This manual replaces manual 85584 for the MicroNet TMR.

Installation and Operation Manual, Volume 2 of 2
DEFINITIONS

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

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

**WARNING**

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.

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

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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.

**NOTICE**

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.

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*.

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

- CPU and I/O module failures will drive the module into an IOLOCK state.
- CPU failure will assert an IOLOCK signal to all modules and expansion racks to drive them into an IOLOCK state.
- Discrete outputs / relay drivers will be non-active and de-energized.
- Analog and actuator outputs will be non-active and de-energized with zero voltage or zero current.

The IOLOCK state is asserted under various conditions including:
- CPU and I/O module watchdog failures
- PowerUp and PowerDown conditions
- System reset and hardware/software initialization
- Entering configuration mode

NOTE: Additional watchdog details and any exceptions to these failure states are specified in the related CPU or I/O module section of the manual.
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Chapter 9.
Actuator Modules

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 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:

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Channels</td>
<td>2</td>
</tr>
<tr>
<td>Actuator Type</td>
<td>Proportional or integrating, hydromechanical or pneumatic actuators</td>
</tr>
<tr>
<td>Power requirements</td>
<td>+5V @ 0.5 A, +24 V @ 1 A</td>
</tr>
</tbody>
</table>
**Driver:**

<table>
<thead>
<tr>
<th>Current range</th>
<th>(range is determined by part number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mA Version</td>
<td>±12.25 mA max</td>
</tr>
<tr>
<td>25 mA Version</td>
<td>±30 mA max</td>
</tr>
<tr>
<td>50 mA Version</td>
<td>±60 mA max</td>
</tr>
<tr>
<td>100 mA Version</td>
<td>±120 mA max</td>
</tr>
<tr>
<td>200 mA Version</td>
<td>±245 mA max</td>
</tr>
<tr>
<td>Dither Current</td>
<td>25 Hz, 25% duty cycle, tunable</td>
</tr>
<tr>
<td>Max Load Resistance</td>
<td>10/(maximum current required, in amps)</td>
</tr>
</tbody>
</table>

**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 Readback 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](image)

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.

![Two Channel Actuator Controller Module Block Diagram](image)

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

Table 9-1—LED Indications of Failure
9.3—Four Channel Actuator Module

9.3.1—Module Description

This Actuator Driver module receives digital information from the CPU and generates four proportional actuator-driver signals. These signals are proportional and their maximum range is 0 to 25 mAdc or 0 to 200 mAdc.

Figure 9-5 is a block diagram of the four-channel Actuator Driver module. The system writes output values to dual-port memory through the VME-bus interface. The microcontroller scales the values using calibration constants stored in EEPROM, and schedules outputs to occur at the proper time.

The microcontroller monitors the output voltage and current of each channel and alerts the system of any channel and load faults. The system can individually disable the current drivers. If a fault is detected which prevents the module from operating, by either the microcontroller or the system, the FAULT LED will illuminate.

This module requires no calibration; an actuator may be replaced with a like actuator without any module or software adjustment.

Figure 9-4—Four Channel Actuator Driver Module
### 9.3.2—Module Specification

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Current Ranges</td>
<td>0–25 mA, 0–200 mA</td>
</tr>
<tr>
<td>Resolution</td>
<td>12 bits</td>
</tr>
<tr>
<td>Accuracy @ 25 °C</td>
<td>0.1% of full scale</td>
</tr>
<tr>
<td>Drift</td>
<td>150 ppm/°C</td>
</tr>
<tr>
<td>Maximum Actuator Resistance</td>
<td>45 Ω @ 200 mA, 360 Ω @ 25 mA</td>
</tr>
<tr>
<td>Maximum Actuator Inductance</td>
<td>1 H</td>
</tr>
<tr>
<td>Dither</td>
<td>Tunable amplitude, 25 Hz square wave</td>
</tr>
<tr>
<td>Analog Driver Bandwidth</td>
<td>50 Hz minimum</td>
</tr>
</tbody>
</table>

**Fault Detection:**

- Load Faults: Module monitors actuator impedance
- Driver Faults: Actuator current is interrupted if fault is detected
- Microcontroller Faults: System monitors a software watchdog
- System Faults: Actuator current is interrupted if communications with CPU are lost
- Shutdowns: Current in each channel may be individually interrupted

### 9.3.3—Installation

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

### 9.3.4—FTM Reference

See Chapter 12 for complete field wiring information for the Four Channel Actuator Module FTM. See Appendix A for part number cross reference for modules, FTMs, and cables.
9.3.5—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 9-5—Four Channel Actuator Driver Module Block Diagram
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 comm 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 9-6—Real Time SIO Module
9.4.2—Module Specification

**RS-485 Ports**

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

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.
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

- 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>
<thead>
<tr>
<th>Cable Specifications:</th>
<th>up to limits of fiber optic cables/transceivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 mm² (24 AWG) or larger standard, shielded, twisted-pair cable</td>
<td>30 m (100 ft) absolute maximum</td>
</tr>
<tr>
<td>0.3 mm² (22 AWG), low-capacitance cable (36 pF/m or 11 pF/ft)</td>
<td>120 m (400 ft) absolute maximum</td>
</tr>
<tr>
<td>0.5 mm² (20 AWG), low-cap cable (WGC P/N 2008-295, Belden 89207)</td>
<td>150 m (500 ft) absolute maximum</td>
</tr>
</tbody>
</table>

**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.

![Shield Termination Diagram](image-url)
9.4.7—Troubleshooting

Each I/O module has a red Fault LED controlled by the CPU, that 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>
<thead>
<tr>
<th>Number of LED flashes</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>External RAM test failure</td>
</tr>
<tr>
<td>2</td>
<td>Module watchdog time-out</td>
</tr>
<tr>
<td>3</td>
<td>Dual Port RAM test failure</td>
</tr>
<tr>
<td>7</td>
<td>VME Communications watchdog time out</td>
</tr>
</tbody>
</table>

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:

- **RS-485 communication faults:**
  - Break Received
  - Framing Error
  - Parity Error
  - Receive Overrun Error
  - Carrier Detect Lost
  - CRC Error
  - Stop Transmit Receive
  - Transmitter Overrun
  - Address error
  - No response

  The GAP block output “comm fault” is set true, for any RS-485 faults. These include:

- **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

9.5.1—Module Description

Figure 9-12 is a block diagram of the Position Controller Module (PCM). The microcontroller executes a position controller which receives a reference input from the CPU across the VME bus. It receives a feedback input from a remote driver via a serial link. The controller output is sent to the remote driver serially. Shutdown, reset, and fault signals are passed between the PCM and the remote driver using discrete lines.

The feedback input from the remote driver is a 16 bit value from the digitized output of a resolver. This gives the PCM the ability to control position with high accuracy and resolution. Consequently, the PCM is used primarily with Dry Low Emissions (DLE) systems or other systems where high accuracy is required.

The PCM can be used with various remote drivers as shown by Figure 9-11. For more information on using the position controller module with specific remote drivers, see the remote driver manual.
9.5.2—Module Specification

Controller Type: model-based
Execution time: 1.67 ms
Dither: Tunable amplitude, 50% duty cycle
Frequency: 40 Hz with TM100 DFB and EM35 drivers, 25 Hz with TM100 SFB

Communications
Type: Synchronous
Interface: RS-485
Data length: 16 bits +1 bit parity
Error detection: Odd parity
PCM Detectable Faults Parity: Shutdown if parity error exist four consecutive times
Feedback: Shutdown if feedback angle > 90°
Position error: Alarm if feedback differs from demand by tunable amount for tunable delay
Null fault: Alarm if null current moves outside settable limits
(Fdbk spread fault: Alarm if feedback signals differ by settable amount. Control from higher/lower feedback selectable.)

Figure 9-11—Position Control Module as used with various Remote Drivers
9.5.3—Installation

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

9.5.4—FTM Reference

See Chapter 12 for complete field wiring information for the EM/TM Position Control Module FTM. See Appendix A for part number cross reference for modules, FTMs, and cables.

9.5.5—Troubleshooting

Following being reset, the PCM will perform a series of self tests. The PCM will also check for run-time errors. This includes checking for the presence of the Minor Frame Timer (MFT) signal along with insuring that proper communications exists between itself and the CPU. If a self test has failed or if a run-time fault exists, the LED will blink according to the following chart:

<table>
<thead>
<tr>
<th>Error Type</th>
<th>Number of Blinks</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-test Errors</td>
<td>1</td>
<td>Internal register test failure</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>RAM test failure—both bytes</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>RAM test failure—high byte</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>RAM test failure—low byte</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>EPROM checksum error</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>EEPROM read/write failure</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>EEPROM checksum error</td>
</tr>
<tr>
<td>Run-time Errors</td>
<td>8</td>
<td>MFT signal absent &gt; 200 ms</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Invalid command received</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Loss of communication with CPU</td>
</tr>
</tbody>
</table>

A fault LED that is constantly lit may indicate that the PCM did not get a proper reset or that it is unable to execute its program.
Figure 9-12—Position Controller Module Block Diagram
Chapter 10.
LinkNet® I/O Network

10.1—Introduction

The LinkNet option provides distributed I/O capabilities for the MicroNet™ control system. The LinkNet I/O modules, while slower and less powerful than MicroNet I/O modules, are well suited for non-turbine control functions like sequencing and monitoring.

10.2—Network Architecture

An I/O network consists of a single 4Ch LinkNet Controller Module, which provides four independent network trunks of up to 60 I/O modules each. The LinkNet I/O modules, or nodes, on each trunk are attached to the LinkNet controller module via a single twisted pair wire. One 4Ch LinkNet Controller Module can therefore, interface with as many as 240 LinkNet I/O modules, each having multiple channels, through four twisted pair wires.

Each of the four channels, or groups, on the LinkNet controller module may run in a different rate group. The rate group for each channel is defined in the application program. The controller module scans all of the nodes asynchronously to the channel rate groups.

Each LinkNet I/O module has two rotary switches that are used to set its network address. On installation, these switches must be dialed so that the I/O module’s number, 1-60, matches the network address defined for this I/O module in the application program. The I/O modules may be placed in any order on the network, and gaps are allowed in the address sequence.

10.3—Hardware

Each network consists of one channel of a LinkNet controller module and many I/O modules. The I/O modules include thermocouple, RTD, 4-20 mA, and discrete input modules, as well as 4-20 mA and relay output modules. All of the analog modules consist of six channels per module. The relay output module contains eight channels and the discrete input module has 16 channels.

Each I/O module is housed in a plastic, field termination module type package for DIN rail mounting. The LinkNet I/O modules can be mounted in the control cabinet or in any convenient location in the vicinity of the prime mover that meets the temperature and vibration specifications. The LinkNet system accommodates hot-replacement of faulty nodes.
10.4—Four Channel LinkNet® Controller Module

10.4.1—Module Description

The Four Channel LinkNet Controller module acts as a network master for each network channel. It performs various scaling and linearization operations and controls the flow of data between the CPU module and the I/O nodes. It determines the health of the nodes by comparing readback values to requested values on output nodes, and by checking the reference test value on analog input nodes.

Figure 10-1—Four Channel LinkNet Controller Module

10.4.2—Module Specification

<table>
<thead>
<tr>
<th>Number of channels:</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Nodes per Ch.:</td>
<td>60</td>
</tr>
</tbody>
</table>

**Scan Rate**

<table>
<thead>
<tr>
<th>Less than 7 output modules:</th>
<th>(# of I/O modules x 6 + 75) ms typical</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(# of I/O modules x 6 + 100) ms max</td>
</tr>
<tr>
<td>7 or more output modules:</td>
<td>(# of I/O mods x 6 + # of output mods x 3 + 55) ms typical</td>
</tr>
<tr>
<td></td>
<td>(# of I/O modules x 6 + # of output modules x 3 + 80) ms max</td>
</tr>
</tbody>
</table>
10.4.3—Installation

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

All LinkNet I/O modules communicate with the LinkNet controller module through shielded twisted pair wiring. The specifications for the LinkNet system require that listed level V type cable be used. The network may be wired directly from I/O module to I/O module, as shown in Figure 10-2, or the I/O modules may be connected to the network via stubs as in Figure 10-3. A LinkNet Termination Module (Figure 10-4) must be installed as the last LinkNet module on the network. Connections are provided at both ends of the LinkNet Termination Module. Connect network to either terminals 1, 2, 3 or 4, 5, 6, but not both. There is no polarity associated with the network wiring.
For optimum EMC performance, the network cable shield should be landed at each I/O module, and the exposed wire length limited to one inch. At the MicroNet control, the outer insulation should be stripped and the bare shield tied-wrapped to the chassis, along with the other MicroNet I/O module wiring shields. See Table 10-1 for cable length and number of LinkNet I/O modules limitations per network connection.

All field wiring should be shielded. The shield should be landed in the terminal block provided, and the exposed wiring, after the shield is separated, should be limited to one inch.

**IMPORTANT** The LinkNet modules should always be mounted in a cabinet, or be otherwise operator inaccessible. The modules should only be accessed for maintenance purposes, in which case, the Electrostatic Discharge procedures on page v of volume 1 should be followed.

<table>
<thead>
<tr>
<th>Specification</th>
<th>0 to 55°C</th>
<th>-20 to 55°C</th>
<th>-40 to 55°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum network cable length</td>
<td>150 meters</td>
<td>150 meters</td>
<td>50 meters</td>
</tr>
<tr>
<td>Maximum number of I/O modules</td>
<td>60</td>
<td>32</td>
<td>20</td>
</tr>
<tr>
<td>Maximum stub length</td>
<td>300 mm</td>
<td>300 mm</td>
<td>300 mm</td>
</tr>
</tbody>
</table>

10.4.4—FTM Reference

The 4Ch LinkNet controller module doesn’t utilize FTMs. The Controller module interfaces to LinkNet I/O modules. Information on the LinkNet I/O modules follows later in this chapter.
10.4.5—Troubleshooting

A 68030 microprocessor communicates with the CPU module through dual-ported RAM connected to the VME bus interface. Each of the four network communications processors communicate with the 68030 through a dual-port RAM.

The LinkNet controller module performs self-tests after a MicroNet system reset. If all tests pass, the Fault LED will go out. If the Fault LED remains on or begins blinking, the module is faulty. The 68030 initializes the four communications processors after the self-tests. The Network Fault LEDs turn off after each communications processor has been initialized. If any of the Network Fault LEDs remains on, the module is faulty. After the Network Fault LEDs have turned off, the controller module initializes the I/O nodes. Node initialization can take up to several seconds for a large network.

The fault status of the module and each network channel may be annunciated through the application program. See Figure 10-5 for block diagram of the 4Ch LinkNet module.

Figure 10-5—4Ch LinkNet Module Block Diagram

Troubleshooting Flowchart

If a problem occurs with the LinkNet network, use Figure 10-25 (Troubleshooting Flowchart) as a guide to find and repair the problem.
10.5—LinkNet 6Ch RTD Module

10.5.1—Module Description

The LinkNet 6Ch RTD Module interfaces to six temperature sensing three wire RTD transducers. The module comes in two different RTD resistance ranges (100 ohm and 200 ohm). Both types of modules have unique part numbers and interface to one of the four channels on the 4Ch LinkNet Controller Module through a serial network cable. See Appendix A for desired part numbers. The module has a built-in reference voltage that is used to verify proper operation of the A/D converter. Appropriate faults are annunciated through the application program. Up to 60 nodes or LinkNet I/O modules can be connected to each channel of the LinkNet Controller Module.

Figure 10-6—LinkNet 6Ch RTD Module

10.5.2—Module Specification

- Number of Inputs: 6
- Input type: 100 or 200 ohm 3-wire RTDs
- RTD source current: 2 mA max

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

- Resolution: 12 bits
- Temp Coefficient (ppm/°C): 290
- Accuracy: 1% at 25°C without field calibration
- Input Impedance: 2.2 MΩ
- Power Supply Input: 18 to 32 Vdc
- Power Required: 3.1 W at 24 Vdc
10.5.3—Isolation

- Network to I/O channel: 277 Vac
- Power supply input to network: 277 Vac
- I/O channel to I/O channel: 0 V
- PS input to I/O channel: 500 Vdc
- Field Wiring: 14 AWG maximum wire size
- Temperature Range: –40 to +55 °C

10.5.4—Shock and Vibration

Mil-Std-810, 30 G's sine wave at 11 ms
Mil-Std-167, 18-50 Hz

10.5.5—EMC

- Emissions: EN 61000-6-4
- ESD Immunity: EN 61000-6-2

10.5.6—Installation

Install the LinkNet 6CH RTD Module on the DIN rail and connect to the appropriate LinkNet network and 24 Vdc power. Wire the RTD connection per Figure 10-7. Set module address one’s and ten’s rotary switches per application setup.

The LinkNet system accommodates hot-replacement of faulty nodes. When replacing a node, the network cable connections must remain intact. A faulty node can be removed from the network by pulling both terminal blocks out of their headers, and removing the node from the DIN rail. The address switches of the replacement node should be set to match those of the faulty node. The replacement node can then be mounted on to the DIN rail, and the terminal blocks pushed into the headers. It is then necessary to reset the node through the application program to reinitiate communications with the LinkNet controller module and to clear the “no message” fault.
10.5.7—Troubleshooting

Each RTD input utilizes a 1 or 2 mA source. The module receives voltages from six 100 or 200 ohm, 3 wire RTDs. Each voltage is compensated for line resistance, and then is multiplexed to a voltage-to-frequency converter. The module processor reads the period of this signal and converts it to a count, which it transmits through the transceiver to the LinkNet controller module. See Figure 10-8 for block diagram of the RTD input module.
The fault LED denotes the status of the module processor, and will be off during normal operation. If the fault LED is on or is blinking, and cycling power to the module does not change it, then the I/O module should be replaced.

The module address circuit reads the selected module address from the rotary switches on each node. This address should correspond to the address of the I/O module hardware in the application program. If these rotary switches are set incorrectly, the node will not communicate with the LinkNet controller module, and a "no message" fault will be annunciated through the application program. If two nodes are set to the same address, an "address" fault will be annunciated through the application program, and both nodes will not function. If the node address switches are changed, power to the module must be cycled before it will read the new module address and change its communication accordingly.

A "type" fault is annunciated through the application program when the wrong module type is installed at a given address. For example, installing a thermocouple module in place of an RTD module generates a type fault. If an output node receives data intended for a different module type, it will not update its outputs, and will set them to the "off" state when its watchdog timer times out.

No message faults, address faults, and type faults are non-latching. When these faults occur for an input module, the application program will give default values for each channel.

**Troubleshooting Flowchart**

If a problem occurs with the LinkNet network, use Figure 10-25 (Troubleshooting Flowchart) as a guide to find and repair the problem.
10.6—LinkNet 6Ch T/C Module

10.6.1—Module Description

The LinkNet 6Ch T/C Module connects to six Type J or K thermocouples. The thermocouple type is selected in the application program. There is a fail high and a fail low version of the module, which allow the input channels to be pulled high or low on an open input. See Appendix A for desired part numbers. The modules have an AD592 ambient temperature sensor mounted on them for cold junction temperature sensing. The cold junction compensation is performed in software. The module has a built-in reference voltage that is used to verify proper operation of the A/D converter. Appropriate faults are annunciated through the application program. Up to 60 nodes or LinkNet I/O modules can be connected to each channel of the LinkNet Controller Module.

![Figure 10-9—LinkNet 6Ch T/C Module]

10.6.2—Module Specification

Number of Inputs: 6 internal +1 cold junction

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

Open thermocouple detection: Fail Low and Fail High depending on P/N

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold Junction</td>
<td>AD590</td>
</tr>
<tr>
<td>Resolution</td>
<td>12 bits</td>
</tr>
<tr>
<td>Temp Coefficient (ppm/°C)</td>
<td>235</td>
</tr>
<tr>
<td>Accuracy</td>
<td>1% at 25°C without field calibration</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>2.0 MΩ</td>
</tr>
<tr>
<td>Power Supply Input</td>
<td>18 to 32 Vdc</td>
</tr>
<tr>
<td>Power Required</td>
<td>2.4 W at 24 Vdc</td>
</tr>
</tbody>
</table>
10.6.3—Isolation

- Network to I/O channel: 277 Vac
- Power supply input to network: 277 Vac
- I/O channel to I/O channel: 0 V
- PS input to I/O channel: 500 Vdc
- Field Wiring: 14 AWG maximum wire size
- Temperature Range: –40 to +55 °C

10.6.4—Shock and Vibration

Mil-Std-810, 30 G's sine wave at 11 ms
Mil-Std-167, 18-50 Hz

10.6.5—EMC

- Emissions: EN 61000-6-4
- ESD Immunity: EN 61000-6-2

10.6.6—Installation

Install the LinkNet 6CH TC Module on the DIN rail and connect to the appropriate LinkNet network and 24 Vdc power. Wire the thermocouple connection per Figure 10-10. Set module address one’s and ten’s rotary switches per application setup.

The LinkNet system accommodates hot-replacement of faulty nodes. When replacing a node, the network cable connections must remain intact. A faulty node can be removed from the network by pulling both terminal blocks out of their headers, and removing the node from the DIN rail. The address switches of the replacement node should be set to match those of the faulty node. The replacement node can then be mounted on to the DIN rail, and the terminal blocks pushed into the headers. It is then necessary to reset the node through the application program to reinitiate communications with the LinkNet controller module and to clear the "no message" fault.
10.6.7—Troubleshooting

The module receives information from thermocouples, which can be either J or K type. The type is selected in the application program. It also has an AD592 ambient temperature sensor mounted on the module for cold junction temperature sensing. The cold junction compensation is performed in software. There is a fail high and a fail low version of the module, selected by jumpers on the board, which allow the input channels to be pulled high or low on an open input. Each input is multiplexed to a voltage-to-frequency converter. The module processor reads the period of this signal and converts it to a count, which it transmits through the transceiver to the LinkNet controller module. See Figure 10-11 for block diagram of the thermocouple input module.
The fault LED denotes the status of the module processor, and will be off during normal operation. If the fault LED is on or is blinking, and cycling power to the module does not change it, then the I/O module should be replaced.

The module address circuit reads the selected module address from the rotary switches on each node. This address should correspond to the address of the I/O module hardware in the application program. If these rotary switches are set incorrectly, the node will not communicate with the LinkNet controller module, and a "no message" fault will be annunciated through the application program. If two nodes are set to the same address, an "address" fault will be annunciated through the application program, and both nodes will not function. If the node address switches are changed, power to the module must be cycled before it will read the new module address and change its communication accordingly.

A "type" fault is annunciated through the application program when the wrong module type is installed at a given address. For example, installing a thermocouple module in place of an RTD module generates a type fault. If an output node receives data intended for a different module type, it will not update its outputs, and will set them to the "off" state when its watchdog timer times out.

No message faults, address faults, and type faults are non-latching. When these faults occur for an input module, the application program will give default values for each channel.

Troubleshooting Flowchart

If a problem occurs with the LinkNet network, use Figure 10-25 (Troubleshooting Flowchart) as a guide to find and repair the problem.
10.7—LinkNet 6Ch Current Input Module

10.7.1—Module Description

The LinkNet 6Ch Current Input Module interfaces to six 4-20mA transducers. There are two version of the module; one for loop powered transducers and the other for self powered transducers. Mixing self powered and loop powered transducers on the same module is not an option. See Appendix A for desired part numbers. The module has a built-in reference voltage that is used to verify proper operation of the A/D converter. Appropriate faults are annunciated through the application program.

10.7.2—Module Specification

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Inputs:</td>
<td>6</td>
</tr>
<tr>
<td>Input range:</td>
<td>0–25 mA</td>
</tr>
<tr>
<td>Resolution:</td>
<td>12 bits</td>
</tr>
<tr>
<td>Temp Coefficient (ppm/°C):</td>
<td>235</td>
</tr>
<tr>
<td>Accuracy:</td>
<td>1% at 25°C without field calibration</td>
</tr>
<tr>
<td>Input Impedance:</td>
<td>250 ohms</td>
</tr>
<tr>
<td>Power Supply Input:</td>
<td>18 to 32 Vdc</td>
</tr>
<tr>
<td>Power Required:</td>
<td>2.4 Watts at 24 Vdc (self powered version)</td>
</tr>
<tr>
<td></td>
<td>5.3 Watts at 24 Vdc (loop powered version)</td>
</tr>
</tbody>
</table>

10.7.3—Isolation

<table>
<thead>
<tr>
<th>Isolation</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network to I/O channel:</td>
<td>277 Vac</td>
</tr>
<tr>
<td>Power supply input to network:</td>
<td>277 Vac</td>
</tr>
<tr>
<td>I/O channel to I/O channel:</td>
<td>0 V</td>
</tr>
<tr>
<td>PS input to I/O channel:</td>
<td>500 Vdc</td>
</tr>
<tr>
<td>Field Wiring:</td>
<td>14 AWG maximum wire size</td>
</tr>
<tr>
<td>Temperature Range:</td>
<td>–40 to +55 °C</td>
</tr>
</tbody>
</table>
10.7.4—Shock and Vibration

Mil-Std-810, 30 G’s sine wave at 11 ms
Mil-Std-167, 18-50 Hz

10.7.5—EMC

<table>
<thead>
<tr>
<th>Emissions</th>
<th>EN 61000-6-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESD Immunity</td>
<td>EN 61000-6-2</td>
</tr>
</tbody>
</table>

10.7.6—Installation

Install the LinkNet 6CH Current Input Module on the DIN rail and connect to the appropriate LinkNet network and 24 Vdc power. Wire the loop or self powered transducers per Figure 10-13 depending on which module is used. Set module address one’s and ten’s rotary switches per application setup.
The LinkNet system accommodates hot-replacement of faulty nodes. When replacing a node, the network cable connections must remain intact. A faulty node can be removed from the network by pulling both terminal blocks out of their headers, and removing the node from the DIN rail. The address switches of the replacement node should be set to match those of the faulty node. The replacement node can then be mounted on to the DIN rail, and the terminal blocks pushed into the headers. It is then necessary to reset the node through the application program to reinitiate communications with the LinkNet controller module and to clear the "no message" fault.

**Figure 10-13—LinkNet 6CH Current Input Module Wiring**

### 10.7.7—Troubleshooting

The module receives information from 4-20 mA sources, such as transducers. Power is provided for these transducers on one version of the module, but all module inputs must use the power provided. No inputs may use a separate power source, as all of the negatives are tied together and to 24 V common. The advantage of this module version is that it simplifies wiring to devices such as transducers that require external power. Each input is converted to a 0-5 V signal, and then multiplexed to a voltage-to-frequency converter. The module processor reads the period of this signal and converts it to a count, which it transmits through the transceiver to the LinkNet controller module. See Figure 10-14 for block diagram of the 4-20 mA input module.
The fault LED denotes the status of the module processor, and will be off during normal operation. If the fault LED is on or is blinking, and cycling power to the module does not change it, then the I/O module should be replaced.

The module address circuit reads the selected module address from the rotary switches on each node. This address should correspond to the address of the I/O module hardware in the application program. If these rotary switches are set incorrectly, the node will not communicate with the LinkNet controller module, and a "no message" fault will be annunciated through the application program. If two nodes are set to the same address, an "address" fault will be annunciated through the application program, and both nodes will not function. If the node address switches are changed, power to the module must be cycled before it will read the new module address and change its communication accordingly.

A "type" fault is annunciated through the application program when the wrong module type is installed at a given address. For example, installing a thermocouple module in place of an RTD module generates a type fault. If an output node receives data intended for a different module type, it will not update its outputs, and will set them to the "off" state when its watchdog timer times out.

No message faults, address faults, and type faults are non-latching. When these faults occur for an input module, the application program will give default values for each channel.

**Troubleshooting Flowchart**

If a problem occurs with the LinkNet network, use Figure 10-25 (Troubleshooting Flowchart) as a guide to find and repair the problem.
10.8—LinkNet 16 Channel Discrete Input Module

10.8.1—Module Description

The LinkNet 16 Channel Discrete Input (DI) Module provides sixteen discrete input for field switches or relay contacts. All sixteen inputs require a +24 Vdc source. A filtered and fused internal power source is provided or an external +24 Vdc source referenced to the 24 V Common of the module may be used to sense the state of the contact or switch.

10.8.2—Module Specification

Number of Inputs: 16
Input thresholds:
Low voltage: <8 Vdc = “OFF”
>16 Vdc = “ON”
Discrete Input Current: 13.1 mA per channel when "on" (@ 24 V)
External input voltage: ?-? Vdc
Power Supply Input: 18 to 32 Vdc
Power Required: 6.5 Watts at 24 Vdc

10.8.3—Isolation

Network to I/O channel: 277 Vac
Power supply input to network: 277 Vac
I/O channel to I/O channel: 0 V
PS input to I/O channel: 500 Vdc
Field Wiring: 14 AWG maximum wire size
Temperature Range: –40 to +55 °C
10.8.4—Shock and Vibration

Mil-Std-810, 30 G's sine wave at 11 ms
Mil-Std-167, 18-50 Hz

10.8.5—EMC

| Emissions: | EN 61000-6-4 |
| ESD Immunity: | EN 61000-6-2 |

10.8.6—Installation

Install the LinkNet 16CH Discrete Input Module on the DIN rail and connect to the appropriate LinkNet network and 24 Vdc power. The inputs can be wired using the internal +24 V connections or an external 24 V power source if desired. Wire the discrete inputs per Figure 10-16. Set module address one’s and ten’s rotary switches per application setup.

The LinkNet system accommodates hot-replacement of faulty nodes. When replacing a node, the network cable connections must remain intact. A faulty node can be removed from the network by pulling both terminal blocks out of their headers, and removing the node from the DIN rail. The address switches of the replacement node should be set to match those of the faulty node. The replacement node can then be mounted on to the DIN rail, and the terminal blocks pushed into the headers. It is then necessary to reset the node through the application program to reinitiate communications with the LinkNet controller module and to clear the "no message" fault.
10.8.7—Troubleshooting

The module receives information from field switches and relays. Power is provided for these contacts, on four terminal blocks, TB-5 through TB-8. The input power on TB-2 may also be used, but does not have the benefit of an internal fuse and some filtering, therefore external fusing should be provided. The state of each discrete input is passed through an optoisolator and an LED to the shift register. In this manner, the LED’s will light when a contact is closed. The module processor receives this information and transmits it through the transceiver to the LinkNet controller module. See Figure 10-17 for block diagram of the Discrete Input module.
The fault LED denotes the status of the module processor, and will be off during normal operation. If the fault LED is on or is blinking, and cycling power to the module does not change it, then the I/O module should be replaced.

The module address circuit reads the selected module address from the rotary switches on each node. This address should correspond to the address of the I/O module hardware in the application program. If these rotary switches are set incorrectly, the node will not communicate with the LinkNet controller module, and a "no message" fault will be annunciated through the application program. If two nodes are set to the same address, an "address" fault will be annunciated through the application program, and both nodes will not function. If the node address switches are changed, power to the module must be cycled before it will read the new module address and change its communication accordingly.

A "type" fault is annunciated through the application program when the wrong module type is installed at a given address. For example, installing a thermocouple module in place of an RTD module generates a type fault. If an output node receives data intended for a different module type, it will not update its outputs, and will set them to the "off" state when its watchdog timer times out.

No message faults, address faults, and type faults are non-latching. When these faults occur for an input module, the application program will give default values for each channel.
Troubleshooting Flowchart

If a problem occurs with the LinkNet network, use Figure 10-25 (Troubleshooting Flowchart) as a guide to find and repair the problem.

10.9—LinkNet 6 Channel Analog Output Module

10.9.1—Module Description

The LinkNet 6 Channel Analog Output (AO) Module provides six 4-20 mA analog outputs. The output current is monitored by the module processor through an A/D converter. The readback value and status are available through the application program. The 4-20 mA output module has a watchdog that monitors the communications from the module processor to the D/A converter, and disables the current drivers upon a loss of communications of more than 1.2 seconds.

![LinkNet 6 Channel Analog Output Module](image)

Figure 10-18—LinkNet 6 Channel Analog Output Module

10.9.2—Module Specification

- Number of Outputs: 6
- Current output range: 0–25 mA
- Power Supply Input: 18 to 32 Vdc
- Power Required: 6.0 Watts at 24 Vdc
10.9.3—Isolation

- Network to I/O channel: 277 Vac
- Power supply input to network: 277 Vac
- I/O channel to I/O channel: 0 V
- PS input to I/O channel: 500 Vdc
- Field Wiring: 14 AWG maximum wire size
- Temperature Range: –40 to +55 °C

10.9.4—Shock and Vibration

Mil-Std-810, 30 G's sine wave at 11 ms
Mil-Std-167, 18-50 Hz

10.9.5—EMC

- Emissions: EN 61000-6-4
- ESD Immunity: EN 61000-6-2

10.9.6—Installation

Install the LinkNet 6CH Analog Output Module on the DIN rail and connect to the appropriate LinkNet network and 24 Vdc power. Wire the analog outputs per Figure 10-19. Set module address one's and ten's rotary switches per application setup.

The LinkNet system accommodates hot-replacement of faulty nodes. When replacing a node, the network cable connections must remain intact. A faulty node can be removed from the network by pulling both terminal blocks out of their headers, and removing the node from the DIN rail. The address switches of the replacement node should be set to match those of the faulty node. The replacement node can then be mounted on to the DIN rail, and the terminal blocks pushed into the headers. It is then necessary to reset the node through the application program to reinitiate communications with the LinkNet controller module and to clear the "no message" fault.
10.9.7—Troubleshooting

The 4-20 mA output module processor receives information through the transceiver, from the LinkNet controller module. The 4-20 mA output module then updates the status of the D/A converter which outputs voltages to the current drivers. The output current is monitored by the module processor through an A/D converter. The readback value and status are available through the application program. The 4-20 mA output module has a watchdog that monitors the communications from the module processor to the D/A converter, and disables the current drivers upon a loss of communications of more than 1.2 seconds. The module will not function after a watchdog timeout until its power is cycled or the MicroNet system is reset. See Figure 10-20 for block diagram of the 4-20 mA Output module.
The fault LED denotes the status of the module processor, and will be off during normal operation. If the fault LED is on or is blinking, and cycling power to the module does not change it, then the I/O module should be replaced.

The module address circuit reads the selected module address from the rotary switches on each node. This address should correspond to the address of the I/O module hardware in the application program. If these rotary switches are set incorrectly, the node will not communicate with the LinkNet controller module, and a "no message" fault will be annunciated through the application program. If two nodes are set to the same address, an "address" fault will be annunciated through the application program, and both nodes will not function. If the node address switches are changed, power to the module must be cycled before it will read the new module address and change its communication accordingly.

A "type" fault is annunciated through the application program when the wrong module type is installed at a given address. For example, installing a thermocouple module in place of an RTD module generates a type fault. If an output node receives data intended for a different module type, it will not update its outputs, and will set them to the "off" state when its watchdog timer times out.

The no message fault, address fault, and type fault are non-latching.

Troubleshooting Flowchart

If a problem occurs with the LinkNet network, use Figure 10-25 (Troubleshooting Flowchart) as a guide to find and repair the problem.
10.10—LinkNet 8 Channel Discrete Output Module

10.10.1—Module Description

The LinkNet 8 Channel Discrete Output (DO) Module provides eight 5 amp form C relay outputs. An internal set of relay contacts is fed back to the module processor, for readback status. The readbacks are compared with the desired outputs, and a status annunciated for each relay in the application program. The relay output module has a watchdog that monitors the communications with the module processor, and disables the relay drivers upon a loss of communications of more than 1.2 seconds.

10.10.2—Module Specification

Number of Outputs: 8 (form C relay outputs)
Ratings: 5.0 A @ 28 Vdc resistive
0.5 A @ 115 Vac resistive

Figure 10-21—LinkNet 8 Channel Discrete Output Module

Figure 10-22—LinkNet Relay Contacts
10.10.3—Isolation

Network to I/O channel: 277 Vac
Power supply input to network: 277 Vac
PS input to I/O channel: 500 Vdc
Field Wiring: 14 AWG maximum wire size
Temperature Range: –40 to +55 °C

10.10.4—Shock and Vibration

Mil-Std-810, 30 G’s sine wave at 11 ms
Mil-Std-167, 18-50 Hz

10.10.5—EMC

Emissions: EN 61000-6-4
ESD Immunity: EN 61000-6-2

10.10.6—Installation

Install the LinkNet 8CH Discrete Output Module on the DIN rail and connect to the appropriate LinkNet network and 24 Vdc power. Wire the discrete outputs per Figure 10-23. Set module address one’s and ten’s rotary switches per application setup.

The LinkNet system accommodates hot-replacement of faulty nodes. When replacing a node, the network cable connections must remain intact. A faulty node can be removed from the network by pulling both terminal blocks out of their headers, and removing the node from the DIN rail. The address switches of the replacement node should be set to match those of the faulty node. The replacement node can then be mounted on to the DIN rail, and the terminal blocks pushed into the headers. It is then necessary to reset the node through the application program to reinitiate communications with the LinkNet controller module and to clear the “no message” fault.
10.10.7—Troubleshooting

The module outputs information through eight 5 amp form C relays. The relay output module processor receives information through the transceiver, from the LinkNet controller module. The node then updates the status of the shift register which updates the relays and a status LED. The second set of relay contacts is input back into the module processor through a shift register, for readback status. The readbacks are compared with the desired outputs, and a status annunciated for each relay in the application program. The relay output module has a watchdog that monitors the communications from the module processor to the shift register, and disables the relay drivers upon a loss of communications of more than 1.2 seconds. The node will not function after a watchdog timeout, until its power is cycled or until the MicroNet system is reset. See Figure 10-24 for block diagram of the Relay Output module.
The fault LED denotes the status of the module processor, and will be off during normal operation. If the fault LED is on or is blinking, and cycling power to the module does not change it, then the I/O module should be replaced.

The module address circuit reads the selected module address from the rotary switches on each node. This address should correspond to the address of the I/O module hardware in the application program. If these rotary switches are set incorrectly, the node will not communicate with the LinkNet controller module, and a "no message" fault will be annunciated through the application program. If two nodes are set to the same address, an "address" fault will be annunciated through the application program, and both nodes will not function. If the node address switches are changed, power to the module must be cycled before it will read the new module address and change its communication accordingly.

A "type" fault is annunciated through the application program when the wrong module type is installed at a given address. For example, installing a thermocouple module in place of an RTD module generates a type fault. If an output node receives data intended for a different module type, it will not update its outputs, and will set them to the "off" state when its watchdog timer times out.

The no message fault, address fault, and type fault are non-latching.
Troubleshooting Flowchart

If a problem occurs with the LinkNet network, use Figure 10-25 (Troubleshooting Flowchart) as a guide to find and repair the problem.

Follow the flowchart down from the title block to the next block. This block may be a rectangular suggestion block, or a diamond shaped decision block. When a suggestion block is entered, perform the check suggested. A suggestion block may refer you to the Control Wiring Diagram, the application program, or the module field wiring.

If this check does no find the problem, continue down the flowchart.

When a decision block is entered, the question asked inside it must be answered. This answer then determines the proper exit from that block. The exit taken will lead you to another point on the flowchart.

By following the flowchart in this manner, you should be able to determine a course of action for most problems.
Figure 10-25—Troubleshooting Flow Chart
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 +15V 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

<table>
<thead>
<tr>
<th>Protocol</th>
<th>RS-422 UART, Honeywell proprietary protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated RS-422 Ports</td>
<td>2</td>
</tr>
<tr>
<td>Isolated +15V Power</td>
<td>2</td>
</tr>
<tr>
<td>Supply Connections</td>
<td>2</td>
</tr>
</tbody>
</table>

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).

![Module Block Diagram](image)

Figure 11-2—Module Block Diagram

Each I/O module has a red Fault LED controlled by the CPU, that is turned on when the system is reset. During initialization of an 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>
<thead>
<tr>
<th>Number of LED Flashes</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>External RAM test failure</td>
</tr>
<tr>
<td>2</td>
<td>Unexpected Exception</td>
</tr>
<tr>
<td>3</td>
<td>Dual Port RAM test failure</td>
</tr>
<tr>
<td>4</td>
<td>Module watchdog time-out</td>
</tr>
</tbody>
</table>

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 6 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>
<thead>
<tr>
<th>INPUT</th>
<th>DESCRIPTION</th>
<th>PIN(S)</th>
<th>FTM TB(S)</th>
<th>LOGIC STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPU No. 1 Channel No. 1</td>
<td>frequency input signal</td>
<td>PIN 37 PIN 36</td>
<td>TB 20 TB 21</td>
<td>AC signal input.</td>
</tr>
<tr>
<td>MPU No. 2 Channel No. 2</td>
<td>frequency input signal</td>
<td>PIN 35 PIN 34</td>
<td>TB 22 TB 23</td>
<td>AC signal input.</td>
</tr>
<tr>
<td>Overspeed Test No. 1 Select</td>
<td>Channel No. 1 static overspeed test selection input, must be used in conjunction with Test Activate input.</td>
<td>PIN 27</td>
<td>TB 30</td>
<td>PIN 27 &quot;high&quot; = ON state, OFF state requires PIN 27 pulled &quot;low&quot; to circuit common.</td>
</tr>
<tr>
<td>Overspeed Test No. 2 Select</td>
<td>Channel No. 2 static overspeed test selection input, must be used in conjunction with Test Activate input.</td>
<td>PIN 31</td>
<td>TB 26</td>
<td>PIN 31 &quot;high&quot; = ON state, OFF state requires PIN 31 pulled &quot;low&quot; to circuit common.</td>
</tr>
<tr>
<td>Test Activate</td>
<td>Input is used as a permissive or activation medium for the static Overspeed Test function</td>
<td>PIN 26</td>
<td>TB 31</td>
<td>PIN 26 &quot;high&quot; = ON state which permits Overspeed Test function, OFF state requires PIN 26 pulled &quot;low&quot; to circuit common which disables Overspeed Test function.</td>
</tr>
<tr>
<td>Reset</td>
<td>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 &quot;low&quot; to &quot;high&quot;.</td>
<td>PIN 25</td>
<td>TB 32</td>
<td>PIN 25 transition from &quot;low&quot; to &quot;high&quot; activates reset command.</td>
</tr>
<tr>
<td>Input Failed Override</td>
<td>Input overrides the input failed detection circuits. Input must be pulled &quot;low&quot; to activate override.</td>
<td>PIN 23</td>
<td>TB 34</td>
<td>PIN 23 &quot;high&quot; = OFF state for the input failed override, PIN 23 &quot;low&quot; = ON state for input failed override.</td>
</tr>
</tbody>
</table>
The module output signals are below. Note: FTM TB’s are based on using an analog cable.

<table>
<thead>
<tr>
<th>OUTPUT</th>
<th>DESCRIPTION</th>
<th>PIN(S)</th>
<th>FTM TB(S)</th>
<th>LOGIC STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Failed No. 1</td>
<td>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.</td>
<td>PIN 29</td>
<td>TB 28</td>
<td>PIN 29 “low” = input failed state TRUE. Will illuminate module LED DS1.</td>
</tr>
<tr>
<td>Input Failed No. 2</td>
<td>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.</td>
<td>PIN 33</td>
<td>TB 24</td>
<td>PIN 33 “low” = input failed state TRUE. Will illuminate module LED DS2.</td>
</tr>
<tr>
<td>Overspeed No. 1</td>
<td>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.</td>
<td>PIN 28</td>
<td>TB 29</td>
<td>PIN 28 “low” = overspeed detected TRUE. Will illuminate LED DS3.</td>
</tr>
<tr>
<td>Overspeed No. 1 Logic</td>
<td>Provides direct connection to the MicroNet Solenoid Monitor module to de-energize the solenoid on when overspeed detected.</td>
<td>PIN 13</td>
<td>TB 7</td>
<td>PIN 13 “low” = overspeed detected TRUE. Will cause solenoid driver to de-energize if connected to the MicroNet Solenoid Monitor module.</td>
</tr>
<tr>
<td>Overspeed No. 2</td>
<td>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.</td>
<td>PIN 32</td>
<td>TB 25</td>
<td>PIN 32 “low” = overspeed detected TRUE. Will illuminate LED DS4.</td>
</tr>
<tr>
<td>Overspeed No. 2 Logic</td>
<td>Provides direct connection to the MicroNet Solenoid Monitor module to de-energize the solenoid on when overspeed detected.</td>
<td>PIN 9</td>
<td>TB 11</td>
<td>PIN 9 “low” = overspeed detected TRUE. Will cause solenoid driver to de-energize if connected to the MicroNet Solenoid Monitor module.</td>
</tr>
<tr>
<td>Alarm Bus</td>
<td>Output indicates Channel No. 1 or 2 overspeed active or both Channel No. 1 and 2 inputs failed. Output should be connected.</td>
<td>PIN 30</td>
<td>TB 27</td>
<td>PIN 30 “low” = fault condition TRUE.</td>
</tr>
</tbody>
</table>
directly to the Alarm Bus input on the MicroNet Dual Solenoid Monitor module. No other connections to this output should be made.

| 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 Monitor module. No other connections to this output should be made. Duplicates functionality of the Alarm Bus input. | PIN 24 | TB 33 | PIN 24 “low” = fault condition(s) TRUE. |

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 module’s 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

\[ F_{TRIP} = \frac{10}{(1.1 \times R_{23} \times C_{23}) + (1.1 \times (R_{ADJ} + R_{EQUIV}) \times C_{17}} \]

where:

<table>
<thead>
<tr>
<th>Channel No. 1</th>
<th>Channel No. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>R23 = 46.4 K ohms</td>
<td>R69 = 46.4 K ohms</td>
</tr>
<tr>
<td>C23 = 0.01 microfarads</td>
<td>C54 = 0.01 microfarads</td>
</tr>
<tr>
<td>C17 = 0.10 microfarads</td>
<td>C45 = 0.10 microfarads</td>
</tr>
<tr>
<td>R_{ADJ} = R_{13} = 0-20 K ohms</td>
<td>RADJ = R_{58} = 0-20 kΩ potentiometer</td>
</tr>
<tr>
<td>REQUIV =</td>
<td>REQUIV =</td>
</tr>
<tr>
<td>R20 (JR11) = 7.50 K ohms</td>
<td>R61 (JR26) = 7.50 K ohms</td>
</tr>
<tr>
<td>R21 (JR12) = 23.2 K ohms</td>
<td>R59 (JR24) = 23.2 K ohms</td>
</tr>
<tr>
<td>R22 (JR13) = 9.75 K ohms</td>
<td>R60 (JR25) = 9.75 K ohms</td>
</tr>
<tr>
<td>Any individual JR or combinations (parallel resistance) can be selected to achieve required REQUIV.</td>
<td>Any individual JR or combinations (parallel resistance) can be selected to achieve required REQUIV.</td>
</tr>
</tbody>
</table>

### 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 each of the individual “overspeed trip” setpoint jumpers (and an example of parallel jumper configuration):

<table>
<thead>
<tr>
<th>Channel No. 1</th>
<th>Channel No. 2</th>
<th>REQUIV</th>
<th>Freq @ RADJ Min</th>
<th>Freq @ RADJ Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>JR11</td>
<td>JR26</td>
<td>7.50 K ohms</td>
<td>7488 Hz</td>
<td>2828 Hz</td>
</tr>
<tr>
<td>JR12</td>
<td>JR24</td>
<td>23.2 K ohms</td>
<td>3265 Hz</td>
<td>1900 Hz</td>
</tr>
<tr>
<td>JR13</td>
<td>JR25</td>
<td>9.75 K ohms</td>
<td>6313 Hz</td>
<td>2642 Hz</td>
</tr>
<tr>
<td>JR11 &amp; JR13</td>
<td>JR26 &amp; JR25</td>
<td>25.424 K ohms</td>
<td>10,240 Hz</td>
<td>3148 Hz</td>
</tr>
</tbody>
</table>
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>
<thead>
<tr>
<th>Channel No. 1</th>
<th>Channel No. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOUT = 20 KHz</td>
<td>FOUT = 20 KHz</td>
</tr>
<tr>
<td>QCNT = Summation of QJPR1, 3, 5, 7, 9</td>
<td>QCNT = Summation of QJPR14, 16, 18, 20, 22</td>
</tr>
<tr>
<td>Binary Equivalent of QJPRX =</td>
<td></td>
</tr>
<tr>
<td>QJPR1 = 4</td>
<td>QJPR14 = 4</td>
</tr>
<tr>
<td>QJPR3 = 8</td>
<td>QJPR16 = 8</td>
</tr>
<tr>
<td>QJPR5 = 16</td>
<td>QJPR18 = 16</td>
</tr>
<tr>
<td>QJPR7 = 32</td>
<td>QJPR20 = 32</td>
</tr>
<tr>
<td>QJPR9 = 64</td>
<td>QJPR22 = 64</td>
</tr>
</tbody>
</table>

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 2 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>
<thead>
<tr>
<th>INPUT</th>
<th>DESCRIPTION</th>
<th>PIN (S)</th>
<th>FTM TB(S)</th>
<th>LOGIC STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 MPU Overspeed</td>
<td>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 shutdown the #1 solenoid.</td>
<td>PIN 25</td>
<td>TB 32</td>
<td>“High” = no Overspeed; “Low” = Overspeed.</td>
</tr>
<tr>
<td>#2 MPU Overspeed</td>
<td>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 shutdown the #2 solenoid.</td>
<td>PIN 24</td>
<td>TB 33</td>
<td>“High” = no Overspeed; “Low” = Overspeed.</td>
</tr>
<tr>
<td>Solenoid Test No. 1 Select</td>
<td>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’.</td>
<td>PIN 32</td>
<td>TB 25</td>
<td>“High” = ON state. Pull low to circuit common for OFF.</td>
</tr>
<tr>
<td>Solenoid Test No. 2 Select</td>
<td>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’.</td>
<td>PIN 26</td>
<td>TB 31</td>
<td>“High” = ON state. Pull low to circuit common for OFF.</td>
</tr>
<tr>
<td>Emergency Shutdown</td>
<td>Discrete input used to shutdown both solenoids. When this input is activated it will turn on LED DS3.</td>
<td>PIN 22</td>
<td>TB 35</td>
<td>“High” = ON state. Pull low to circuit common for OFF.</td>
</tr>
<tr>
<td>Reset</td>
<td>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.</td>
<td>PIN 21</td>
<td>TB 36</td>
<td>Transition from “Low” to “High” activates reset.</td>
</tr>
<tr>
<td>INPUT</td>
<td>DESCRIPTION</td>
<td>PIN (S)</td>
<td>FTM TB(S)</td>
<td>LOGIC STATE</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------</td>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>Solenoid Failure Override</td>
<td>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.</td>
<td>PIN 19</td>
<td>TB 1</td>
<td>&quot;High&quot; = ON state. Pull low to circuit common for OFF.</td>
</tr>
<tr>
<td>Alarm Bus</td>
<td>Discrete input used to shutdown both solenoids. This input is a normally 'HIGH' signal, that 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.</td>
<td>PIN 13</td>
<td>TB 7</td>
<td>Normally &quot;High&quot; = run mode. &quot;Low = Fault.</td>
</tr>
<tr>
<td>Turn Off Solenoids</td>
<td>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'.</td>
<td>PIN 15</td>
<td>TB 5</td>
<td>&quot;High&quot; = ON state. Pull low to circuit common for OFF.</td>
</tr>
<tr>
<td>Turn On Solenoids</td>
<td>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.</td>
<td>PIN 17</td>
<td>TB 3</td>
<td>&quot;High&quot; = ON state. Pull low to circuit common for OFF.</td>
</tr>
<tr>
<td>Test Activate</td>
<td>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.</td>
<td>PIN 3</td>
<td>TB 17</td>
<td>&quot;High&quot; = ON state. Pull low to circuit common for OFF.</td>
</tr>
<tr>
<td>+ 24 Vdc Externally Supplied</td>
<td>+ 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.</td>
<td>PIN 7</td>
<td>PIN 5</td>
<td>External isolated power supply (+) input.</td>
</tr>
<tr>
<td>24 Vdc External Common</td>
<td>24 Vdc common from an external source used for the solenoids. NOTE: Use both pins to distribute current demand.</td>
<td>PIN 9</td>
<td>PIN 11</td>
<td>External isolated power supply (-) input.</td>
</tr>
</tbody>
</table>
The module output signals are described in the following table:

<table>
<thead>
<tr>
<th>OUTPUT</th>
<th>DESCRIPTION</th>
<th>PIN</th>
<th>FTM TB(S)</th>
<th>LOGIC STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Undercurrent</td>
<td>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.</td>
<td>PIN 33</td>
<td>TB 24</td>
<td>“Low” = under current cond. of #1 solenoid.</td>
</tr>
<tr>
<td>#2 Undercurrent</td>
<td>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.</td>
<td>PIN 27</td>
<td>TB 30</td>
<td>“Low” = under current cond. of #2 solenoid.</td>
</tr>
<tr>
<td>#1 Overcurrent</td>
<td>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.</td>
<td>PIN 34</td>
<td>TB 23</td>
<td>“Low” = over current cond. of #1 solenoid.</td>
</tr>
<tr>
<td>#2 Overcurrent</td>
<td>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.</td>
<td>PIN 28</td>
<td>TB 29</td>
<td>“Low” = over current cond. of #2 solenoid.</td>
</tr>
<tr>
<td>Solenoid Current Sensor #1</td>
<td>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.</td>
<td>PIN 35</td>
<td>TB 22</td>
<td>Solenoid current from #1 driver circuit. Usually across 1 ohm resistor. 1 Amp = 1 Volt.</td>
</tr>
<tr>
<td>Driver #1 (-)</td>
<td>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.</td>
<td>PIN 36</td>
<td>TB 21</td>
<td>Solenoid #1 (-) conn. to driver circuit.</td>
</tr>
<tr>
<td>Driver #1 (+)</td>
<td>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.</td>
<td>PIN 37</td>
<td>TB 20</td>
<td>Solenoid #1 (+) conn. to driver circuit.</td>
</tr>
<tr>
<td>OUTPUT Description</td>
<td>PIN</td>
<td>FTM (S)</td>
<td>LOGIC STATE</td>
<td></td>
</tr>
<tr>
<td>--------------------</td>
<td>------</td>
<td>---------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>Solenoid Current Sensor #2</td>
<td>PIN 29</td>
<td>TB 28</td>
<td>Solenoid current from #2 driver circuit. Usually across 1 ohm resistor. 1 Amp = 1 Volt.</td>
<td></td>
</tr>
<tr>
<td>Driver #2 (-)</td>
<td>PIN 30</td>
<td>TB 27</td>
<td>Solenoid #2 (-) conn. to driver circuit.</td>
<td></td>
</tr>
<tr>
<td>Driver #2 (+)</td>
<td>PIN 31</td>
<td>TB 26</td>
<td>Solenoid #2 (+) conn. to driver circuit.</td>
<td></td>
</tr>
<tr>
<td>Current Faults Cleared</td>
<td>PIN 2</td>
<td>TB 18</td>
<td>“Low” = all faults cleared on both channels.</td>
<td></td>
</tr>
<tr>
<td>Common</td>
<td>PIN 23</td>
<td>TB 34</td>
<td>Common</td>
<td></td>
</tr>
</tbody>
</table>

**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:
  \[ \text{Imax} = \text{Overcurrent trip value in amps} \]
  \[ \text{Rsense} = \text{Value of sense resistor on the external solenoid driver} \]
  \[ \text{Vmax} = \text{Imax} \times \text{Rsense} \]
  \[ \text{Set Vtrip} = \text{Vmax} \]
  \[ \text{Vzener} = \text{Voltage across VR6} \]

  \[ \text{R44} = \frac{\text{R45} \times \text{Vtrip}}{\text{Vzener} - \text{Vtrip}} \]

  Most common selection: ‘12.1 K’ (BOM 1648-885).

  If Rsense = 1.0 ohm, 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:
  \[ \text{Imax} = \text{Over current trip value in amps} \]
  \[ \text{Rsense} = \text{Value of sense resistor on the external solenoid driver} \]
  \[ \text{Vmax} = \text{Imax} \times \text{Rsense} \]
  \[ \text{Set Vtrip} = \text{Vmax} \]
  \[ \text{Vzener} = \text{Voltage across VR9} \]

  \[ \text{R72} = \frac{\text{R73} \times \text{Vtrip}}{\text{Vzener} - \text{Vtrip}} \]

  Most common selection: ‘12.1 K’ (BOM 1648-885).

  If Rsense = 1.0 ohm, Vtrip = 2.5 A

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**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 35mm 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.

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.

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.
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).

12.2.3—34Ch HDVIM FTM (AI/RTD/TC)

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 used 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 12-1—34Ch HDVIM FTM Outline Dimensions
Figure 12-2a—34Ch HDVIM FTM Schematic (part 1)
Figure 12-2b—34Ch HDVIM FTM Schematic (part 2)

Figure 12-3—34Ch HDVIM FTM Cold Junction Sensor Schematic
12.2.4—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 used 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 4-20mA inputs. Each connection is protected with a 0.1 A fuse.

Figure 12-4—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 12-5—24/8 Analog FTM Schematic
12.2.5—Dataforth® FTM
[shown without I/O modules installed]

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 4-20mA inputs. Each connection is protected with a 0.1 A fuse (F3 – F14). Jumpers P3 through P14 are used to configure the module for self-powered or loop-powered setups. See Chapter 8 for proper jumper configurations.

Figure 12-6—Dataforth FTM Outline Dimensions
Figure 12-7—Dataforth FTM Schematic (Inputs)
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

<table>
<thead>
<tr>
<th>Type Module</th>
<th>Description</th>
<th>Dataforth P/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-20mA Input Module</td>
<td>Pass Through Module</td>
<td>SCM7BPT-1460</td>
</tr>
<tr>
<td>0-5 Vdc Input Module</td>
<td>Pass Through +200Ω Module</td>
<td>SCM7BPT</td>
</tr>
<tr>
<td>RTD (100Ω) Module</td>
<td>European Curve</td>
<td>SCM7B34-1459</td>
</tr>
<tr>
<td>RTD (200Ω) Module</td>
<td>European Curve</td>
<td>SCM7B34-1472</td>
</tr>
<tr>
<td>TC Module</td>
<td>Type K</td>
<td>SCM7B47K-1458</td>
</tr>
</tbody>
</table>

[See Appendix A for Woodward part numbers.]
Figure 12-9—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 (200mA) or (25mA) 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 12-10—Four Channel Actuator Driver FTM Outline Dimensions
Figure 12-11—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 10mA) Modules (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 2Ch Actuator module (see Appendix A for part numbers).

Figure 12-12—Two Channel Actuator Controller FTM Outline Dimensions
Figure 12-13—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 use to connect the FTM with the Analog modules (see Appendix A for part numbers).
Figure 12-15—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 12-16—TC Input FTM Outline Dimensions
Figure 12-17—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 4-20mA inputs. Each connection is protected with a 0.1 A fuse (F1-F8). There are four +24/12VDC output connections available for powering four proximity sensors. Each of these connections are protected with a 0.1 A fuse (F9-F12).

Figure 12-18—Analog Combo FTM Outline Dimensions
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 8 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 0-25mA 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 12-20—Non-Standard Analog Input FTM Outline Dimensions
Figure 12-21—Non-Standard Analog 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 12-22—24 Vdc Discrete Input/Output FTM Outline Dimensions
Figure 12-23—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 12-24—Position Controller FTM Outline Dimensions
12.3.3—24/12 Discrete Module (Phoenix Contact)

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:
- 10A @ 28 Vdc Resistive
- 3A @ 150 Vdc Resistive
- 10A @ 115 Vac Resistive
- 10A @ 240 Vac Resistive
- 3A @ 28 Vdc Inductive
- 1.2A @ 150 Vdc Inductive
- 6A @ 115 Vac Inductive
- 3A @ 240 Vac Inductive

Figure 12-26—24/12 Discrete Module Outline Dimensions
Figure 12-27—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 source’s 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 $100 \div V$, 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 12-28—24 Vdc 48/24 Discrete FTM Outline Dimensions
Figure 12-29—24 Vdc 48/24 Discrete FTM Schematic
12.3.5—125 Vdc 48/24 Discrete FTM

**WARNING**—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 12-30—125 Vdc 48/24 Discrete FTM Outline Dimensions
Figure 12-31a—125 Vdc 48/24 Discrete FTM Schematic (part 1)
12.3.6—Discrete Input (with LEDs) FTM

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 doesn’t 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 use 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 12-32—Discrete Input (with LEDs) FTM Outline Dimensions

Figure 12-33—Discrete Input (with LEDs) FTM Schematic
12.4—Relays

12.4.1—16 Channel Relay Module (Phoenix Contact)

**IMPORTANT**  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.

![16 Channel Relay Module (Phoenix Contact) Configuration](image)

Figure 12-34—16 Channel Relay Module (Phoenix Contact) Configuration
Replacement Relays (see Appendix A)

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 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 12-35—16 Channel Relay Module (Phoenix Contact) Outline Dimensions](image-url)
Figure 12-36—16 Channel Relay Module (Phoenix Contact) Schematic
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.

![16 Channel Relay Module Configuration](image)

Figure 12-37—16 Channel Relay Module Configuration

Replacement Relays (see Appendix A)
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 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)
- 1 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 12-38—16 Channel Relay Module Outline Dimensions**
Figure 12-39—Relay Contact Connections for a 16 Channel Relay Box
Figure 12-40—Typical 16 Channel Relay Module Relay Driver Circuit (K1)

Figure 12-41—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)

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.

EXPLOSION HAZARD—Substitution of components may impair suitability for Class I, 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 12-42) 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 12-42—32 Channel Relay Module De-rating Curves

Figure 12-43—32 Channel Relay Module Outline Dimensions
Figure 12-44—Relay Contact Connections for a 32 Channel Relay Module
Figure 12-45—Typical 32 Channel Relay Module Driver Circuit (K1).

Figure 12-46—32 Channel Relay Module I/O Lock Circuit.
12.5—Service Panel

The Service panel can be used by the system operator to communicate with an 040 CPU Module in a stand alone MicroNet system (see Chapter 5 for MicroNet CPU module information and Appendix A for applicable module part number). The panel can be used to occasionally check the system, continuously monitor a value, or tune variables, (when applicable), through a 24-key keypad with a split-screen display. An optional mounting panel may be used to install the Service Panel in a 19 inch rack.

**IMPORTANT** The Service Panel is used only with the 68040 CPU Module.
The VFD module communicates with the CPU through a twin fiber-optic cable. The fiber optic cables come in several different lengths. See Appendix A for part numbers and lengths.
Figure 12-49—Service Panel Cutout Dimensions

Figure 12-50—Service Panel Optional 19 Inch Mounting Panel
12.6—CPU Interfaces

12.6.1—Ethernet FTM

To ensure signal integrity and robust operation of Ethernet devices on the Pentium CPU module, an Ethernet FTM (Field Termination Module) is required when interfacing an Ethernet connection (see Appendix A for the Ethernet Isolation FTM part number). Its primary function is to implement EMI shielding and cable shield termination of the Ethernet cable. Along with this FTM, double shielded Ethernet cables (SSTP) are required for customer installations. This FTM should be installed between the CPU Ethernet connection and your field network connection.

Figure 12-51—Ethernet Interface FTM Outline Drawing
12.6.2—CPU Serial Interface (RS-232-RS-232) FTM

**IMPORTANT**

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

This kit is required when a RS-232 serial port connection on either the MicroNet CPU (040) or (Pentium) module is needed (see Appendix A for the CPU Serial Interface (RS-232-RS-232) FTM part number). These communication ports are non-isolated. A shielded cable and Serial Port Isolator/Converter are required when using any of these ports to avoid susceptibility to EMI noise and ground loops related to PC connections and typical industrial environments. The kit consist of the following parts:

1 Ea Filter—RS-232 Db9mf
1 Ea Instruction—CPU Serial Interface Kit
1 Ea Cable—10 ft Molded Db9f to Db9f Null Modem w/thumbscrews
1 Ea Converter—Isolated RS-232-RS-232, Phoenix Contact, DIN Rail

Configure the kit for a 040 CPU as shown in Figure 12-52.

![Figure 12-52—Kit Configuration (040 CPU)](image)

The filter is not needed if the Pentium CPU is used. Configure the kit for a Pentium CPU as shown in Figure 12-53.

![Figure 12-53—Kit Configuration (Pentium CPU)](image)
12.6.3—CPU Serial Interface (RS-232-RS-232) FTM
Marine Certified

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

This kit is required for Marine Certified applications when a RS-232 serial port connection on either the MicroNet CPU (040) or (Pentium) module is needed (see Appendix A for the CPU Serial Interface (RS-232-RS-232) FTM Marine Certified part number). The kit consist of the following parts:

1 Ea Filter—RS-232 Db9mf
1 Ea Instruction—CPU Serial Interface Kit
1 Ea Cable—10 ft Molded Db9f to Db9f Null Modem w/thumb screws
1 Ea Converter—Isolated RS-232-RS-232, Kd485, DIN Rail

See Figure 12-52 040 CPU and 11-53 for Pentium configurations.

12.6.4—CPU Serial Interface (RS-232-RS-485) FTM

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

This kit is required when a RS-485 serial port connection on either the MicroNet CPU (040) or (Pentium) module is needed (see Appendix A for the CPU Serial Interface (RS-232-RS-485) FTM part number). The kit consist of the following parts:

1 Ea Filter—RS-232 Db9mf
1 Ea Instruction—CPU Serial Interface Kit
1 Ea Cable—10 ft Molded Db9f to Db9f Null Modem w/thumb screws
1 Ea Converter—Interface (RS-232 To RS-485)

See Figure 12-52 for 040 CPU and 11-53 for Pentium configurations.
12.6.5—CPU Serial Interface (RS-232-RS-485) FTM Marine Certified

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

This kit is required for Marine Certified applications when a RS-485 serial port connection on either the MicroNet CPU (040) or (Pentium) module is needed (see Appendix A for the CPU Serial Interface (RS-232-RS-485) FTM Marine Certified part number). The kit consist of the following parts:

- 1 Ea Filter–RS-232 Db9mf
- 1 Ea Instruction–CPU Serial Interface Kit
- 1 Ea Cable–10 ft Molded Db9f to Db9f Null Modem w/thumbscrews

See Figure 12-52 for 040 CPU and 11-53 for Pentium configurations.
Chapter 13.
Distributed I/O Network

This chapter (Distributed I/O Network) is a future feature of the MicroNet™ control.
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 Module

**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 push the module into the slot until the connector on the module and the connector on the motherboard make contact.

3. With even pressure exerted at the top and bottom of the module, firmly push the module into 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.

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

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

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.
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. After the FTM, the VME module, and the relay box(es) are installed, the cables that connect them may be installed.
6. If your system includes a second relay box, repeat the above steps for the second relay box.

NOTE—For use in ordinary or non-hazardous locations only.

Figure 14-2—16 Channel Relay Box Outline Drawing

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

Figure 14-3—32 Channel Relay Box Outline Drawing
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.

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 DIN earth ground terminal. Torque to 0.37 to 0.5 to 0.8 Nm (0.59 ft lbs). This wire should be kept short for optimum high frequency grounding. It must be no longer than 150 mm (6 in) in length. After both the FTM and the module are installed, the cables that connect them may be installed.
8. Alternatively, 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.

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 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.
- Do not place shielded wires in the same conduit as high voltage or large current-carrying cables.
14.2.4—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 control terminal block. The length of exposed wire extending beyond the shield should be limited to 25.4 mm (1 in). Relay outputs, contact inputs, and power supply wiring do not normally require shielding, but can be shielded if desired.

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.
For compliance with EMC standards, it is required that all analog and discrete input/output wiring be separated from all power wiring.

Preferred

Second Choice

Third Choice

Fourth Choice

Figure 14-5—Shield Termination Diagram Example
Signal lines, mainly Analog Outputs and Actuator Outputs, send the system ground (DGND) out of the control as part of the field wiring. Take great care in wiring the field devices with cable runs longer than 30 m (99 feet), so that DGND does not become referenced to Protective Earth.

When there is significant transient ground bounce and the ground potential at the control and field device is significantly different (significant resistance between the two points), referencing DGND to Protective Earth at the field device can cause system disruptions in some VME modules.

A significant potential difference in Protective Earth grounds generally arises when the physical distance between protective earth points is longer than 30 m (99 feet), but may happen any time there is a significant enough inductance and/or resistance.

Transient ground bounce is caused when there is a nearby lightning strike, or nearby switched, high current, heavy inductive loads are switched off.

The control DGND is referenced to Protective Earth internally to the control via capacitance and local shielded cabling capacitance. If the field device’s Protective Earth is referenced to DGND, transient ground bounce is placed across the control DGND and field device via the low impedance cabling. The transients can significantly disrupt some modules.

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 FTM Grounding Diagram Example
14.2.5—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.
- 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, 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, 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).
  - 4 places minimum — 4 corners + 2 mid-points preferred.
- Door must be electrically connected to the main structural frame (<2.5 mΩ).
  - 2 places minimum, 3 places preferred, use of 25 mm/1” 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).
  - 1 place minimum, 2 places preferred (placed at opposite sides).
- Floor and top panels must be electrically connected to structural frame (<2.5 mΩ).
  - 2 places minimum, 4 places at the corners preferred.
- DIN rail must be electrically connected to structural frame (<2.5 mΩ).
  - Once every 300 mm/12”, 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.

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, 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, 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).

- 4 places minimum — 4 corners + 2 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”, 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.

### 14.2.6—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 grounding of cable shields.

### 14.2.7—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 or 6” of separation between areas
14.2.8—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” 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. 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.

14.2.9—Analog I/O Routing and Shield Termination

I/O Module in Cabinet
- Use shielded cable from MicroNet module to I/O module (FTM, Analog Driver etc.)
- 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”)

I/O Cable w/ I/O Module 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 overbraid, ground overbraid shield to cabinet - connect inner braids at I/O module termination point
  - If single shield, ground shield to cabinet
- If 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

I/O Module not in Cabinet
- Route cable from MicroNet module to I/O module with cable against cabinet metal wall
- Ground cable shield at entry point to cabinet at MicroNet FTM and I/O module

I/O Cable w/o I/O Module in Cabinet
- connect all braids at I/O module termination point

14.2.10—Discrete I/O Routing and Shield Termination

I/O Module in Cabinet
- Use shielded cable from MicroNet module to I/O module (FTM, Analog Driver etc.)
- Ground cable, direct, at MicroNet module and I/O module
- Locate as close to I/O cable entry point as possible
- Locate I/O module away from unshielded discrete areas (> 6")
I/O Cable w/ I/O Module 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 overbraid, ground overbraid shield to cabinet - connect inner braids at I/O module termination point
  - If single shield, ground shield to cabinet
  - If I/O cable is grounded direct at remote end of cable, ground the I/O cable shield, capacitively at the FTM
- I/O cable ground at I/O module must be the same type as at cable entry point into cabinet

I/O Module 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 I/O module

I/O Cable w/o I/O Module in Cabinet
- Connect all braids at I/O module termination point

14.2.11—Unshielded I/O

I/O Module in Cabinet
- Use Shielded cable from MicroNet module to I/O module (FTM, Analog driver, etc.)
- Ground cable direct at MicroNet module and I/O module
- Locate as close to I/O cable entry point as possible;
- Locate I/O module away from sensitive analog areas (> 6”);

I/O Cable w/ I/O Module in Cabinet
- Route I/O cable against cabinet metal wall from entry point to I/O module;
- Do not let other cables within 12” of unshielded discrete I/O cables if they are parallel for > 2’
- Do not let other cables within 6” of unshielded discrete I/O cables if they are parallel for less than 2’
- Limit length of unshielded I/O cable inside the cabinet. Any length over 2’ is too long
- If lengths greater than 2’ are required, special considerations should be used to separate this unshielded wiring from other circuits and minimize electromagnetic and RF emissions.

I/O Module 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 I/O module

14.2.12—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 >12”
- Locate from all other cables > 6” away
- Use only CE compliant devices
CE Complaint to Industrial Levels
- Locate based on Zoning restrictions

14.2.13—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.

14.2.14—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.

14.2.15—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”

14.2.16—Equipment Bonding
- DIN rail shall be electrically connected to structural frame (<2.5 mΩ) once every 30 cm/12”.
- 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).

14.2.17—Safety Ground Wire Installation
- Safety wires shall be routed against the grounded cabinet structure. Locate safety ground wire 6” from unshielded cabling, 3” from internal shielded cabling, and 15 cm/6” from any I/O cabling exiting the cabinet.

14.2.18—Installation of other Equipment, Fans, Meters, etc.

Shield Termination Schemes
- See Application Note B51204 for this information.
14.2.19—Shielded I/O Cable

- 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 volume1 of this manual.

*—VxWorks is a trademark of Wind River Systems, Inc.
## CPU5200 Module, Fault LED Flash Codes

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<tr>
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## AppManager Diagnostic Codes / Message ID Values

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<tr>
<td>Re-sync -- Lost CPU failed to sync properly</td>
<td>139</td>
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</tbody>
</table>
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 it’s 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.

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**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.

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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’s 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.

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 (slot A2) 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.

**SYS CON 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/O LOCK 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**—CAN communication ports – NOT USED THIS SYSTEM

**CPU Module Replacement Procedure:**

1. Read all warnings on pages v and vi of this Volume before replacing any module. **Replacing a CPU will disable all IO from this kernel.**
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>
<thead>
<tr>
<th></th>
<th>KERNEL A</th>
<th>KERNEL B</th>
<th>KERNEL C</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENET1</td>
<td>IP =</td>
<td>IP =</td>
<td>IP =</td>
</tr>
<tr>
<td></td>
<td>Subnet =</td>
<td>Subnet =</td>
<td>Subnet =</td>
</tr>
<tr>
<td>ENET2</td>
<td>IP =</td>
<td>IP =</td>
<td>IP =</td>
</tr>
<tr>
<td></td>
<td>Subnet =</td>
<td>Subnet =</td>
<td>Subnet =</td>
</tr>
</tbody>
</table>

**Refer to volume1 of this manual (CPU5200 section) for factory defaults.

Table 15-1—Customer-Specific IP Addresses

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 of the front panel, 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 front panel, 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, that 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 the other CPUs are running without faults.

3. 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.

4. **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.

5. **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.)

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

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

8. **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.)

9. **Fully insert the I/O module:** 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.
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).

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 step #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).

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).

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:**

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

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

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

This procedure will shut down the control system.

**IMPORTANT**

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

1. Installation of MicroNet Power Supply:
   - Use the following procedure to remove faulty fan from chassis
     - Use a stubby (approximately 3.5" long) #2 Phillips screwdriver.
     - Loosen, but do not remove, the four retaining screws holding the fan assembly to the chassis.
     - Rotate fan to remove power by accessing wire quick connects.
     - Remove fan and guard assembly from chassis.
     - Remove guard from faulty fan, noting captive nut location.

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

2. Installation of MicroNet General Chassis/Power Supply Only
   - Locate power supply a minimum of 8 cm (3") with a maximum distance of 11.4 cm (4.5") directly below the TMR chassis.

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

   - Use a stubby (approximately 9 cm/3.5" long) #2 Phillips screwdriver.
   - Loosen, but do not remove, the four retaining screws holding the fan assembly to the chassis.
   - Rotate fan to remove power by accessing wire quick connects.
   - Remove fan and guard assembly from chassis.
   - Remove guard from faulty fan.
   - Install new fan.
   - Reinstall fan assembly (flow arrows should point "UP").
   - Connect RED wire to the + fan terminal and BLACK wire to – fan terminal.

   Do not contact quick connect terminals with any metallic surface during reinstallation.
Chapter 16.
Service Options

16.1—Product Service 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 and 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 **Recognized Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.

- A **Recognized Turbine Retrofitter (RTR)** is an independent company that does both steam and gas turbine control retrofits and upgrades globally, and can provide the full line of Woodward systems and components for the retrofits and overhauls, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at [www.woodward.com/support/directory.cfm](http://www.woodward.com/support/directory.cfm).
16.2—Woodward Factory Servicing 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 (5-01-1205) 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 Product and Service Warranty 5-01-1205).

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 Product and Service Warranty 5-01-1205) 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 Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

16.3—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.
16.3.3—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.

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.

16.4—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.

16.5—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 us via telephone, email us, or use our website: www.woodward.com/support.
16.6—How to Contact Woodward

For assistance, call one of the following Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

### Electrical Power Systems

<table>
<thead>
<tr>
<th>Facility</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>+55 (19) 3708 4800</td>
</tr>
<tr>
<td>China</td>
<td>+86 (512) 6762 6727</td>
</tr>
<tr>
<td>Germany:</td>
<td></td>
</tr>
<tr>
<td>Kempen</td>
<td>+49 (0) 21 52 14 51</td>
</tr>
<tr>
<td>Stuttgart</td>
<td>+49 (711) 78954-0</td>
</tr>
<tr>
<td>India</td>
<td>+91 (129) 4097100</td>
</tr>
<tr>
<td>Japan</td>
<td>+81 (43) 213-2191</td>
</tr>
<tr>
<td>Korea</td>
<td>+82 (51) 636-7080</td>
</tr>
<tr>
<td>Poland</td>
<td>+48 12 618 92 00</td>
</tr>
<tr>
<td>United States</td>
<td>+1 (970) 482-5811</td>
</tr>
</tbody>
</table>

### Engine Systems

<table>
<thead>
<tr>
<th>Facility</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>+55 (19) 3708 4800</td>
</tr>
<tr>
<td>China</td>
<td>+86 (512) 6762 6727</td>
</tr>
<tr>
<td>Germany:</td>
<td></td>
</tr>
<tr>
<td>Stuttgart</td>
<td>+49 (711) 78954-0</td>
</tr>
<tr>
<td>India</td>
<td>+91 (129) 4097100</td>
</tr>
<tr>
<td>Japan</td>
<td>+81 (43) 213-2191</td>
</tr>
<tr>
<td>Korea</td>
<td>+82 (51) 636-7080</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>+31 (23) 5661111</td>
</tr>
<tr>
<td>United States</td>
<td>+1 (970) 482-5811</td>
</tr>
</tbody>
</table>

### Turbine Systems

<table>
<thead>
<tr>
<th>Facility</th>
<th>Phone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>+55 (19) 3708 4800</td>
</tr>
<tr>
<td>China</td>
<td>+86 (512) 6762 6727</td>
</tr>
<tr>
<td>Germany:</td>
<td></td>
</tr>
<tr>
<td>Kempen</td>
<td>+49 (0) 21 52 14 51</td>
</tr>
<tr>
<td>Stuttgart</td>
<td>+49 (711) 78954-0</td>
</tr>
<tr>
<td>India</td>
<td>+91 (129) 4097100</td>
</tr>
<tr>
<td>Japan</td>
<td>+81 (43) 213-2191</td>
</tr>
<tr>
<td>Korea</td>
<td>+82 (51) 636-7080</td>
</tr>
<tr>
<td>The Netherlands</td>
<td>+31 (23) 5661111</td>
</tr>
<tr>
<td>United States</td>
<td>+1 (970) 482-5811</td>
</tr>
</tbody>
</table>

You can also contact the Woodward Customer Service Department or consult our worldwide directory (www.woodward.com/support/directory.cfm) for the name of your nearest Woodward distributor or service facility.

16.7—Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

<table>
<thead>
<tr>
<th>Information</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your Name</td>
<td></td>
</tr>
<tr>
<td>Site Location</td>
<td></td>
</tr>
<tr>
<td>Phone Number</td>
<td></td>
</tr>
<tr>
<td>Fax Number</td>
<td></td>
</tr>
<tr>
<td>Engine/Turbine Model Number</td>
<td></td>
</tr>
<tr>
<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Number of Cylinders (if applicable)</td>
<td></td>
</tr>
<tr>
<td>Type of Fuel (gas, gaseous, steam, etc)</td>
<td></td>
</tr>
<tr>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td></td>
</tr>
<tr>
<td>Control/Governor #1</td>
<td></td>
</tr>
<tr>
<td>Woodward Part Number &amp; Rev. Letter</td>
<td></td>
</tr>
<tr>
<td>Control Description or Governor Type</td>
<td></td>
</tr>
<tr>
<td>Serial Number</td>
<td></td>
</tr>
<tr>
<td>Control/Governor #2</td>
<td></td>
</tr>
<tr>
<td>Woodward Part Number &amp; Rev. Letter</td>
<td></td>
</tr>
<tr>
<td>Control Description or Governor Type</td>
<td></td>
</tr>
<tr>
<td>Serial Number</td>
<td></td>
</tr>
<tr>
<td>Control/Governor #3</td>
<td></td>
</tr>
<tr>
<td>Woodward Part Number &amp; Rev. Letter</td>
<td></td>
</tr>
<tr>
<td>Control Description or Governor Type</td>
<td></td>
</tr>
<tr>
<td>Serial Number</td>
<td></td>
</tr>
</tbody>
</table>

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

[starts next page]
The "X" indicates approval from the agency shown in the columns. This chart is for reference only. Woodward must be consulted for latest compliance information.
<p>| 6561-204 | ANP | MODULE | ISO 516 10V ANALOG IN | X x X n/a x x x |
| 6561-203 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-100 | ANP | MODULE | ISO 1-10V ANALOG IN | X x X n/a x x x |
| 6560-101 | ANP | MODULE | ISO 1-10V ANALOG IN | X x X n/a x x x |
| 6560-102 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-103 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-104 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-105 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-106 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-107 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-108 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-109 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-110 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-111 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-112 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-113 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-114 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-115 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-116 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-117 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-118 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-119 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-120 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-121 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-122 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-123 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-124 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-125 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-126 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-127 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-128 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-129 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-130 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-131 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-132 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-133 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |
| 6560-134 | ANP | MODULE | ISO 4-20 ANALOG IN | X x X n/a x x x |</p>
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Status</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>5501-431</td>
<td>BOARD NETCON 2CH ACTUATOR CONTROLLER (1000MA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-432</td>
<td>BOARD NETCON 2CH ACTUATOR CONTROLLER (2000MA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-461</td>
<td>ANP MODULE POSITION CONTROLLER TM QFB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-462</td>
<td>ANP MODULE POSITION CONTROLLER TM SFB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-465</td>
<td>BOARD MICRONET SIMPLEX POWER SUPPLY (24V DC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-466</td>
<td>BOARD MICRONET SIMPLEX POWER SUPPLY (120V AC/DC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-467</td>
<td>BOARD MICRONET SIMPLEX POWER SUPPLY (220V AC/DC)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-468</td>
<td>ANP MODULE NETCON CPU_040 W/O LL MEMORY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-469</td>
<td>ANP MODULE NETCON CPU_040 W/O LL MEMORY (EMI FILTER)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-470</td>
<td>ANP MODULE NETCON CPU_040 W/O LL MEMORY (EMI FILTER)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-471</td>
<td>ANP MODULE NETCON 5000B SIO W/SCREW POSTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-473</td>
<td>ANP MODULE NETCON DUAL OVERSPEED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-476</td>
<td>ANP MODULE NETCON DUAL OVERSPEED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-477</td>
<td>ANP MODULE NETCON DUAL OVERSPEED @ 5478 HZ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-478</td>
<td>ANP MODULE NETCON DUAL OVERSPEED @ 5404 HZ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5501-479</td>
<td>ANP MODULE NETCON DUAL OVERSPEED @ 6160 HZ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5503-267</td>
<td>BOARD NETCON IIB 3/8 PIN RT SID W/SCREW POSTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5503-279</td>
<td>BOARD MICRONET HDVI(M) THRU HOLE ASSY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5503-282</td>
<td>MODULE FTM HDVI(M) THRU HOLE ASSY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5503-336</td>
<td>AS MODULE MICRONET REAL-TIME NETWORK XCV/R (REMOTE)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5503-364</td>
<td>A MODULE HD ANALOG 10-12 CH 4-20MA AND 12 CH 0-5V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9905-998</td>
<td>KIT CPU EMI DB9 RS232 ADAPTOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9905-976</td>
<td>MODULE LINKNET 2 CHANNEL 200 OHM RTO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9905-970</td>
<td>MODULE ASSEMBLY OF LINKNET TERMINATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9905-966</td>
<td>MODULE LINKNET TC INPUT FAIL HIGH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9905-967</td>
<td>MODULE LINKNET TC INPUT FAIL LOW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9905-968</td>
<td>MODULE LINKNET 6 CHANNEL 4-20 MA IN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9905-969</td>
<td>MODULE LINKNET 6 CHANNEL 4-20 MA IN W/ 24 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9905-970</td>
<td>MODULE LINKNET 6 CHANNEL 100 OHM RTO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9905-971</td>
<td>MODULE LINKNET DISCRETE IN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9905-972</td>
<td>MODULE LINKNET 6 CHANNEL 4-20 MA OUT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9905-973</td>
<td>MODULE LINKNET DISCRETE OUT</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Updated: Jan 27, 2003 (Compliance Technical File: 00372-04-07-01.xls)

Status
A: Active
ANP: Active, Non-preferred
AS: Active Service
### Appendix B.
### Environmental Specifications

Operating Temperature for the MicroNet TMR® Control

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to +55 °C (+32 to +131 °F)</td>
<td>Continuous operation with insufficient airflow or higher operating temperatures will lead to reduced reliability and possible damage.</td>
</tr>
<tr>
<td>–40 to +105 °C (–40 to +221 °F)</td>
<td>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.</td>
</tr>
</tbody>
</table>

Storage Temperature

<table>
<thead>
<tr>
<th>Temperature Range</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>–40 to +105 °C (–40 to +221 °F)</td>
<td>except CPU module: –20 to +45 °C (–4 to +113 °F) to maximize real time clock battery life.</td>
</tr>
</tbody>
</table>

Humidity (TMR, Simplex)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lloyd's Register Test Specification No. 1, 1996, Humidity Test 1</td>
<td>2 cycles 20–55 °C at 95% RH non-condensing, over 48 hours</td>
</tr>
<tr>
<td>EN 50178</td>
<td>96 hours @ 93 +2 -3% RH @ 40 °C (104 °F)</td>
</tr>
</tbody>
</table>

Humidity (MicroNet Plus)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lloyd's Register Test Specification No. 1, 2002, Humidity Test 1</td>
<td>2 cycles 20–55 °C at 95% RH non-condensing, over 48 hours</td>
</tr>
<tr>
<td>EN 50178</td>
<td>96 hours @ 93 +2 -3% RH @ 40 °C (104 °F)</td>
</tr>
</tbody>
</table>

Vibration (TMR, Simplex)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lloyd's Register Test Specification No. 1, 1996, Vibration Test 1</td>
<td>5–13.2 Hz, ±1 mm; 13.2–100 Hz, ±0.7 g</td>
</tr>
<tr>
<td>EN 50178 vibration test 1</td>
<td>10–57 Hz @ 0.075 mm amplitude and 57–150 Hz @ 1 g, 10 sweeps per axis at 1 octave/minute</td>
</tr>
</tbody>
</table>

Vibration (MicroNet Plus)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lloyd's Register Test Specification No. 1, 2002, Vibration Test 1</td>
<td>3–16 Hz, ±1 mm; 16–100 Hz, ±1.0 g</td>
</tr>
<tr>
<td>EN 50178 vibration test 1</td>
<td>10–57 Hz @ 0.075 mm amplitude and 57–150 Hz @ 1 g, 10 sweeps per axis at 1 octave/minute</td>
</tr>
</tbody>
</table>

Shock

<table>
<thead>
<tr>
<th>Specification</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>US MIL-STD-810C, Figure 516.2-1 procedure 1b</td>
<td>(15 g 11 ms half sine pulse)</td>
</tr>
</tbody>
</table>

Air Quality

<table>
<thead>
<tr>
<th>Quality</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollution Degree 2</td>
<td></td>
</tr>
<tr>
<td>Altitude (max.)</td>
<td>4000 m</td>
</tr>
</tbody>
</table>

Installation Overvoltage Rating

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category II</td>
<td></td>
</tr>
</tbody>
</table>

Ingress Protection

In accordance with the requirements of IP20 as defined in IEC 529, unless mounted in a protective enclosure.

Sound Level

<table>
<thead>
<tr>
<th>Weight</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 70 dBA</td>
<td></td>
</tr>
</tbody>
</table>

Dielectric Withstand

<table>
<thead>
<tr>
<th>Weight</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 V power supply: 707 Vdc from power input to chassis</td>
<td>AC/DC and HVAC version: 2200 Vdc from power input to chassis</td>
</tr>
</tbody>
</table>

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

### WARNING
Ground leakage exceeds 3.5 mA. Protective earth grounding is required.
Appendix C.
MicroNet™ Hardware and Software Compatibility

- 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

Coder Compatibility with CPU modules on different Control Platforms

<table>
<thead>
<tr>
<th>Coder List</th>
<th>Control Platforms</th>
<th>TMR 5200</th>
<th>PowerPC 5200</th>
<th>Pentium</th>
<th>Motorola x040</th>
<th>Motorola x060</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coder 5.x</td>
<td>5.x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coder 4.x</td>
<td>4.x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coder 3.x</td>
<td>3.x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coder 2.x</td>
<td>2.x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*—NOTE—CAN communications and short chassis enabled in Coder 4.02
### MicroNet TMR Manual 26167V2

**C.2—Module Compatibility Matrix**

- 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>
<thead>
<tr>
<th>Module Compatibility</th>
<th>MicroNet Family</th>
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<td>MicroNet TMR, 3-Slot</td>
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<td>Speed Sensor MPU Input (4ch)</td>
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<td>Analog Input 4-20ma (8ch)</td>
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<td>Analog Input T/C (8ch)</td>
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<td>Analog Input RTD (8ch)</td>
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<td>Discrete Input (64ch)</td>
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<td>Discrete Input (32ch)</td>
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<td>Pressure Input</td>
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<tr>
<td>Voltage Input (8ch)</td>
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<td><strong>Output Modules</strong></td>
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<td>Actuator Controller (2ch)</td>
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<td>Integrating Actuator Driver (2ch)</td>
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<td>Proportional Actuator Driver (4ch)</td>
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<td>Position Control Module (PCM)</td>
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<tr>
<td>Analog Output 4-20ma (8ch)</td>
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<tr>
<td>Voltage Output (8ch)</td>
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</tbody>
</table>
Appendix D. Declarations

DECLARATION OF CONFORMITY
According to EN 45014

Manufacturer's Name: WOODWARD GOVERNOR COMPANY (WGC) Industrial Controls Group

Manufacturer's Address: 1000 F. Drake Rd
Fort Collins, CO, USA, 80525

Model Name(s)/Number(s): MicroNet™ TMR and 5009 MicroNet™ TMR families of Digital Control Systems, 18 36 VDC.


Applicable Standards: EN61000-6-2, 2005: EMC Part 6-2: Generic Standards - Immunity for Industrial Environments
EN61000-6-4, 2007: EMC Part 6-4: Generic Standards - Emissions for Industrial Environments

We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER

[Signature]

[Full Name]

Compliance Engineering Manager

[Position]

[Place]

[Date]
DECLARATION OF CONFORMITY
According to EN 15014

Manufacturer’s Name: WOODWARD GOVERNOR COMPANY (WGC)
Industrial Controls Group

Manufacturer’s Address: 1000 E. Drake Rd.
Fort Collins, CO, USA, 80525

Model Name(s)/Number(s): MicroNet™ TMR and 5009 MicroNet™ TMR families of
Digital Control Systems, 88-264 VAC, and 100-300 VDC.

Conformance to Directive(s): Declared to 2004/108/EC COUNCIL DIRECTIVE of 15 Dec 2004 on
the approximation of the laws of the Member States relating to
electromagnetic compatibility.

Declared to 2006/95/EC COUNCIL DIRECTIVE of 12 December
2006 on the harmonized laws of Member States relating to electrical
equipment designed for use within certain voltage limits.

for Industrial Environments
EN61000-6-4, 2007. EMC Part 6-4: Generic Standards - Emissions
for Industrial Environments
EN50178, 1997: Electronic Equipment for Use in Power Installations

We, the undersigned, hereby declare that the equipment specified above conforms to the above
Directive(s).

MANUFACTURER

[Signature]

Sam Coleman
Full Name

Compliance Engineering Manager
Position

WIC, Fort Collins, CO, USA
Place

[April 30, 2009]
Date

5-09-1183 Rev 6, 16-Oct-2002

Woodward
СИСТЕМА СЕРТИФИКАЦИИ ГОСТ Р ГОССТАНДАРТ РОССИИ

СЕРТИФИКАТ СООТВЕТСТВИЯ

№ POCC US.М.103.B00605
Срок действия с 08.07.2008 по 07.07.2011

ОРГАНИЗАЦИЯ № POCC RU.0001.11М.103
НП "СЕРТИФИКАЦИОННЫЙ ИСПЫТАТЕЛЬНЫЙ ЦЕНТР" (ОС НП "СИЦ")
195112, Санкт-Петербург, Малоохтинский пр., д. 68, тел. (812) 528-08-83; факс (812) 331-07-73

ПРОДУКЦИЯ Программно-технический комплекс
модели MicroNet TMR
Серийный выпуск

СООТВЕТСТВУЕТ ТРЕБОВАНИЯМ НОРМАТИВНЫХ ДОКУМЕНТОВ
ГОСТ МЭК 60950-2002, ГОСТ 26329-84 (п.п. 1.2, 1.3),
ГОСТ Р 51318.22-99, ГОСТ Р 51318.24-99,
ГОСТ Р 51317.3.3-99, ГОСТ Р 51317.3.2-2006 (п. п. 6, 7)

ИЗГОТОВИТЕЛЬ Woodward Governor Co
1000 East Drake Road, Fort Collins CO 80525, USA

СЕРТИФИКАТ ВЫДАН Woodward Governor Co
1000 East Drake Road, Fort Collins CO 80525, USA
tел. (970) 498-5811; факс (970) 498-3058

НА ОСНОВАНИИ протокола испытаний № 06069-08-СИЦ от 27.06.2008
ИЛ НП "СИЦ"; reg № POCC RU.0001.21МЕ95 (до 16.01.2011 г.)

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ Маркировка знаком соответствия по
ГОСТ Р 50460-92 производится на изделии (упаковке) и в сопроводительной документации.
СИСТЕМА СЕРТИФИКАЦИИ ГОСТ Р ГОССТАНДАРТ РОССИИ

СЕРТИФИКАТ СООТВЕТСТВИЯ

№ РОСС US.ML03.B00606
Срок действия с 08.07.2008 по 07.07.2011
7754198

ОРГАН ПО СЕРТИФИКАЦИИ РОСС RU.0001.11М.Л03
НП “СЕРТИФИКАЦИОННЫЙ ИСПЫТАТЕЛЬНЫЙ ЦЕНТР” (ОС НП “СИЦ”)
195112, Санкт-Петербург, Малоохтинский пр., д. 68, тел. (812) 528-08-83; факс (812) 331-07-73

ПРОДУКЦИЯ  Программно - технический комплекс
модель 5009
Серийный выпуск

СООТВЕТСТВУЕТ ТРЕБОВАНИЯМ НОРМАТИВНЫХ ДОКУМЕНТОВ
ГОСТ Р МЭК 60950-2002, ГОСТ 26329-84 (п.п. 1.2, 1.3),
ГОСТ Р 51318.22-99, ГОСТ Р 51318.24-99,
ГОСТ Р 51317.3.3-99, ГОСТ Р 51317.3.2-2006 (п.п. 6, 7)

ИЗГОТОВИТЕЛЬ  Woodward Governor Co
1000 East Drake Road, Fort Collins CO 80525, USA

СЕРТИФИКАТ ВЫДАН  Woodward Governor Co
1000 East Drake Road, Fort Collins CO 80525, USA
тел. (970) 498-5811, факс (970) 498-3058

НА ОСНОВАНИИ  протокола испытаний № 97061-08-СИЦ от 27.06.2008
ИЛ НП “СИЦ”, Сер. № РОСС RU.0001.21МЕ95 (до 16.01.2011 г.)

ДОПОЛНИТЕЛЬНАЯ ИНФОРМАЦИЯ  Маркировка знаком соответствия по
ГОСТ Р 50460-92 производится на изделии (утпаковке) и в сопроводительной документации.

Руководитель органа  Эксперт

М.Е. Долгаков  Э.И. Троиная
инженер, финанс

именует, финанс

именует, финанс

именует, финанс
## Appendix E. Acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>A</td>
<td>Ampere</td>
</tr>
<tr>
<td>ac</td>
<td>Alternating Current</td>
</tr>
<tr>
<td>Act</td>
<td>Actuator</td>
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<tr>
<td>A/D</td>
<td>Analog-to-Digital</td>
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<td>AD590</td>
<td>Temperature Measurement Device</td>
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<td>AI</td>
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<tr>
<td>AM</td>
<td>Amplitude Modulated</td>
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<tr>
<td>App</td>
<td>Application</td>
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<tr>
<td>AO</td>
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<tr>
<td>ASTM</td>
<td>American Society of Testing and Materials</td>
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<tr>
<td>AWG</td>
<td>American Wire Gauge</td>
</tr>
<tr>
<td>Baud</td>
<td>Bits per Second (Data Transmission Rate)</td>
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<tr>
<td>BIOS</td>
<td>Basic I/O Software</td>
</tr>
<tr>
<td>BOM</td>
<td>Bill of Materials</td>
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<td>CAN</td>
<td>Control Area Network</td>
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<td>CAT</td>
<td>Category</td>
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<tr>
<td>COAX</td>
<td>Co-axial</td>
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<td>cm</td>
<td>Centimeter</td>
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<td>CD-ROM</td>
<td>Computer Disc Read Only Memory</td>
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<tr>
<td>CE</td>
<td>Symbol representing compliance to the EU Directives</td>
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<td>Ch</td>
<td>Channel</td>
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<td>CJ</td>
<td>Cold Junction</td>
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<td>CMRR</td>
<td>Common Mode Rejection Ratio</td>
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<td>COM</td>
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<td>Combo</td>
<td>Combination</td>
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<td>Central Processor Unit</td>
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<td>CSR</td>
<td>Control Status register</td>
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<td>dB</td>
<td>Decibel</td>
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<td>dc</td>
<td>Direct Current</td>
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<td>DCS</td>
<td>Distributed Control System</td>
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<td>DFB</td>
<td>Dual Feedback</td>
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<td>DLE</td>
<td>Dry Low Emissions</td>
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<td>DI</td>
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<td>DIN</td>
<td>Deutsche Institut für Normung</td>
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<td>DIO</td>
<td>Discrete Input/Output</td>
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<td>DRAM</td>
<td>Dynamic Random Access Memory</td>
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<tr>
<td>Drv</td>
<td>Driver</td>
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<td>DSP</td>
<td>Digital Signal Processor</td>
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<td>DTR</td>
<td>Data Terminal Ready</td>
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<td>DUART</td>
<td>Dual Universal Asynchronous Receive/Transmit</td>
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<td>EIA</td>
<td>Electronic Industry Alliance</td>
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<td>EMC</td>
<td>Electromagnetic Compatibility</td>
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<td>Electromagnetic Interference</td>
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<td>EN</td>
<td>Europäische Norm (European Norm)</td>
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<td>ESD</td>
<td>Electrostatic Discharge</td>
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<td>EU</td>
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<td>FDBK</td>
<td>Feedback</td>
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<td>FDOC</td>
<td>Fixed Disk on Chip</td>
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<td>FS</td>
<td>Full Scale</td>
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<td>FTM</td>
<td>Field Termination Module</td>
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<td>FPU</td>
<td>Floating Point Unit</td>
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<td>G</td>
<td>Force of Gravity</td>
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<td>Woodward Graphical Application Program(mer)</td>
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<td>Ground</td>
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<td>GS</td>
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<td>HDVIM</td>
<td>High Density Versatile Input Module</td>
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<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
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<tr>
<td>Hz</td>
<td>Hertz (cycles per second)</td>
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<td>HD</td>
<td>High Density</td>
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<td>HV</td>
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<td>HVAC</td>
<td>High Voltage Alternating Current</td>
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<td>IEC</td>
<td>International Electro technical Commission</td>
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<td>IEEE</td>
<td>Institute of Electronic &amp; Electrical Engineers</td>
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<td>IP</td>
<td>Internet Protocol</td>
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<td>I/O</td>
<td>Input/Output</td>
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<td>IOLOCK</td>
<td>I/O Control Signal on MicroNet™ Motherboard</td>
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<td>ISO</td>
<td>International Standards Organization</td>
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<td>KB</td>
<td>Data Transmission Rate / 1000</td>
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<td>Light Emitting Diode</td>
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<td>LinkNet</td>
<td>Woodward Local Area Network Product Line</td>
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<td>LM</td>
<td>GE Gas Turbine Family</td>
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<td>LPT1</td>
<td>Line Printer Terminal #1</td>
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<td>Woodward Liquid Valve Family</td>
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<td>Low Voltage</td>
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<td>LVD</td>
<td>Low Voltage Directive</td>
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<td>LVDT</td>
<td>Linear Variable Differential Transformer</td>
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<tr>
<td>mA</td>
<td>Milliampere</td>
</tr>
<tr>
<td>Max</td>
<td>Maximum</td>
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<tr>
<td>Mbps</td>
<td>Million Bits per Second</td>
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<td>MFT</td>
<td>Minor Frame Timer</td>
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<tr>
<td>Min</td>
<td>Minimum</td>
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<tr>
<td>MPU</td>
<td>Magnetic Pick-up</td>
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<tr>
<td>ms</td>
<td>Millisecond</td>
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<tr>
<td>mV</td>
<td>Millivolt</td>
</tr>
<tr>
<td>MUX</td>
<td>Multiplex(er)</td>
</tr>
<tr>
<td>NEC</td>
<td>(US) National Electrical Code</td>
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<tr>
<td>NTCPU</td>
<td>CPU That Runs Microsoft NT Operating System</td>
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<td>NT</td>
<td>Pentium</td>
</tr>
<tr>
<td>NV</td>
<td>Same as NTCPU</td>
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<tr>
<td>OPC</td>
<td>Non-volatile</td>
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<tr>
<td>OPC</td>
<td>OLE for Process Control (Communication Protocol)</td>
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<td>OPSYS</td>
<td>Operating System</td>
</tr>
<tr>
<td>O/S</td>
<td>Overspeed</td>
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<tr>
<td>PC</td>
<td>Personal Computer</td>
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<tr>
<td>PC104</td>
<td>Type of Bus Structure Used in PC Industry</td>
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<td>PCB</td>
<td>Printed Circuit Board</td>
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<td>PCM</td>
<td>Position Controller Module</td>
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<td>PCMCIA</td>
<td>Personal Computer Memory Card International Association</td>
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<tr>
<td>PE</td>
<td>Protective Earth</td>
</tr>
<tr>
<td>PPM</td>
<td>Parts Per Million</td>
</tr>
<tr>
<td>PROM</td>
<td>Programmable Read Only Memory</td>
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<tr>
<td>PS</td>
<td>Power Supply</td>
</tr>
<tr>
<td>PS/2</td>
<td>IBM trademark for keyboard/mouse port</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>PWM</td>
<td>Pulse Width Modulation</td>
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<td>RAM</td>
<td>Random Access Memory</td>
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<td>RTD</td>
<td>Resistance Temperature Device</td>
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<td>RVDT</td>
<td>Rotary Variable Differential Transformer</td>
</tr>
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<td>Rx</td>
<td>Receive</td>
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<tr>
<td>SAE</td>
<td>Society of Automotive Engineers</td>
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<tr>
<td>SFB</td>
<td>Single Feedback</td>
</tr>
<tr>
<td>Shld</td>
<td>Shield</td>
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<tr>
<td>Simplex</td>
<td>Control scheme that utilizes one core processor</td>
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<tr>
<td>SIO</td>
<td>Serial Input/Output</td>
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<td>SPDT</td>
<td>Single Pole/Double Throw</td>
</tr>
<tr>
<td>SSTP</td>
<td>Shielded Shielded Twisted Pair</td>
</tr>
<tr>
<td>STP</td>
<td>Shielded Twisted Pair</td>
</tr>
<tr>
<td>TC</td>
<td>Thermocouple</td>
</tr>
<tr>
<td>TCP/IP</td>
<td>Transmission Control Protocol/Internet Protocol</td>
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<tr>
<td>TM</td>
<td>Woodward Actuator Family (Torque Motor)</td>
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<td>TM100</td>
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<tr>
<td>TMR</td>
<td>Triple Modular Redundant</td>
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<tr>
<td>Tx</td>
<td>Transmit</td>
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<tr>
<td>USB</td>
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</tr>
<tr>
<td>UART</td>
<td>Universal Asynchronous Receive/Transmit</td>
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<tr>
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</tr>
<tr>
<td>Vac</td>
<td>Volts ac (Alternating Current)</td>
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<tr>
<td>Vdc</td>
<td>Volts dc (Direct Current)</td>
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<tr>
<td>VFD</td>
<td>Vacuum Florescent Display</td>
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<td>VERSA Module Eurocard</td>
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<tr>
<td>VRMS</td>
<td>Volts RMS (root mean square)</td>
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<td>Watt</td>
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