						x	x	x
2008-349	A	WIRE	2 CONDUCTOR 22AWG, LOW CAP				n/a	x	x	x	x
2008-535	A	CABLE	TRIAXIAL 50 OHM IMPEDANCE						x	x	x
3799-301	A	PANEL	NETCON IIIB VME BLANK				n/a	x	x	x	x
5009-411	INA	MODULE	5009 CPU SIO WITH APPLICATION		x						
5009-413	INA	MODULE	5009 CPU WITH APPLICATION		x						
5009-415	INA	MODULE	5009 CPU WITH APPLICATION		x						
5009-418	INA	MODULE	5009 CPU SIO WITH APPLICATION		x						
5009-419	INA	MODULE	5009 CPU WITH APPLICATION		x						

Part No	Status	Description	Extended Description	CSA	UL	ATEX	CE (LVD)	CE (EMC)	ABS	DNV	LRS
5009-421	INA	MODULE	5009 CPU APPLICATION W/ SIO		x						
5009-423	INA	MODULE	5009 CPU APPLICATION W/ SIO		x						
5009-500	INA	MODULE	5009 CPU W/DUAL CPC APPLICATION		x						
5009-502	INA	MODULE	5009 CPU WITH APPLICATION		x						
5415-962	A	CABLE	NETCON TRANSCEIVER 3FT				n/a	x	x	x	x
5415-963	A	CABLE	NETCON TRANSCEIVER 10FT				n/a	x	x	x	x
5416-190	A	CABLE	NETCON SERIAL I/O						x	x	x
5416-332	A	CABLE	NETCON 3FT DISCRETE GRA						x	x	x
5416-333	A	CABLE	NETCON 6FT DISCRETE GRA						x	x	x
5416-334	A	CABLE	NETCON 8FT DISCRETE GRA						x	x	x
5416-335	A	CABLE	NETCON 10FT DISCRETE GY						x	x	x
5416-336	A	CABLE	NETCON 12FT DISCRETE GY						x	x	x
5416-337	A	CABLE	NETCON 14FT DISCRETE GY						x	x	x
5416-338	A	CABLE	NETCON 16FT DISCRETE GY						x	x	x
5416-339	A	CABLE	NETCON 18FT DISCRETE GY						x	x	x
5416-340	A	CABLE	NETCON 20FT DISCRETE GY						x	x	x
5416-341	A	CABLE	NETCON 22FT DISCRETE GY						x	x	x
5416-342	A	CABLE	NETCON 24FT DISCRETE GY						x	x	x
5416-350	A	CABLE	NETCON 3B 14FT ANLG BLK						x	x	x
5416-413	A	CABLE	SERIAL I/O RS422						x	x	x
5416-425	A	CABLE	THINNET ETHERNET COAX						x	x	x
5416-519	A	CABLE	MACINTOSH SERIAL I/O						x	x	x
5416-863	A	CABLE	PMU (POWER MONITORING UNIT), VAASA ELECTRONICS VX008-3						x	x	x
5416-966	A	CABLE	MICRONET HIGH DENSITY LV DISCRETE GRA 6FT						x	x	x
5416-967	A	CABLE	MICRONET HIGH DENSITY LV DISCRETE GRA 8 FT						x	x	x
5416-968	A	CABLE	MICRONET HIGH DENSITY LV DISCRETE GRA 10FT						x	x	x
5416-969	A	CABLE	MICRONET HIGH DENSITY LV DISCRETE GRA 12FT						x	x	x
5416-970	A	CABLE	MICRONET HIGH DENSITY LV DISCRETE GRA 14FT						x	x	x
5416-971	A	CABLE	MICRONET HIGH DENSITY LV DISCRETE GRA 16FT						x	x	x
5416-972	A	CABLE	MICRONET HIGH DENSITY LV DISCRETE GRA 18FT						x	x	x
5416-973	A	CABLE	MICRONET HIGH DENSITY LV DISCRETE GRA 20FT						x	x	x
5416-977	A	CABLE	5009 POWER SUPPLY FLAT RIBBON (6 IN)				n/a	x			
5417-019	A	CABLE	5009 RELAY INTERCONNECT (6 INCH LENGTH)				n/a	x			
5417-026	A	CABLE	NETCON LOW DENSITY ANALOG BLACK 6FT				n/a	x	x	x	x
5417-027	A	CABLE	NETCON LOW DENSITY ANALOG BLACK 8FT				n/a	x	x	x	x

Part No	Status	Description	Extended Description	CSA	UL	ATEX	CE (LVD)	CE (EMC)	ABS	DNV	LRS
5417-028	A	CABLE	NETCON LOW DENSITY ANALOG BLACK 10FT				n/a	x	x	x	x
5417-029	A	CABLE	NETCON LOW DENSITY ANALOG BLACK 12FT				n/a	x	x	x	x
5417-030	A	CABLE	NETCON LOW DENSITY ANALOG BLACK 14FT				n/a	x	x	x	x
5417-031	A	CABLE	NETCON LOW DENSITY ANALOG BLACK 16FT				n/a	x	x	x	x
5417-032	A	CABLE	NETCON LOW DENSITY ANALOG BLACK 18FT				n/a	x	x	x	x
5417-033	A	CABLE	NETCON LOW DENSITY ANALOG BLACK 20FT				n/a	x	x	x	x
5417-034	A	CABLE	NETCON LOW DENSITY ANALOG BLACK 22FT				n/a	x	x	x	x
5417-035	A	CABLE	NETCON LOW DENSITY ANALOG BLACK 26FT				n/a	x	x	x	x
5417-036	A	CABLE	NETCON LOW DENSITY ANALOG BLACK 40FT				n/a	x	x	x	x
5417-037	A	CABLE	NETCON 3FT DISCRETE GRA W/BACKSHELL TAPE				n/a	x	x	x	x
5417-038	A	CABLE	NETCON 6FT DISCRETE GRA W/BACKSHELL TAPE				n/a	x	x	x	x
5417-039	A	CABLE	NETCON 8FT DISCRETE GRA W/BACKSHELL TAPE				n/a	x	x	x	x
5417-040	A	CABLE	NETCON 10FT DISCRETE GRA W/BACKSHELL TAPE				n/a	x	x	x	x
5417-041	A	CABLE	NETCON 12FT DISCRETE GRA W/BACKSHELL TAPE				n/a	x	x	x	x
5417-042	A	CABLE	NETCON 14FT DISCRETE GRA W/BACKSHELL TAPE				n/a	x	x	x	x
5417-043	A	CABLE	NETCON 16FT DISCRETE GRA W/BACKSHELL TAPE				n/a	x	x	x	x
5417-044	A	CABLE	NETCON 18FT DISCRETE GRA W/BACKSHELL TAPE				n/a	x	x	x	x
5417-045	A	CABLE	NETCON 20FT DISCRETE GRA W/BACKSHELL TAPE				n/a	x	x	x	x
5417-046	A	CABLE	NETCON 22FT DISCRETE GRA W/BACKSHELL TAPE				n/a	x	x	x	x
5417-047	A	CABLE	NETCON 24FT DISCRETE GRA W/BACKSHELL TAPE				n/a	x	x	x	x
5417-048	A	CABLE	NETCON 26FT DISCRETE GRA W/BACKSHELL TAPE				n/a	x	x	x	x
5417-049	A	CABLE	NETCON 40FT DISCRETE GRA W/BACKSHELL TAPE				n/a	x	x	x	x
5417-171	A	CABLE	MICRONET HIGH DENSITY ANALOG/DISCRETE GRA 6FT UL				n/a	x	x	x	x
5417-172	A	CABLE	MICRONET HIGH DENSITY ANALOG/DISCRETE GRA 8FT UL				n/a	x	x	x	x
5417-173	A	CABLE	MICRONET HIGH DENSITY ANALOG/DISCRETE GRA 10FT UL				n/a	x	x	x	x
5417-174	A	CABLE	MICRONET HIGH DENSITY ANALOG/DISCRETE GRA 12FT UL				n/a	x	x	x	x
5417-175	A	CABLE	MICRONET HIGH DENSITY ANALOG/DISCRETE GRA 14FT UL				n/a	x	x	x	x
5417-176	A	CABLE	MICRONET HIGH DENSITY ANALOG/DISCRETE GRA 16FT UL				n/a	x	x	x	x
5417-177	A	CABLE	MICRONET HIGH DENSITY ANALOG/DISCRETE GRA 18FT UL				n/a	x	x	x	x
5417-178	A	CABLE	MICRONET HIGH DENSITY ANALOG/DISCRETE GRA 20FT UL				n/a	x	x	x	x

Part No	Status	Description	Extended Description	CSA	UL	ATEX	CE (LVD)	CE (EMC)	ABS	DNV	LRS
5417-179	A	CABLE	NETCON TRANSCEIVER 6FT				n/a	x	x	x	x
5417-180	A	CABLE	MICRONET HIGH DENSITY ANALOG/DISCRETE GRA 40FT UL								
5417-229	A	CABLE	THINNET ETHERNET TRIAX 450 FT						x	x	x
5417-290	A	CABLE	MOLDED DB9F TO DB9F NULL MODEM W/THUMBSCREWS				n/a	x			
5417-293	A	CABLE	TMR CHASSIS/POWER SPLY INTERCONNECT				n/a	x			
5417-391	A	CABLE	DOUBLE SHIELDED CAT-5 ETHERNET (SSTP), 1.5 FT				n/a	x	x	x	x
5417-392	A	CABLE	DOUBLE SHIELDED CAT-5 ETHERNET (SSTP), 3 FT				n/a	x	x	x	x
5417-393	A	CABLE	DOUBLE SHIELDED CAT-5 ETHERNET (SSTP), 7 FT				n/a	x	x	x	x
5417-394	A	CABLE	DOUBLE SHIELDED CAT-5 ETHERNET (SSTP), 10 FT				n/a	x	x	x	x
5417-395	A	CABLE	DOUBLE SHIELDED CAT-5 ETHERNET (SSTP), 14 FT				n/a	x	x	x	x
5417-396	A	CABLE	DOUBLE SHIELDED CAT-5 ETHERNET (SSTP), 25 FT				n/a	x	x	x	x
5417-397	A	CABLE	DOUBLE SHIELDED CAT-5 ETHERNET (SSTP), 50 FT				n/a	x	x	x	x
5417-398	A	CABLE	DOUBLE SHIELDED CAT-5 ETHERNET (SSTP), 100 FT				n/a	x			
5417-399	A	CABLE	SHIELDED PS/2 REPLACEMENT (MALE-MALE) 6 FT				n/a	x	x	x	x
5417-400	A	CABLE	SHIELDED PS/2 REPLACEMENT (MALE-MALE) 10 FT				n/a	x	x	x	x
5417-401	A	CABLE	SHIELDED PS/2 REPLACEMENT (MALE-MALE) 15 FT				n/a	x	x	x	x
5417-402	A	CABLE	SHIELDED PS/2 EXT (MALE-FEMALE) 6 FT				n/a	x	x	x	x
5417-403	A	CABLE	SHIELDED PS/2 EXT (MALE-FEMALE) 10 FT				n/a	x	x	x	x
5417-404	A	CABLE	SHIELDED PS/2 EXT (MALE-FEMALE) 15 FT				n/a	x	x	x	x
5417-405	A	CABLE	TRIPLE SHIELDED VGA VIDEO EXT (HD15M-HD15F) 6 FT				n/a	x	x	x	x
5417-406	A	CABLE	TRIPLE SHIELDED VGA VIDEO EXT (HD15M-HD15F) 10 FT				n/a	x	x	x	x
5417-407	A	CABLE	TRIPLE SHIELDED VGA VIDEO EXT (HD15M-HD15F) 15 FT				n/a	x	x	x	x
5417-408	A	CABLE	TRIPLE SHIELDED VGA VIDEO (HD15M-HD15M) 6 FT				n/a	x	x	x	x
5417-409	A	CABLE	TRIPLE SHIELDED VGA VIDEO (HD15M-HD15M) 10 FT				n/a	x	x	x	x
5417-410	A	CABLE	TRIPLE SHIELDED VGA VIDEO (HD15M-HD15M) 15 FT				n/a	x	x	x	x
5417-411	A	CABLE	SHIELDED RS232 SERIAL EXT (DB9M-DB9F) 6 FT				n/a	x	x	x	x
5417-412	A	CABLE	SHIELDED RS232 SERIAL EXT (DB9M-DB9F) 10 FT				n/a	x	x	x	x
5417-413	A	CABLE	SHIELDED RS232 SERIAL EXT (DB9M-DB9F) 15 FT				n/a	x	x	x	x
5418-1560	A	SOFTWARE	9140RF HMI'S ON HARD DISK								
5437-050	INA	DOOR	NETCON 3B SIMPLEX MAIN VFD								

Part No	Status	Description	Extended Description	CSA	UL	ATEX	CE (LVD)	CE (EMC)	ABS	DNV	LRS
5437-052	INA	MODULE	NETCON FIELD TERMINAL								
5437-059	INA	MODULE	I/O XCVR T-MODULE	x			n/a	x	x	x	x
5437-060	ANP	MODULE	NETCON FIELD TERMINAL								
5437-061	INA	MODULE	NETCON DISCRETE INPUT								
5437-078	INA	CHASSIS	NETCON 3B SPLX MAIN						x	x	x
5437-079	INA	MODULE	NETCON FIELD TERMINAL	x							
5437-080	A	MODULE	NETCON FIELD TERMINAL	x			n/a	x	x	x	x
5437-085	ANP	MODULE	NETCON FIELD TERMINAL								
5437-086	INA	MODULE	NETCON FIELD TERMINAL								
5437-087	INA	MODULE	NETCON FIELD TERMINAL								
5437-092	INA	POWER SUP	EXP CHAS (REDUN)						x	x	x
5437-095	ANP	MODULE	DUPLEX FIELD TERMINAL								
5437-096	ANP	MODULE	DUPLEX FIELD TERMINAL								
5437-173	INA	MODULE	NETCON FIELD TERMINAL	x							
5437-281	INA	MODULE	ANALOG FIELD TER (STD)	x							
5437-282	INA	MODULE	ANALOG FIELD TERM (TC)	x							
5437-283	INA	MODULE	ANALOG FIELD TER (ACT)	x							
5437-291	INA	MODULE	NETCON FIELD TERMINAL								
5437-371	ANP	RACK	NETCON 3B REMOTE I/O								
5437-375	INA	MODULE	FIELD TERMINAL								
5437-403	ANP	MODULE	FIELD TERMINAL STD								
5437-404	ANP	MODULE	FIELD TERMINAL TC								
5437-405	INA	MODULE	FIELD TERMINAL ACT								
5437-418	ANP	MODULE	NETCON DERIVATIVE ANAL	x			n/a	x	x	x	x
5437-419	A	MODULE	NETCON 24 CHANNEL FTM	x		x	n/a	x	x	x	x
5437-455	INA	MODULE	SMART 3000 RESISTOR	x					x	x	x
5437-484	INA	MODULE	DUPLEX CURRENT/VOLTAGE FTM				n/a	x	x	x	x
5437-507	A	PANEL	SERVICE NETCON /C						x	x	x
5437-523	A	MODULE	ANALOG FIELD TERM (STD)	x		x	n/a	x	x	x	x
5437-524	A	MODULE	ANALOG FIELD TERM (TC)	x		x	n/a	x	x	x	x
5437-525	INA	MODULE	ANALOG FIELD TERM (ACT)						x	x	x
5437-672	A	MODULE	NETCON FIELD TERMINAL	x		x	n/a	x	x	x	x
5437-687	A	MODULE	NETCON 24 CHANNEL FIELD TERMINAL	x		x	n/a	x	x	x	x
5437-727	INA	MODULE	FTM ASSEMBLY						x	x	x
5437-730	INA	Control	(SNG) York - Unit #1 NetCon/OCP						x		x
5437-838	A	CHASSIS	5009 POWER SUPPLY	x			x	x	x	x	x
5437-839	A	CHASSIS	5009/MICRONET TMR DIGITAL CONTROL	x			n/a	x	x	x	x
5437-843	A	CHASSIS	MICRONET 12 SLOT W/6 SLOT I/O	x			n/a	x	x	x	x
5437-844	INA	CHASSIS	MICRONET 18 SLOT W/12 SLOT I/O	x					x	x	x
5437-845	A	BOARD	NOTCH FILTER 3KHZ	x			n/a	x	x	x	x
5437-852	A	CHASSIS	MICRONET TMR						x	x	x
5439-754	INA	CHASSIS	NETCON 3B SIMPLEX						x	x	x
5439-756	ANP	MODULE	NETCON FIELD TERMINAL								
5439-758	ANP	MODULE	NETCON FIELD TERMINAL								
5439-794	ANP	CHASSIS	NETCON 3B I/O						x	x	x
5441-413	A	RELAY	32 CHAN RELAY INTERFACE	x		x		x	x	x	x
5441-419	A	RELAY	16C INTERFACE [Ordinary Locations Only]		x			x	x	x	x
5441-691	INA	MODULE	16 CHANNEL RELAY FTM [Ordinary Locations Only]				x	x			
5441-693	A	MODULE	HD DISCRETE I/O FTM (24 IN/12 OUT) [Ordinary Locations Only]		x		x	x	x	x	x
5441-694	A	MODULE	HD DISCRETE I/O FTM RELAY DRIVER (24 IN/12 OUT)	x		x	n/a	x	x	x	x
5441-695	A	MODULE	SIMPLEX FTM, DataForth	x		x	n/a	x	x	x	x
5441-697	A	MODULE	TMR FTM, DataForth	x			n/a	x		x	x

Part No	Status	Description	Extended Description	CSA	UL	ATEX	CE (LVD)	CE (EMC)	ABS	DNV	LRS
5453-008	INA	RACK	FADC LOCOP NETCON CHASSIS, DUAL P. S. CONNECTION								
5453-203	INA	PANEL	DISPLAY								
5453-276	A	RELAY	5009 F/T DISCRETE IN [Ordinary Locations Only]		x		x	x	x	x	x
5453-277	A	CHASSIS	MICRONET TMR POWER SUPPLY W/REDUNDANT FANS	x							
5453-278	A	CHASSIS	MICRONET 12 SLOT	x			n/a	x	x	x	x
5453-279	A	CHASSIS	MICRONET TMR	x							
5453-750	INA	Box	MicroNet Ethernet Interface FTM				x	x	x		x
5453-751	INA	BOX	MICRONET VIDEO INTERFACE FTM	x			n/a	x	x	x	x
5453-754	A	BOX	MICRONET ETHERNET INTERFACE FTM	x			n/a	x		x	
5453-759	A	CHASSIS	MICRONET-PLUS 14 SLOT, REDUND WITH SMART FANS	x		x	x	x	x	x	x
5453-829	A	CHASSIS	MICRONET PLUS 8 SLOT, REDUND WITH SMART FANS	x		x	x	x	x	x	x
5454-425	A	CHASSIS	5009 TMR POWER SUPPLY W/REDUNDANT FANS	x							
5458-127	A	Board	NetCon 5000B SIO SMT						x		x
5463-783	INA	MODULE	NETCON DISCRETE INPUT								
5463-784	INA	MODULE	NETCON DISCRETE OUTPUT								
5463-786	INA	MODULE	8 CH ANALOG OUT 4-20MA								
5463-787	INA	MODULE	DIGITAL SPEED SENSOR								
5463-789	INA	MODULE	ANALOG 8 CHANNEL 0-1MA								
5463-870	INA	MODULE	INTEGRATING ACT DRIVER								
5463-872	INA	MODULE	NON-VOLITAL MEMORY								
5463-877	INA	MODULE	4 CHANNEL ACUATOR								
5464-015	INA	MODULE	DIGITAL SPEED SENSOR								
5464-027	INA	MODULE	4 CH. ACT 4-20MA								
5464-035	INA	MODULE	4 CHANNEL ACTUATOR								
5464-125	INA	MODULE	NETCON 5000 MEMORY								
5464-214	ANP	MODULE	NETCON NV MEMORY 1.5M								
5464-215	ANP	MODULE	NETCON NV MEMORY 3M								
5464-310	INA	MODULE	NETCON 5000 SWITCHED M								
5464-332	INA	MODULE	ISO T/C ANALOG IN (HF)	x		x	n/a	x	x	x	x
5464-333	INA	MODULE	ISO T/C HIGH IN	x		x	n/a	x	x	x	x
5464-334	INA	MODULE	ISO 4-20 ANALOG INPUT	x			n/a	x	x	x	x
5464-335	INA	MODULE	ISO 0-10V ANALOG	x			n/a	x	x	x	x
5464-336	INA	MODULE	SEMI ISO RTD 10	x			n/a	x	x	x	x
5464-337	INA	MODULE	SEMI ISO RTD 100	x		x	n/a	x	x	x	x
5464-338	INA	MODULE	SEMI ISO RTD 200	x		x	n/a	x	x	x	x
5464-339	INA	MODULE	SEMI ISO RTD 500	x		x	n/a	x	x	x	x
5464-340	INA	MODULE	SEMI ISO RTD 100 HIGH TEMP	x		x	n/a	x	x	x	x
5464-414	INA	MODULE	DIGITAL SPEED SENSOR								
5464-444	INA	MODULE	NETCON 5000 CPU 40MHZ								
5464-449	INA	MODULE	NETCON 5000 CPU AUX								
5464-458	INA	MODULE	64 CH DISCRETE OUTPUT								
5464-459	ANP	MODULE	NON-VOL MEMORY 500K								
5464-460	ANP	MODULE	NON-VOL MEMORY 1M								
5464-466	INA	MODULE	NETCON 5000B CPU 33MHZ								
5464-544	INA	MODULE	4 CH ACT 0-200MA	x			n/a	x	x	x	x
5464-545	INA	MODULE	4 CH ACT 0-25MA	x			n/a	x	x	x	x
5464-546	INA	MODULE	1,2 0-200MA 3,4 0-25MA								
5464-553	INA	MODULE	INT. ACT DRIVER	x							
5464-554	INA	MODULE	INT. ACT DRIVER	x							
5464-555	INA	MODULE	INT. ACT DRIVER	x							
5464-556	INA	MODULE	INT. ACT DRIVER	x							

Part No	Status	Description	Extended Description	CSA	UL	ATEX	CE (LVD)	CE (EMC)	ABS	DNV	LRS
5464-575	INA	MODULE	SPEED SENSOR								
5464-576	INA	MODULE	SPEED SENSOR								
5464-643	A	MODULE	DISCRETE INPUT	x			n/a	x	x	x	x
5464-644	INA	MODULE	INT. ACT DRIVER	x							
5464-645	INA	MODULE	INT. ACT DRIVER	x							
5464-648	INA	MODULE	ANALOG 8 CH 4-20MA OUT	x					x	x	x
5464-649	INA	MODULE	ANALOG 8 CH 0-1MA OUT	x					x	x	x
5464-650	INA	MODULE	ANALOG 8 CH 0-5V OUT	x					x	x	x
5464-652	INA	MODULE	ANALOG 8 CH 0-10V OUT	x					x	x	x
5464-653	INA	MODULE	32 CH DISCRETE OUT	x					x	x	x
5464-654	A	MODULE	64 CH DISCRETE OUT	x			n/a	x	x	x	x
5464-655	INA	MODULE	4 CHANNEL ACTUATOR	x							
5464-656	INA	MODULE	4 CH. ACT 4-20MA								
5464-657	INA	MODULE	4 CHANNEL ACTUATOR								
5464-658	INA	MODULE	DIGITAL SPEED SENSOR	x		x	n/a	x	x	x	x
5464-659	INA	MODULE	DIGITAL SPEED SENSOR	x			n/a	x	x	x	x
5464-660	INA	MODULE	ISO 4-20MA DERIVATIVE	x			n/a	x	x	x	x
5464-679	INA	MODULE	NETCON 5000 CPU 40MHZ								
5464-697	INA	MODULE	NETCON CPU 40MHZ W/FSH	x							
5464-752	ANP	MODULE	NON VOLATILE MEMORY								
5464-756	ANP	MODULE	NETCON NV MEMORY 4M								
5464-781	INA	MODULE	NETCON ANALOG OVERSPEED								
5464-782	INA	MODULE	NETCON ANALOG OVERSPEED								
5464-834	INA	MODULE	DIGITAL SPEED SENSOR	x		x	n/a	x	x	x	x
5464-837	INA	MODULE	ISO T/C ANALOG IN (HF)	x			n/a	x	x	x	x
5464-839	INA	MODULE	POSITION CONTROLLER TM								
5464-844	INA	MODULE	DIGITAL SPEED SENSOR								
5464-850	INA	MODULE	DIGITAL SPEED SENSOR	x			n/a	x	x	x	x
5464-935	ANP	MODULE	NETCON ANALOG OVERSPEED								
5464-936	ANP	MODULE	NETCON ANALOG OVERSPEED								
5466-001	INA	MODULE	NETCON DUAL SOLENOID MONITOR								
5466-003	INA	MODULE	NETCON PRESSURE XDCR OUTPUT								
5466-026	INA	MODULE	NETCON DUPLEX CURRENT INPUT	x			n/a	x	x	x	x
5466-030	INA	MODULE	POSITION CONTROLLER EM	x			n/a	x	x	x	x
5466-031	INA	MODULE	NETCON I/O CONTROLLER	x		x	n/a	x	x	x	x
5466-037	INA	MODULE	NETCON IIIB REAL TIME SIO								
5466-039	INA	Module	NetCon Kernal Power Supply						x	x	x
5466-045	INA	MODULE	PRESSURE XDUCER INTERFACE				n/a	x	x	x	x
5466-253	A	MODULE	ANALOG COMBO (TMR)	x			n/a	x	x	x	x
5466-254	ANP	MODULE	ACTUATOR DRIVER CH1,CH2 +/- 200MA WITH WIDE NULL SHIFT								
5466-255	ANP	MODULE	ACTUATOR DRIVER CH1,CH2 +/-200MA WITH WIDER NULL SHIFT								
5466-256	INA	MODULE	FT DISCRETE I/O	x			n/a	x	x	x	x
5466-257	A	MODULE	HIGH DENSITY ANALOG I/O (TMR)	x			x	x	x	x	x
5466-258	INA	MODULE	SIMPLEX DISCRETE I/O	x		x	n/a	x	x	x	x
5466-260	INA	MODULE	NETCON IIIB REAL TIME SIO VER2.06								
5466-272	ANP	MODULE	NETCON DUAL SOLENOID MONITOR								
5466-285	A	MODULE	SOLENOID PROTECTION 4CHANNEL 18-30VDC								
5466-315	INA	MODULE	HIGH DENSITY ANALOG I/O	x		x	n/a	x	x	x	x
5466-316	A	MODULE	ANALOG COMBO	x			n/a	x	x	x	x

Part No	Status	Description	Extended Description	CSA	UL	ATEX	CE (LVD)	CE (EMC)	ABS	DNV	LRS
5466-318	INA	MODULE	MICRONET TMR KERNEL P.S.	x			n/a	x			
5466-320	INA	MODULE	SOLENOID PROTECTION 4CHANNEL 18-30VDC								
5466-326	A	MODULE	NETCON IIIB PRESSURE INPUT	x		x	n/a	x	x	x	x
5466-328	A	MODULE	NETCON IIIB 3-9 PIN RT SIO	x		x	n/a	x	x	x	x
5466-332	INA	MODULE	HIGH DENSITY ANALOG I/O	x		x	n/a	x	x	x	x
5466-344	INA	MODULE	POSITION CONTROLLER EM DFB	x			n/a	x	x	x	x
5466-345	INA	MODULE	POSITION CONTROLLER EM SFB	x			n/a	x			
5466-348	ANP	MODULE	NETCON 5000B SIO	x		x	n/a	x	x	x	x
5466-350	INA	MODULE	NETCON CPU_060								
5466-351	INA	MODULE	NETCON CPU_040 WITH LL MEMORY	x							
5466-352	INA	MODULE	NETCON CPU_040 W/O LL MEMORY	x			n/a	x			
5466-353	INA	MODULE	NETCON MAIN CHASSIS TR	x			n/a	x	x	x	x
5466-354	INA	MODULE	NETCON REMOTE CHASSIS TRANSCEIVER	x			n/a	x			
5466-355	INA	MODULE	NETCON REMOTE CHASSIS TRANSCEIVER	x			n/a	x	x	x	x
5466-400	INA	MODULE	ISO 4-20 ANALOG INPUT	x							
5466-404	INA	MODULE	DIGITAL SPEED SENSOR	x							
5466-405	INA	MODULE	DIGITAL SPEED SENSOR								
5466-407	A	MODULE	PENTIUM 233MHZ CPU (W/O OP-SYS)	x			x		x	x	x
5466-409	INA	MODULE	MICRONET PENTIUM CPU,233MHZ,64MB RAM,NT4.0				n/a	x		x	x
5466-411	INA	MODULE	MICRONET ETHERNET (RJ45)	x			n/a	x	x		x
5466-416	INA	MODULE	MICRONET PENTIUM WITH DUAL ETHERNET OPTION	x			n/a	x	x	x	x
5466-419	INA	MODULE	NETCON PENTIUM CPU, 233MHZ,128MB RAM,NT4.0,RTX4.3.2.1	x							
5466-425	INA	MODULE	HIGH DENSITY ANALOG I/O (TMR)	x			n/a	x		x	x
5466-1000	A	MODULE	POWER SUPPLY, 2 SLOT, 24VDC INPUT, MICRONET-PLUS	x		x	x	x	x	x	x
5466-1001	A	MODULE	POWER SUPPLY, 2 SLOT, 110VAC/125VDC INPUT, MICRONET-PLUS	x		x	x	x	x	x	x
5466-1002	A	MODULE	POWER SUPPLY, 2 SLOT, 220VAC INIPUT, MICRONET-PLUS	x		x	x	x	x	x	x
5466-1005	INA	MODULE	ISO T/C FAIL LOW	x							
5466-1006	INA	MODULE	ISO T/C FAIL HIGH	x						x	
5466-1007	INA	MODULE	ISO 4-20 ANALOG IN	x							
5466-1008	INA	MODULE	ISO 0-10 V ANALOG	x							
5466-1009	INA	MODULE	ISO 4-20 ANALOG IN	x							
5466-1010	INA	MODULE	ISO 4-20 MA DERIVATIVE	x							
5466-1011	INA	MODULE	ISO 4-20/ AD590 ANALOG IN	x							
5466-1012	INA	MODULE	ISO T/C ANALOG IN (HF)	x							
5466-1013	INA	MODULE	SEMI ISO RTD 100	x						x	

Part No	Status	Description	Extended Description	CSA	UL	ATEX	CE (LVD)	CE (EMC)	ABS	DNV	LRS
5466-1014	INA	MODULE	SEMI ISO RTD 200	x							
5466-1015	INA	MODULE	SEMI ISO RTD 500	x							
5466-1016	INA	MODULE	SEMI ISO RTD 100 HIGH TEMP	x							
5466-1017	INA	MODULE	SEMI ISO RTD 100 (10MS)	x							
5466-1018	INA	MODULE	SEMI ISO RTD 200 (10MS)	x							
5466-1019	INA	MODULE	SEMI ISO RTD 500 (10MS)	x							
5466-1020	INA	MODULE	PENTIUM CPU W/ APPL S/W FOR D-R LM2500+								
5466-1035	A	MODULE	MICRONET CPU5200 (POWERPC MPC5200, 400MHZ, 64MB FLASH, 128MB RAM, DUAL CAN)	x		x	x	x	x	x	
5466-1036	A	MODULE	MICRONET REMOTE RTN (REMOTE REAL TIME NETWORK XCVR)	x		x	x	x	x	x	
5466-1037	INA	MODULE	MICRONET CPU5200L (POWERPC MPC5200, SINGLE ETHERNET, SINGLE CAN, NO RTN)	x		x	x	x	x	x	
5466-1045	A	MODULE	MICRONET PLUS CPU5200 (CYBER-SECURITY)	x		x	n/a	x	x	x	x
5466-1046	A	MODULE	MICRONET PLUS RTN (CYBER-SECURITY)	x		x	n/a	x	x	x	x
5466-1047	A	MODULE	MICRONET TMR CPU5200, 400MHz, 64MB FLASH, 128MB RAM, NO-CAN	x			x	x			
5466-1049	A	MODULE	MICRONET TMR PLUS KERNEL P.S.	x			n/a	x			
5466-1050	A	MODULE	MICRONET DIO SIMPLEX	x		x	n/a	x	x	x	x
5466-1051	A	MODULE	MICRONET DIO TMR	x			n/a	x	x	x	x
5466-1070	INA	MODULE	ANALOG COMBO (TMR) 3 MPU/1 PROX				n/a	x	x	x	x
5466-1105	A	MODULE	MICRONET SPEED/ANALOG I/O COMBO - 4X SPEED, 12X I/V SELECTABLE INPUTS, 4X 4-20 MA OUTPUTS	x		x	n/a	x	x	x	x
5466-1115	A	MODULE	MICRONET HIGH DENSITY COMBO I/O - 4 SPEED INPUTS (SELECTABLE MPU/PROX/EDDY), 12 ANALOG INPUTS (SELECTABLE 4-20 MA OR 0-5 V), 4 ANALOG OUTPUTS (4-20 MA 600 OHM)	x		x	n/a	x	x	x	x
5466-1141	A	MODULE	MICRONET PLUS CPU5200SA (SECURED APPLICATION)	x		x	n/a	x	x	x	X
5466-1145	A	MODULE	MICRONET PLUS CPU5200 (CYBER-SECURITY) LICENSED	x		x	n/a	x	x	x	x
5466-1146	A	MODULE	MICRONET PLUS RTN (CYBER-SECURITY) LICENSED	x		x	n/a	x	x	x	x
5466-1156	A	MODULE	MICRONET TMR 48/24 HDDIO-2 SMART-PLUS	x			n/a	x			
5466-1158	A	MODULE	MICRONET SIMPLEX 48/24 HDDIO-2 SMART-PLUS	x		x	n/a	x	x	x	x
5466-1245	A	MODULE	MICRONET PLUS CPU5200 (CYBER-READY) EHANCED PERF.	x		x	n/a	x	x	x	X

Part No	Status	Description	Extended Description	CSA	UL	ATEX	CE (LVD)	CE (EMC)	ABS	DNV	LRS
5466-1246	A	MODULE	MICRONET PLUS RTN (CYBER-READY) EHANCED PERF.	x		x	n/a	x	x	x	x
5466-1247	A	MODULE	MICRONET TMR CPU5200, SHARED RTN	x			n/a	x			
5466-1250	A	MODULE	MICRONET TMR CPU5200, DIRECT EXPANSION	x			n/a	x			
5466-1347	A	MODULE	MICRONET TMR CPU5200, SHARED RTN W/CANOPEN	x							
5466-1510	ANP	MODULE	MICRONET PLUS P1020 CPU (NON-SECURE)	x		x	n/a	x	x	x	x
5466-1511	A	MODULE	MICRONET PLUS P1020 CPU	x		x	n/a	x	x	x	x
5466-1520	ANP	MODULE	MICRONET PLUS P1020 CPU (SECURED APPLICATION)	x		x	n/a	x	x	x	x
5466-1521	A	MODULE	MICRONET PLUS P1020 CPU (CYBER SECURITY APPLICATION)	x		x	n/a	x	x	x	x
5466-5000	A	MODULE	MODULE - MICRONET SPEED SENSOR, 4 CHANNEL, MPU	x		x	n/a	x	x	x	X
5466-5001	A	MODULE	MODULE - MICRONET SPEED SENSOR, 4 CHANNEL, EDDY PROBE CH1/MPU	x		x	n/a	x	x	x	x
5466-5002	A	MODULE	MICRONET SPEED SENSOR, 4 CHANNEL, 2 MPU/2 PROX SMART-PLUS	x		x	n/a	x	x	x	x
5466-5003	A	MODULE	MICRONET SPEED SENSOR, 4 CHANNEL, 3 MPU/1 PROX SMART-PLUS	x		x	n/a	x	x	x	x
5466-5006	A	MODULE	MODULE - SIO MODULE, W/SCREW POSTS, SMART-PLUS	x		x	n/a	x			
5466-5007	A	MODULE	MODULE - SIO MODULE, W/SLIDE LOCK, SMART-PLUS	x		x	n/a	x			
5466-5025	A	MODULE	MODULE - MICRONET HIGH DENSITY ANALOG I/O - 24 INPUTS (SELECTABLE 4-20 MA OR 0-5 V), 8 OUTPUTS (4-20 MA 600 OHMS) ISOLATED I/O	x		x	n/a	x	x	x	x
5466-5026	A	MODULE	MODULE - MICRONET SIMPLEX HIGH DENSITY ANALOG I/O - 24X 4-20 MA INPUTS, 8X 4-20 MA OUTPUTS	x		x	n/a	x	x	x	x
5466-5027	A	MODULE	MODULE - MICRONET SIMPLEX HIGH DENSITY ANALOG I/O - DATAFORTH 24X 0-5 V INPUTS, 8X 4-20 MA OUTPUTS	x		x	n/a	x	x	x	x
5500-332	A	MODULE	RELAY								
5501-224	INA	BOARD	FAULT TOLERANT RELAY [Ordinary Locations Only]								
5501-325	A	BOARD	MICRONET HV DISC FTM	x					x	x	x
5501-361	A	SENSOR	EMR 1000 Flex Circuit Speed						x		
5501-365	A	BOARD	ANALOG COMBO TMR FTM	x			n/a	x	x	x	x
5501-367	A	BOARD	MICRONET SIMPLEX LV DISCRETE FTM	x		x	n/a	x	x	x	x
5501-370	A	BOARD	5009/MICRONET TMR POWER SUPPLY (24V DC)	x			n/a	x	x	x	x
5501-371	A	BOARD	MICRONET SIMPLEX MPU & AIO FTM	x			n/a	x	x	x	x
5501-372	A	BOARD	HIGH DENSITY ANALOG I/O TRIPLEX FTM	x					x	x	x
5501-373	INA	BOARD	F/T RELAY - UL APPROVED [Ordinary Locations Only]								

Part No	Status	Description	Extended Description	CSA	UL	ATEX	CE (LVD)	CE (EMC)	ABS	DNV	LRS
5501-376	A	BOARD	ANALOG HIGH DENSITY MODULE SIMPLEX FTM	x		x	n/a	x	x	x	x
5501-380	A	BOARD	5009/MICRONET TMR POWER SUPPLY (120V AC/DC)	x			x	x	x	x	x
5501-381	A	BOARD	5009/MICRONET TMR POWER SUPPLY (220V AC)	x			x	x	x	x	x
5501-409	A	Board	MicroNet Motherboard (6 Slot)	x					x		x
5501-410	INA	Board	MicroNet Power Supply (24V DC)	x					x		x
5501-411	INA	Board	MicroNet Power Supply (120V AC/DC)	x					x		x
5501-412	INA	Board	MicroNet Power Supply (220V AC)	x					x		x
5501-423	A	Board	MicroNet Motherboard (12 Slot)	x					x		x
5501-428	ANP	BOARD	NETCON 2CH ACTUATOR CONTROLLER (10MA)	x			n/a	x	x	x	x
5501-429	ANP	BOARD	NETCON 2CH ACTUATOR CONTROLLER (25MA)	x		x	n/a	x	x	x	x
5501-430	ANP	BOARD	NETCON 2CH ACTUATOR CONTROLLER (50MA)	x		x	n/a	x	x	x	x
5501-431	ANP	BOARD	NETCON 2CH ACTUATOR CONTROLLER (100MA)	x		x	n/a	x	x	x	x
5501-432	ANP	BOARD	NETCON 2CH ACTUATOR CONTROLLER (200MA)	x		x	n/a	x	x	x	x
5501-461	INA	MODULE	POSITION CONTROLLER TM DFB	x				x	x	x	x
5501-462	INA	MODULE	POSITION CONTROLLER TM SFB	x				x	x	x	x
5501-465	A	BOARD	MICRONET SIMPLEX POWER SUPPLY (24V DC)	x			x	x	x	x	x
5501-466	A	BOARD	MICRONET SIMPLEX POWER SUPPLY (120V AC/DC)	x			x	x	x	x	x
5501-467	A	BOARD	MICRONET SIMPLEX POWER SUPPLY (220V AC/DC)	x			x	x	x	x	x
5501-468	INA	MODULE	NETCON CPU_040 W/O LL MEMORY				n/a	x			
5501-469	INA	MODULE	NETCON CPU_040 WITH LL MEMORY (EMI FILTER)	x			n/a	x			
5501-470	INA	MODULE	NETCON CPU_040 W/O LL MEMORY (EMI FILTER)	x			n/a	x			
5501-471	ANP	MODULE	NETCON 5000B SIO W/SCREW POSTS	x		x	n/a	x	x	x	x
5501-473	ANP	MODULE	NETCON DUAL OVERSPEED								
5501-476	INA	MODULE	NETCON DUAL OVERSPEED								
5501-477	INA	MODULE	NETCON DUAL OVERSPEED @ 5478 HZ								
5501-478	INA	MODULE	NETCON DUAL OVERSPEED @ 5404 HZ								
5501-479	INA	MODULE	NETCON DUAL OVERSPEED @ 6160 HZ								
5501-502	A	MODULE	TMR SPEED INPUT FTM								
5501-1428	A	MODULE	2CH ACTUATOR CONTROLLER (10MA) W/ FEEDBACK FAULT LATCHING	x		x	n/a	x	x	x	x
5501-1429	A	MODULE	2 CH ACTUATOR CONTROLLER (25MA) W/ FEEDBACK FAULT LATCHING	x		x	n/a	x	x	x	x

Part No	Status	Description	Extended Description	CSA	UL	ATEX	CE (LVD)	CE (EMC)	ABS	DNV	LRS
5501-1430	A	MODULE	2CH ACTUATOR CONTROLLER (50MA) W/ FEEDBACK FAULT LATCHING	x		x	n/a	x	x	x	x
5501-1431	A	MODULE	2CH ACTUATOR CONTROLLER (100MA) W/ FEEDBACK FAULT LATCHING	x		x	n/a	x	x	x	x
5501-1432	A	MODULE	2CH ACTUATOR CONTROLLER (200MA) W/ FEEDBACK FAULT LATCHING	x		x	n/a	x	x	x	x
5503-267	A	MODULE	NETCON IIIB 3-9 PIN RT SIO W/SCREW POSTS	x			n/a	x		x	
5503-279	INA	BOARD	MICRONET HDVIM (AI/RTD/TC) THRU HOLE ASSY	x			x	x	x	x	x
5503-282	INA	MODULE	FTM HDVIM (AI/RTD/TC) THRU HOLE ASSY	x			x	x	x	x	x
5503-335	INA	MODULE	MICRONET 5200 CPU, 400MHZ, 64MB FLASH, 128MB RAM	x			x	x		x	
5503-336	INA	MODULE	MICRONET REAL-TIME NETWORK XCVR (REMOTE)	x			x	x		x	
5503-904	INA	MODULE	HD ANALOG I/O 12 CH 4-20MA AND 12 CH 0-5V	x							
8928-096	INA	KIT	CPU EMI DB9 RS232 ADAPTOR								
9905-678	INA	MODULE	LINKNET 6 CHANNEL 200 OHM RTD		x	x	n/a	x	x	x	x
9905-760	INA	MODULE	ASSY OF LINKNET TERMINATION		x	x	n/a	x	x	x	x
9905-966	INA	MODULE	LINKNET TC INPUT FAIL HIGH		x	x	n/a	x	x	x	x
9905-967	INA	MODULE	LINKNET TC INPUT FAIL LOW		x	x	n/a	x	x	x	x
9905-968	INA	MODULE	LINKNET 6 CHANNEL 4-20 MA IN		x	x	n/a	x	x	x	x
9905-969	INA	MODULE	LINKNET 6 CHANNEL 4-20 MA IN W/ 24 V		x	x	n/a	x	x	x	x
9905-970	INA	MODULE	LINKNET 6 CHANNEL 100 OHM RTD		x	x	n/a	x	x	x	x
9905-971	INA	MODULE	LINKNET DISCRETE IN		x	x	n/a	x	x	x	x
9905-972	INA	MODULE	LINKNET 6 CHANNEL 4-20 MA OUT		x	x	n/a	x	x	x	x
9905-973	INA	MODULE	LINKNET DISCRETE OUT		x	x	n/a	x	x	x	x
9907-072	INA	Power Supply	SGL Out 18-32 VDC NetCon	x			x	x	x	x	x
9907-073	INA	Power Supply	Multi Out 18-32 VDC NetCon	x			x	x	x	x	x
9907-074	INA	Power Supply	SGL Out 42-60 VDC NetCon	x			x	x	x	x	x
9907-075	INA	Power Supply	Multi Out 42-60 VDC NetCon	x			x	x	x	x	x
9907-076	INA	Power Supply	SGL Out 120 VAC/DC NetCon	x			x	x	x	x	x
9907-077	INA	Power Supply	Multi Out 120 VAC/DC NetCon	x			x	x	x	x	x
9907-078	INA	Power Supply	SGL Out 220 VAC/DC NetCon	x			x	x	x	x	x
9907-079	INA	Power Supply	Multi Out 220 VAC/DC NetCon	x			x	x	x	x	x
9907-205	A	Programmer	Hand Held, CE Compliant, 4 Piece Kit				x	x	x		

Updated: August 2024

Status	Definition
A	Active
ANP	Active, Non-preferred
AS	Active Service
INA	Inactive
A	Active

Appendix B. Environmental Specifications

Operating Temperature for The MicroNet TMR Control r	0 to +55 °C (+32 to +131 °F) Lloyd's: ENV 2

NOTICE **Continuous operation with insufficient airflow or higher operating temperatures will lead to reduced reliability and possible damage.**

Storage Temperature:	–40 to +105 °C (–40 to +221 °F) Except CPU module: –20 to +45 °C (–4 to +113 °F) to maximize real time clock battery life. Component life is adversely affected by high temperature, high humidity environments. Room temperature storage is recommended for long life. If unit is to be stored for a long period of time, operating power must be applied at least once every 18–24 months.
Humidity (TMR, Simplex):	Lloyd's Register Test Specification No. 1, 1996, Humidity Test 1 (2 cycles 20–55 °C at 95% RH non-condensing, over 48 hours) EN 50178 (96 hours @ 93 +2 -3% RH @ 40 °C (104 °F))
Humidity (MicroNet Plus):	Lloyd's Register Test Specification No. 1, 2002, Humidity Test 1 (2 cycles 20–55 °C at 95% RH non-condensing, over 48 hours) EN50178 (96 hours @ 93 +2 -3% RH @ 40 °C (104 °F))
Vibration (TMR, Simplex):	Lloyd's Register Test Specification No. 1, 1996, Vibration Test 1 (5–13.2 Hz, ±1 mm; 13.2–100 Hz, ±0.7 g) EN 50178 vibration test 1 (10–57 Hz @ 0.075 mm amplitude and 57–150 Hz @ 1 g, 10 sweeps per axis at 1 octave/minute)
Vibration (MicroNet Plus):	Lloyd's Register Test Specification No. 1, 2002, Vibration Test 1 (3–16 Hz, ±1 mm; 16–100 Hz, ±1.0 g) EN 50178 vibration test 1 (10–57 Hz @ 0.075 mm amplitude and 57–150 Hz @ 1 g, 10 sweeps per axis at 1 octave/minute)
Shock:	US MIL-STD-810C, Figure 516.2-1 procedure 1b (15 g 11 ms half sine pulse)
Air Quality:	Pollution Degree 2 Note: For Extended Atmospheric Environment Requirements please reference Application Note 51530.
Altitude (max.):	4000 m
Installation Overvoltage Rating:	Category II
Ingress Protection:	In accordance with the requirements of IP20 as defined in IEC 529, unless mounted in a protective enclosure.
Sound Level:	Less than 70 dBA
Weight:	MicroNet TMR, Plus, or Simplex I/O Chassis Weight (varies with module set, and may require 2 people to lift safely): 22 kg (48 lb.) MicroNet TMR/5009 Main Power Supply Chassis Weight (varies with module set): 8 kg (17 lb.)
Dielectric Withstand:	24 V power supply: 707 Vdc from power input to chassis AC/DC and HVAC version: 2200 Vdc from power input to chassis

⚠WARNING **Ground leakage exceeds 3.5 mA. Protective earth grounding is required.**

Appendix C.
MicroNet Hardware and Software Compatibility

IMPORTANT

- **Upgrading from one Control Platform to another typically requires hardware or CPU changes and a coder conversion.**
- **During upgrades, it is always recommended to verify that the system is using preferred hardware part numbers and current revisions to take advantage of any robustness improvements that have been made.**
- **When converting from older systems to the newer MicroNet Plus family, Coder 4.00 (or greater) must be used and all hardware modules must be preferred part numbers with current revisions as of OCT-2005.**
- **For specific I/O modules, important update notes are listed in the Module Compatibility list.**

C.1 Coder and CPU Compatibility Matrix

Table C-1. Coder Compatibility with CPU Modules

		CPU Modules						
		CPU P1020	CPU 5200 Cyber/ Enhanced	CPU 5200	CPU 5200 TMR	Pentium	Motorola x040	Motorola x060
Coder List	Micronet 1.0	●	●					
	Coder 6.x		●					
	Coder 5.x			●	●			
	Coder 4.x			●				
	Coder 3.x					●	●	
	Coder 2.x						●	●
	TMR 1.0				●			

C.2 Control Platforms and CPU Compatibility Matrix

Table C-2. Control Platforms with CPU Modules.

		CPU Modules						
		CPU P1020	CPU 5200 Cyber/ Enhanced	CPU 5200	CPU 5200 TMR	Pentium	Motorola x040	Motorola x060
Control Platforms	MicroNet Plus [1]	●	●	●				
	MicroNet Simplex 12	●	●	●		●	●	●
	MicroNet Simplex 6	●	●	●		●	●	●
	MicroNet TMR [2, 3]				●		●	●
	NetCon Simplex					●	●	●
	NetCon Remote I/O						●	●
	NetCon F/T						●	●

NOTES:

(1) CAN communications and short chassis enabled in Coder 4.02

(2) If used with an expansion chassis, a Plus Expansion Chassis is required.

(3) 040 TMR only compatible with Coder 2.x

C.3 Module Compatibility Matrix

IMPORTANT

- **MicroNet Plus Family refers to using the 14 or 8 slot chassis.**
- **MicroNet Simplex Family refers to using the 12 slot or 6 slot chassis.**
- **MicroNet TMR Family refers to using the TMR 18 slot chassis and supports using the PLUS or Simplex chassis as an expansion rack.**

Table C-3. Module Compatibility Matrix

Module Compatibility	MicroNet Family					Notes
	TMR	Plus		Simplex		
Power Supplies	**Main**	**Main**	**Exp**	**Main**	**Exp**	
MicroNet Plus, 2-Slot		●	●			
MicroNet Simplex, 3-Slot				●	●	
MicroNet TMR, 3-Slot						Must use in a TMR PS rack
MicroNet TMR, Kernel PS, 1-slot	●					
CPU Modules						
CPU, TMR5200	●					Only for TMR rack, CAN not active
CPU, PowerPC 5200		●		●		Updated 2006 for CAN, Plus8 chassis
CPU, Pentium				●		
CPU, Motorola x040				●		

CPU, Motorola x060				●		
Expansion Transceivers						
Remote RTN Transceiver			●		●	Requires use of CPU5200
Main Expansion XCVR (copper)				●	●	Not allowed with CPU5200
Remote Expansion XCVR(copper)				●	●	Not allowed with CPU5200
Fiber Optic Remote XCVR						Not allowed with CPU5200
Communication Modules						
Serial I/O (4 port)	●	●		●		Use 5466-348A, 5466-471, or later
RTSIO, Real Time SIO (3ch)	●	●	●	●	●	
LINKnet LON Network Controller	●	●	●	●	●	
Ethernet module (1 port, 10Mbps)				●		Not allowed with CPU5200 or Pentium
Combo Modules						
High Density Analog (24/8)	●	●	●	●	●	Updated 2001
24/8 Analog Smart-Plus Module	●	●	●	●	●	See section 8.31 for coder compatibility information.
Speed/Analog IO Combo Smart-Plus Module	●	●	●	●	●	See section 8.32 for coder compatibility information.
Discrete I/O Smart-Plus (48/24 HDDIO)	●	●	●			Released in 2010,. Coder 5.03 or greater required. Use 5466-1158 (Simplex) or 5466-1156 (TMR) for backward compatibility with Coder 4.06.
High Density Discrete (48/24)	●	●	●	●	●	Updated 2007 required for CPU5200
Analog Input MPU Combo	●	●	●	●	●	Updated 2001
Analog Input TC/RTD (34ch)	●	●	●	●	●	Available in Coder 3.02 and above Updated 2004
Module Compatibility	**MicroNet Family**					**Notes**
	TMR		**Plus**		**Simplex**	
Input Modules						
Speed Sensor MPU Input (4ch)	●	●	●	●	●	For CPU5200 Cyber-Security compatibility, see chart in section 8.29.1
Speed Sensor Smart-Plus Module	●	●	●	●	●	See section 8.30 for coder compatibility information.
Analog Input 4–20 mA (8ch)	●	●	●	●	●	
Analog Input T/C (8ch)	●	●	●	●	●	
Analog Input RTD (8ch)	●	●	●	●	●	
Discrete Input (64ch)	●	●	●	●	●	
Discrete Input (32ch)	●	●	●	●	●	
Pressure Input	●	●	●	●	●	
Voltage Input (8ch)	●	●	●	●	●	
Output Modules						
Actuator Controller (2ch)	●	●	●	●	●	Updated 2004
Integrating Actuator Driver (2ch)						Available in Coder 3.00 and below
Proportional Actuator Driver (4ch)	●	●	●	●	●	
Position Control Module (PCM)		●	●	●	●	
Analog Output 4-20ma (8ch)	●	●	●	●	●	
Voltage Output (8ch)	●	●	●	●	●	

Appendix D. Acronyms

A	Ampere
ac	Alternating Current
Act	Actuator
A/D	Analog-to-Digital
AD590	Temperature Measurement Device
AI	Analog Input
AM	Amplitude Modulated
App	Application
AO	Analog Output
ASTM	American Society of Testing and Materials
AWG	American Wire Gauge
Baud	Bits per Second (Data Transmission Rate)
BIOS	Basic I/O Software
BOM	Bill of Materials
CAN	Control Area Network
CAT	Category
COAX	Co-axial
cm	Centimeter
CD-ROM	Computer Disc Read Only Memory
CE	Symbol representing compliance to the EU Directives
Ch	Channel
CJ	Cold Junction
CMRR	Common Mode Rejection Ratio
COM	Communication
Combo	Combination
CPU	Central Processor Unit
CSR	Control Status register
dB	Decibel
dc	Direct Current
DCS	Distributed Control System
DFB	Dual Feedback
DLE	Dry Low Emissions
DI	Discrete Input
DIN	Deutsche Institut für Normung
DIO	Discrete Input/Output
DIP	Dual Inline Package
DO	Discrete Output
DPDT	Double Pole/Double Throw
DRAM	Dynamic Random Access Memory
Drv	Driver
DSP	Digital Signal Processor
DTR	Data Terminal Ready
DUART	Dual Universal Asynchronous Receive/Transmit
EIA	Electronic Industry Alliance
EM	Woodward Actuation Family (Electric Motor)
EM-35	Woodward Actuation Model (Electric Motor)
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EN	Europäische Norm (European Norm)
ESD	Electrostatic Discharge
EU	European Union

FDBK	Feedback
FDOC	Fixed Disk on Chip
FS	Full Scale
FTM	Field Termination Module
FPU	Floating Point Unit
G	Force of Gravity
GAP	Woodward Graphical Application Program(mer)
GND	Ground
GS	Woodward Gas Valve Family
HDVIM	High Density Versatile Input Module
HMI	Human Machine Interface
Hz	Hertz (cycles per second)
HD	High Density
HV	High Voltage
HVAC	High Voltage Alternating Current
IEC	International Electro technical Commission
IEEE	Institute of Electronic & Electrical Engineers
IP	Internet Protocol
I/O	Input/Output
IOLOCK	I/O Control Signal on MicroNet Motherboard
ISO	International Standards Organization
KB	Data Transmission Rate / 1000
KBAUD	Same as KB
LED	Light Emitting Diode
LINKnet	Woodward Local Area Network Product Line
LM	GE Gas Turbine Family
LPT1	Line Printer Terminal #1
LQ	Woodward Liquid Valve Family
LV	Low Voltage
LVD	Low Voltage Directive
LVDT	Linear Variable Differential Transformer
mA	Milliampere
Max	Maximum
Mbps	Million Bits per Second
MFT	Minor Frame Timer
Min	Minimum
MPU	Magnetic Pick-up
ms	Millisecond
mV	Millivolt
MUX	Multiplex(er)
NEC	(US) National Electrical Code
NTCPU	CPU That Runs Microsoft NT Operating System
NT Pentium	Same as NTCPU
NV	Non-volatile
OPC	OLE for Process Control (Communication Protocol)
OPSYS	Operating System
O/S	Overspeed
PC	Personal Computer
PC104	Type of Bus Structure Used in PC Industry
PCB	Printed Circuit Board
PCM	Position Controller Module
PCMCIA	Personal Computer Memory Card International Association
PE	Protective Earth
PPM	Parts Per Million
PROM	Programmable Read Only Memory
PS	Power Supply
PS/2	IBM trademark for keyboard/mouse port

PWM	Pulse Width Modulation
RAM	Random Access Memory
RTD	Resistance Temperature Device
RVDT	Rotary Variable Differential Transformer
Rx	Receive
SAE	Society of Automotive Engineers
SFB	Single Feedback
Shld	Shield
Simplex	Control scheme that utilizes one core processor
SIO	Serial Input/Output
SPDT	Single Pole/Double Throw
SSTP	Shielded Twisted Pair
STP	Shielded Twisted Pair
TC	Thermocouple
TCP/IP	Transmission Control Protocol/Internet Protocol
TM	Woodward Actuator Family (Torque Motor)
TM100	Woodward Actuator Model (Torque Motor)
TMR	Triple Modular Redundant
Tx	Transmit
USB	Universal Serial Bus
UART	Universal Asynchronous Receive/Transmit
UL	Underwriters Laboratories
Vac	Volts ac (Alternating Current)
Vdc	Volts dc (Direct Current)
VFD	Vacuum Florescent Display
VME	VERSA Module Eurocard
VRMS	Volts RMS (root mean square)
W	Watt
Xcvr	Transceiver
Xdcr	Transducer
68030	Motorola Microprocessor
68040	Motorola Microprocessor
µA	Microampere

Revision History

Changes in Revision P—

- Moved Chapter 10 – LinkNet I/O Network from Volume 2 to Volume 3 MicroNet TMR manual 26167V3
- Updated Table 12-1 DataForth Module Types
- Updated Appendix A – Matrix of Modules with Compliance Information

Changes in Revision N —

- Added ID numbers 200 and 201 to Table 15-2
- Replaced CAN LEDs definition in Chapter 15
- Added Modules 5466-1247 (CPU5200) and 5466-1347 (CPU5200 Dual CAN) to Appendix A
- Updated the following modules in Appendix A
  - Inactivated 5437-059
  - Activated 5466-257
  - Added 5466-1347
- Multiple updates in Appendix A to align with changes in the table not documented above

Changes in Revision M —

- Replaced paragraph in Chapter 13
- Added CAN I/O Connections section 14.2.16 to Chapter 14. Renumbered the sections which follow
- Replaced CAN LEDs definition in Chapter 15
- Added Modules 5466-1247 (CPU5200) and 5466-1347 (CPU5200 Dual CAN) to Appendix A
- Added ID numbers 200 and 201 to Table 15-2

Changes in Revision L—

- Three new figures added to section 12.2
- Figure 12-26 revised length in the outline dimensions
- Important boxes changed to Warning in Section 12.3.3., 12.4.1, 12.4.2, and 12.4.3
- Added full Warning and French language warning to section 12.4.3
- Removed reference slot A2 from first paragraph in Chapter 15.7
- Added content to note in CPU Module Replacement Procedure in Chapter 15.7
- Split Table C-1 into Tables C-1 and C-2. Renumbered existing Table C-2 to Table C-3
- Added note to top of Appendix A

Changes in Revision K—

- Updated DOC & DOI
- Added note to Air Quality in Appendix B
- Moved sections in Chapters 9 and 12 to Volume 3
- Added switches 1711-1350 and 1711-1351 to the Compliance Matrix

Changes in Revision J—

- Updated compliance matrix in Appendix A
- Modules 5464-458 and 5464-653 marked inactive in compliance matrix.

Changes in Revision K—

- Removed one view of the Analog Input FTM Outline Dimensions from Chapter 12
- Removed TMR Speed Input FTM Analog Input FTM Schematic from Chapter 12
- Inserted Speed/Analog IO Combo Smart-Plus Module information into the C.2 Module Compatibility Matrix
- Part Number 5466-5027 has been changed to Part Number 5466-5035 in Chapter 8.

Changes in Revision H—

- Updated some figures and text as marked to improve clarity

Changes in Revision G—

- Updated several drawings as marked
- Updated LINKnet current input module information
- Updated Appendix A
- Updated Compatibility chart (Appendix C)

Declarations

EU DECLARATION OF CONFORMITY

EU DoC No.:	00103-04-CE-02-01
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Name(s)/Number(s):	MicroNet™ TMR and 5009 MicroNet™ TMR families of Digital Control Systems, 18-36 VDC.
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/30/EU on the harmonisation of the laws of the Member States relating to electromagnetic compatibility, EMC
Applicable Standards:	EN 61000-6-4, 2007/A1:2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments EN 61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments

This declaration of conformity is issued under the sole responsibility of the manufacturer
We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER

Signature

Christopher Perkins
Full Name

Engineering Manager
Position

Woodward, Fort Collins, CO, USA
Place

20 - MAY - 2016
Date

5-09-1183 Rev 24

EU DECLARATION OF CONFORMITY

EU DoC No.:	00103-04-CE-02-08
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Name(s)/Number(s):	MicroNet™ TMR and 5009 MicroNet™ TMR families of Digital Control Systems, 88-264 VAC, and 100-300VDC.
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	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)
	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
Applicable Standards:	EN 61000-6-4, 2007/A1:2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments
	EN 61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments
Last two digits of the year in which the CE marking was affixed for the first time:	00

This declaration of conformity is issued under the sole responsibility of the manufacturer
We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER

Signature

Christopher Perkins
Full Name

Engineering Manager
Position

Woodward, Fort Collins, CO, USA
Place

06-MAY-2016
Date

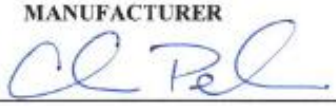
5-09-1183 Rev 26

EU DECLARATION OF CONFORMITY

EU DoC No.:	00117-04-EU-02-01
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Name(s)/Number(s):	LinkNet Modules; Termination Module, 9905-760; T/C Input, 9905-966; -967; Analog Input, 9905-968; -969; RTD, 9905-970, -678; Discrete In, 9907-971; Analog Output, 9905-972; Discrete Out, 9905-973.
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	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 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)
Markings in addition to CE marking:	Ex Category 3 Group II G, Ex nA [nL] IIC T4 X
Applicable Standards:	EN 61000-6-4, 2007/A1:2011: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments EN 61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments EN60079-15; 2005: Electrical apparatus for explosive gas atmospheres – Part 15: Type of protection "n" EN 60079-0: 2009 Explosive atmospheres – Part 0 – General Requirements
Conformity Assessment:	ATEX Annex IV - Production Quality Assessment, 01 220 113542 TUV Rheinland Industrie Service GmbH (0035) Am Grauen Stein, D51105 Cologne

This declaration of conformity is issued under the sole responsibility of the manufacturer
We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER



Signature

Christopher Perkins

Full Name

Engineering Manager

Position

Woodward, Fort Collins, CO, USA

Place

06- MAY- 2016

Date

5-09-1183 Rev 26

Released

We appreciate your comments about the content of our publications.

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WOODWARD

PO Box 1519, Fort Collins CO 80522-1519, USA
1041 Woodward Way, Fort Collins CO 80524, USA
Phone +1 (970) 482-5811

Email and Website—www.woodward.com

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