

M4RTU/M4IO USER'S GUIDE

Form 0676-100301—March 2010

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M4RTU/M4IO User's Guide
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Introduction

About the M4RTU/M4IO

Thank you for purchasing an Opto 22 Modular M4RTU or M4 I/O Controller. The M4RTU/M4IO delivers the functionality and robustness of a remote telemetry unit with the power of a distributed automation system, all in one controller.

The M4RTU/M4IO consolidates two processors on a single processor board. Program control and host communications are handled by a 32-bit microprocessor, while another processor handles I/O interfacing and control. This dual-processor board is combined with a digital/analog I/O board, a 3-slot vertical expansion bus board (M4BUS), and a modular power supply into a compact aluminum extrusion package that can be mounted horizontally or vertically.

A complete line of modular adapter cards is also available, providing a wide range of communication options.

About this Manual

This reference manual provides complete specifications and instructions to set up and install a M4RTU or M4 I/O controller. In this manual you'll find:

Chapter 1, "Introduction"—Product support information as well as general information about the M4RTU/M4IO, its applications, basic architecture, and hardware diagrams.

Chapter 2, "Quick Start"—A brief explanation of how to quickly get the M4RTU/M4IO up and running.

Chapter 3, "Installation and Setup"—Detailed descriptions of jumper settings and communication connections.

Chapter 4, "Software and Firmware"—General software and firmware overviews and communication procedures.

Chapter 5, "Field Wiring"—Detailed information on digital and analog field wiring, including examples.

Chapter A, "Troubleshooting"—Tips for resolving problems you may encounter.

Chapter B, “Cable and Connector Specifications”—A list of recommended communication cables and connectors.

Chapter C, “Product Specifications”—A list of specifications for the M4RTU/M4IO.

Chapter D, “Worksheets”—Worksheets that can be used to plan field wiring installation and power consumption.

For Help

If you have problems installing or using the M4RTU or M4 I/O and cannot find the help you need in this guide or on our website, contact Opto 22 Product Support.

Phone:	800-TEK-OPTO (835-6786) 951-695-3080 (Hours are Monday through Friday, 7 a.m. to 5 p.m. Pacific Time)
Fax:	951-695-3017
Email:	support@opto22.com
Opto 22 website:	www.opto22.com

NOTE: Email messages and phone calls to Opto 22 Product Support are grouped together and answered in the order received.

When calling for technical support, be prepared to provide the following information about your system to the Product Support engineer:

- Software and version being used
- Controller firmware (kernel) version
- PC configuration
- A complete description of your hardware and operating systems, including:
 - jumper configuration
 - accessories installed (such as expansion daughter cards)
 - type of power supply
 - types of I/O units installed
 - third-party devices installed (e.g., barcode readers)
- Specific error messages seen

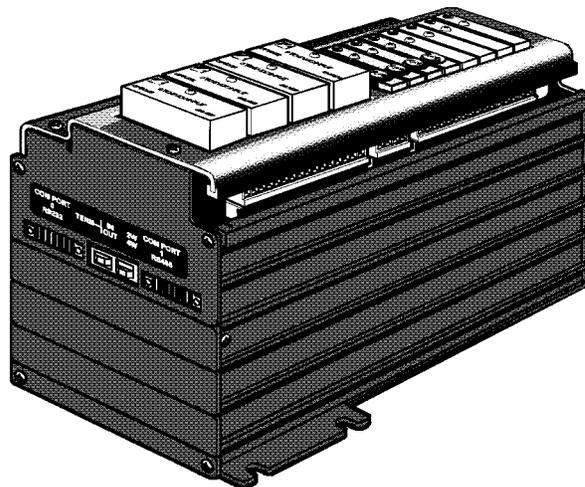
Overview—M4RTU/M4IO Remote Telemetry Unit

The M4RTU/M4IO combines the features and functions of a Remote Telemetry Unit (RTU) with the power of a distributed automation system all in a single controller. The M4RTU/M4IO is built to be deployed in any type of network or remote control environment. The M4RTU/M4IO was designed specifically for industrial field applications, such as wastewater treatment, well monitoring, tank farms, substation automation, and gas/petrochemical applications.

The M4RTU/M4IO is fully supported with FactoryFloor, Opto 22's legacy suite of Windows™ software for industrial automation customers. FactoryFloor consists of four integrated components:

- OptoControl™, a graphical, flowchart-based development environment for control solutions
- OptoDisplay™, a graphical, multimedia operator interface package
- OptoServer™, a data server that connects the controller network with the PC-based FactoryFloor network
- Plus OptoConnect™, a drag-and-drop database utility

The M4RTU/M4IO is part of Opto 22's Modular line of controllers. These units feature a modular design that incorporates Opto 22's M4 bus technology (M4BUS). This technology lets customers tailor their controller and interface hardware to the scale of the project at hand. The M4BUS allows users to create custom interface configurations by simply plugging in one or more of the modular interface cards. These open options allow customers to share real-time plant floor data with telemetry or network-based control and information systems. All modular interface cards for serial communications or network connectivity are supported as standard selections in the FactoryFloor software.



The M4RTU/M4IO consolidates two processors on a single processor board. Program control and host communications are handled by a 32-bit 68020 microprocessor, while a 16-bit 80C196 processor handles I/O interfacing and control. This dual-processor board is combined with a digital/analog I/O board, a 3-slot vertical expansion bus board (M4BUS), and a modular power supply into a compact aluminum extrusion package that can be mounted horizontally or vertically.

The M4RTU/M4IO base unit has two serial ports: RS-232 and RS-485/422. The RS-485/422 port can be used to support I/O expansion using standard Opto 22 digital or analog I/O units. These serial ports can communicate at up to 115 K baud, and the RS-485/422 port logically supports up to 4,096 remote I/O channels as a remote bus.

The M4RTU/M4IO comes standard with 1 MB of battery-backed RAM and 256 KB of flash memory. The RAM can be used to store a user's control strategy (program) and data. The flash memory stores firmware (an operating system, sometimes called a *kernel*) and can be used to store a user's control strategy permanently. The use of flash technology throughout the M4RTU/M4IO allows the user to remotely download new firmwares offered by Opto 22. This avoids the need to visit an M4RTU/M4IO site to download new firmware that offers features required for a given application.

The M4RTU/M4IO base unit accommodates a total of eight digital and four analog Generation 4® (G4) I/O modules. The G4 digital I/O modules provide optical isolation, come in a variety of DC and AC voltages, feature an integral status LED as well as fused outputs, and offer an optional integral automatic/manual diagnostic switch. The G4 analog I/O modules provide both optical and transformer isolation, eliminating ground loops and channel-to-channel interference. Analog modules come in a variety of field input and output types, including current loop, voltage, thermocouple, RTD, ICTD, and TPOs. Analog current modules include the option to power the current loop, eliminating costly power supplies and wiring.

For safety and convenience, the M4RTU/M4IO has system monitors for temperature, AC operation, and low battery, and includes such features as a real-time clock and watchdog timers. Removable connector technology is integrated throughout the unit for easy maintenance and wiring removal. Expansion options are available for adding I/O channels as well as for communicating with SCADA systems, industrial PCs, other controllers or intelligent equipment devices.

Available Options

The M4RTU/M4IO accommodates eight digital and four analog G4 I/O modules. For applications requiring additional I/O modules, the Modular Controller product line includes a Modular Controller I/O Extender, called the M4RTUX, which connects to the M4RTU/M4IO base unit using an Opto 22 shielded 25-pin M4RTUXCAB cable. The M4RTUX provides an additional eight digital and four analog I/O channels. With the M4RTUX option connected to the M4RTU/M4IO base unit, up to 24 G4 I/O modules can be installed. Additional I/O can be connected via an RS-485 serial link.

To accommodate a wide variety of applications, seven power supplies are available for the M4RTU/M4IO: four wide-input-range DC (12V, 24V, 48V, 125V), two wide-input-range AC (120V, 220V), and one line filter base for connecting user-supplied power supplies. These fuse-protected power supplies feature input-to-output isolation protection, a built-in EMI filter, and an on/off switch. They supply enough power to operate the M4RTU/M4IO base unit, three M4BUS expansion options, and I/O modules for both the base unit and the Modular M4 Controller I/O Extender. They can also supply the current loop for analog current modules.

The M4BUS technology provides a variety of communication interface cards. M4RTU/M4IO options include an Ethernet interface card (M4SENET-100), an ARCNET® interface card (M4SARC), a serial (RS-232 and RS-422/RS-485) interface card (M4SSER), a fiber optic ARCNET® card (M4SARCF) and a fiber optic ARCNET® repeater card (M4SARCFR). These open options allow customers to share

real-time data with telemetry-based SCADA systems or network-based control and information systems. The available serial ports communicate at up to 115 K baud. These ports can be used to support additional I/O units, perform host communications, interface to a modem or transmit data to and from third-party devices. The Ethernet and ARCNET options enable you to connect the M4RTU/M4IO to other major system components using plantwide information networks. All modular interface cards for serial communications or network connectivity are supported as standard selections in the FactoryFloor software.

Software

M4RTU/M4IO configuration and program development are performed on a PC workstation through OptoControl, Opto 22's PC-based graphical flowchart language. OptoControl is easy to learn and easy to use. Six months after you write an OptoControl program, you can come back to it and understand it. Four key features of OptoControl are:

- OptoControl's flowchart programming environment, which provides a precise, graphical view of your control process.
- OptoControl's "Strategy Tree," which provides a tree-like view of your system configuration.
- OptoControl's animated debugger, which makes it easy to step through your process and see what's happening at every point in your control program.
- OptoControl flowcharts, which can be packaged as subroutines to provide extensive code reusability.

All these tools can be live on your workstation at the same time. OptoControl uses a plain English command set and a long tagname database that is shared by all FactoryFloor components.

During development of your application, you can download your control strategy to the M4RTU/M4IO and debug the program using OptoControl debug mode. OptoDisplay, Opto 22's operator interface package, uses the same long-tagname database generated by OptoControl when you develop a graphical display of your process.

OptoControl's built-in Software Developers Kit (SDK) allows custom software developers a direct interface to Opto 22 controllers from high level programming languages. OptoControl also provides open access to the database for third-parties and custom developers through the use of OptoServer. Using OptoServer, the data server that connects the controller network with the PC-based FactoryFloor network, you can develop client/server architectures supporting any DDE or OPC aware third-party applications.

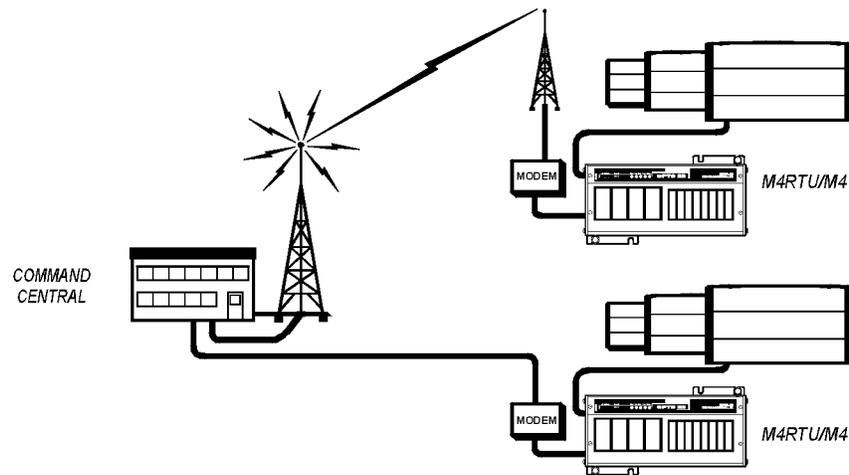
The FactoryFloor software environment supports modems (direct, lease, and radio), two-way dial-up capability (host to M4RTU/M4IO, M4RTU/M4IO to host), and peer-to-peer communications. It also supports remote firmware (kernel) downloading to flash memory, remote program downloading and debugging, and remote data uploading and downloading.

Possible Applications

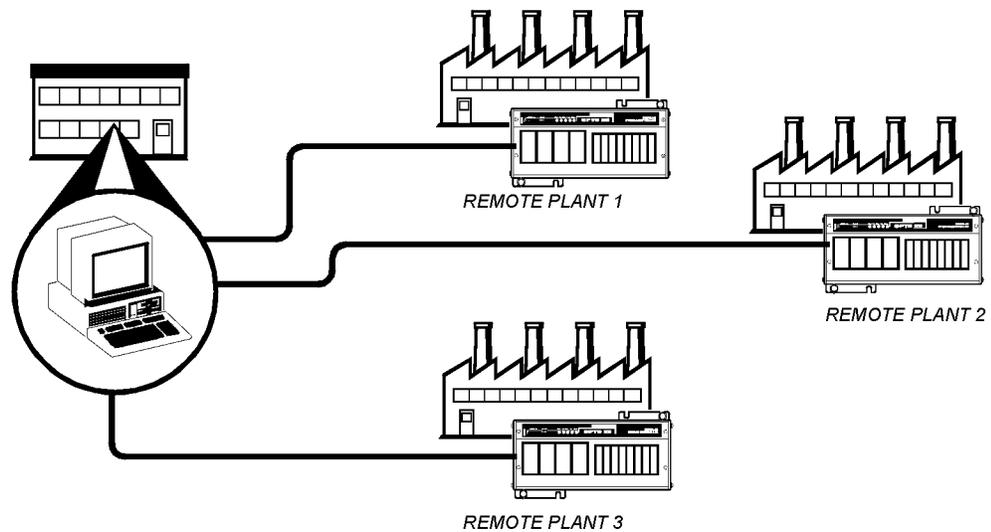
The M4RTU/M4IO can be used in a wide range of applications, including SCADA, remote, distributive, stand alone, process control, tooling, communication, data acquisition, and OEM applications.

The following diagrams depict two common applications for the M4RTU/M4IO: a tank farm and a remote plant management system. Both applications typically require process control and data acquisition to be performed remotely.

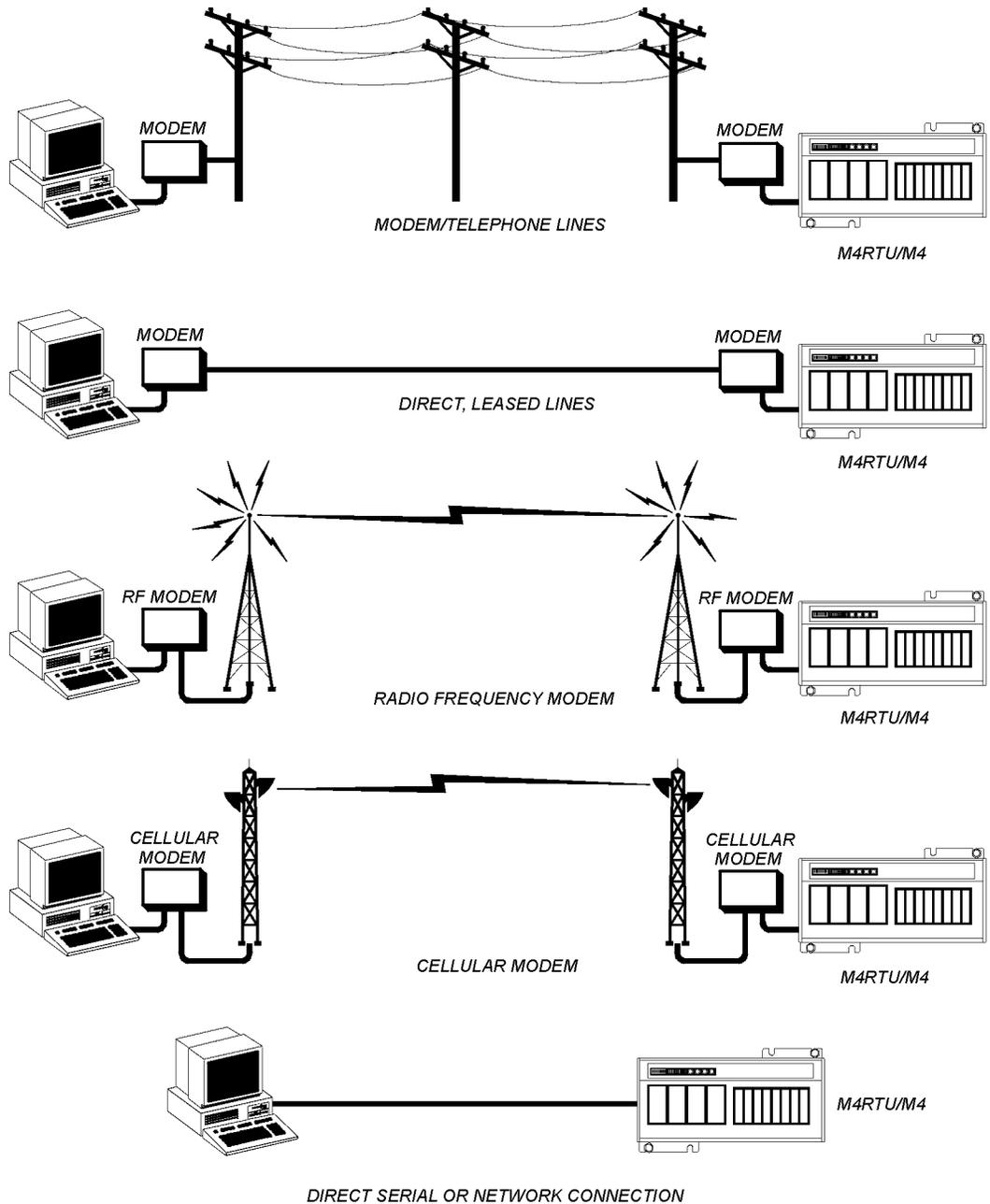
Tank Farm



Remote Plant Management

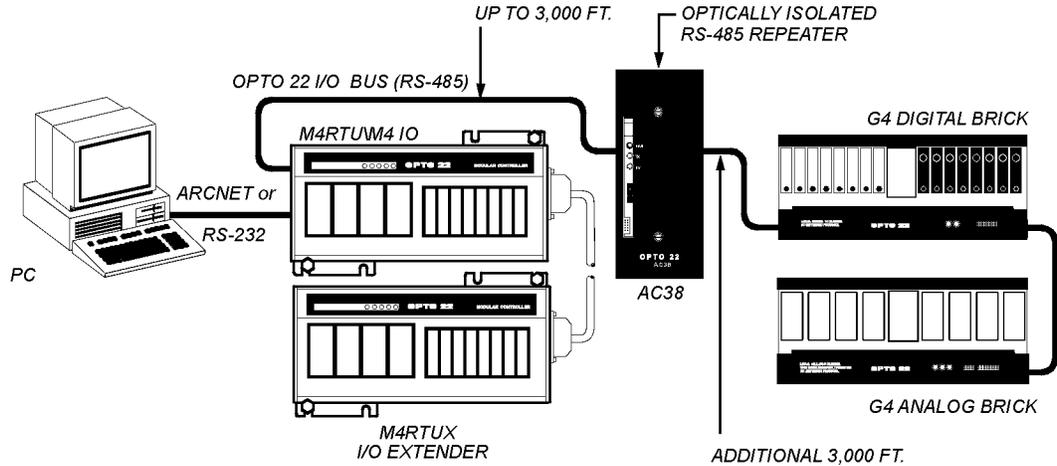


The M4RTU/M4IO is designed to be easy to configure in a variety of communication configurations, including modems connected to standard telephone lines, leased lines, radio frequency transceivers, and direct serial connections to PC hardware, as illustrated below.

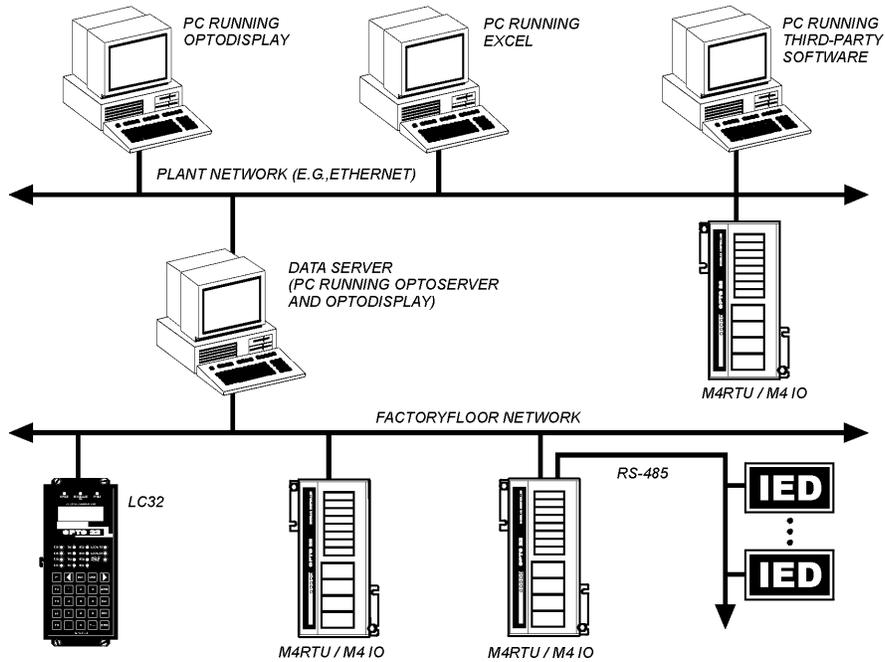


The design of the M4RTU/M4IO is also conducive to integration with Opto 22's digital and analog I/O systems as well as with other intelligent equipment devices, such as industrial PCs, additional M4RTUs or other Opto 22 controllers, subsystem automation gear, wastewater equipment, and various gas/petrochemical devices.

Integration of M4RTU/M4IO with Expanded I/O

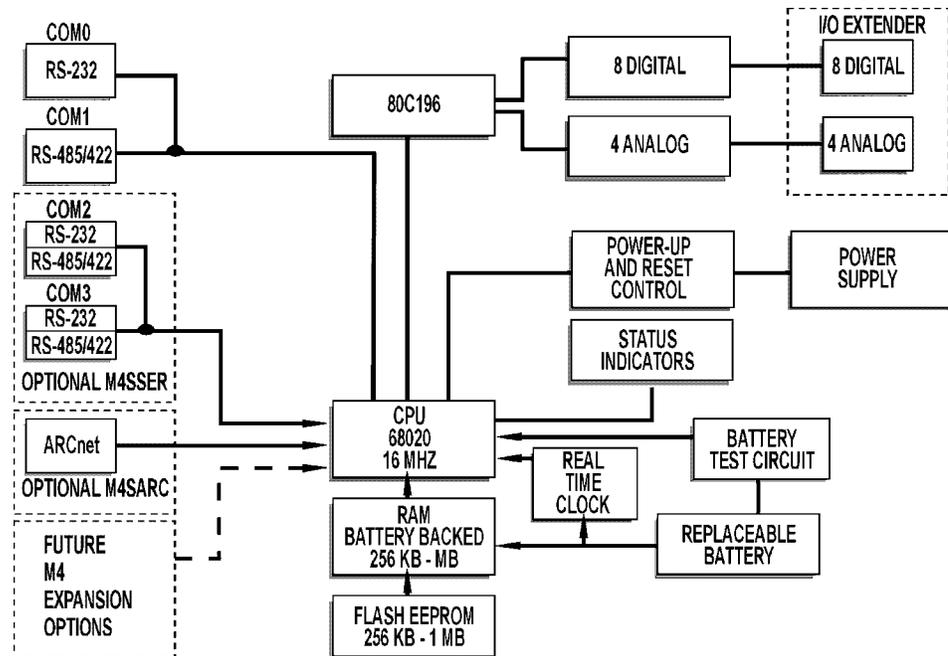


Integration of M4RTU/M4IO with Other Devices



Basic Architecture

The M4RTU/M4IO consolidates two processors on a single processor board. Program control and host communications are handled by a 32-bit 68020 microprocessor, while a 16-bit 80C 196 processor handles I/O interfacing and control. This dual-processor board is combined with a digital/analog I/O board, a 3-slot vertical expansion bus board (M4BUS), and a modular power supply into a compact aluminum extrusion package that can be mounted horizontally or vertically. A block diagram of the M4RTU/M4IO is shown below.



The two-processor architecture allows the main processor to off-load onto the I/O processor such tasks as counting, frequency and pulse measurement, latching, totalizing, time proportional output control, pulse generation, linearization, ramping, engineering unit conversion, averaging, peak and valley measurement, PID control, and event/reactions, to name a few. I/O control can continue even if the main processor fails or needs to be reset.

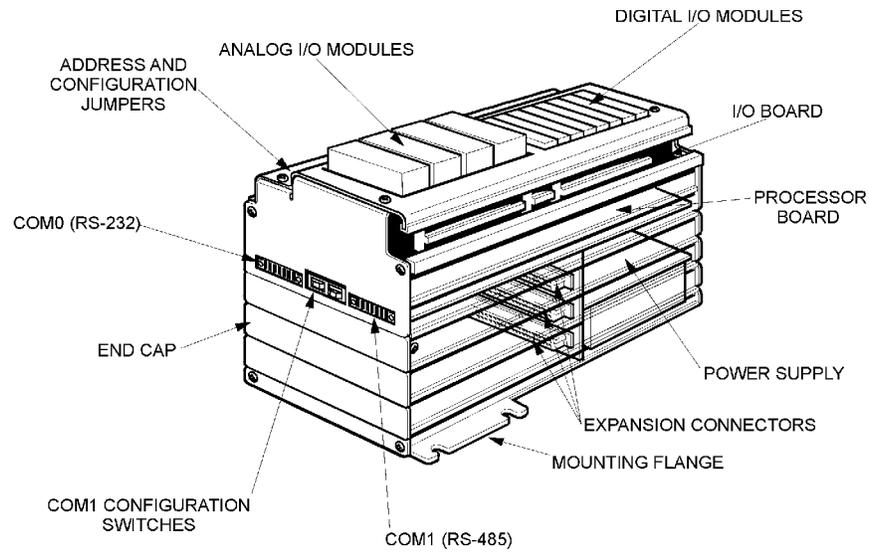
Sophisticated reset circuitry and watchdog timer capability permit a user to develop intelligent, robust error recovery.

Finally, the M4BUS lays the foundation for intelligent coprocessor daughter cards, which have the capability to interface to various industry hardware and software protocols without degrading overall real-time performance.

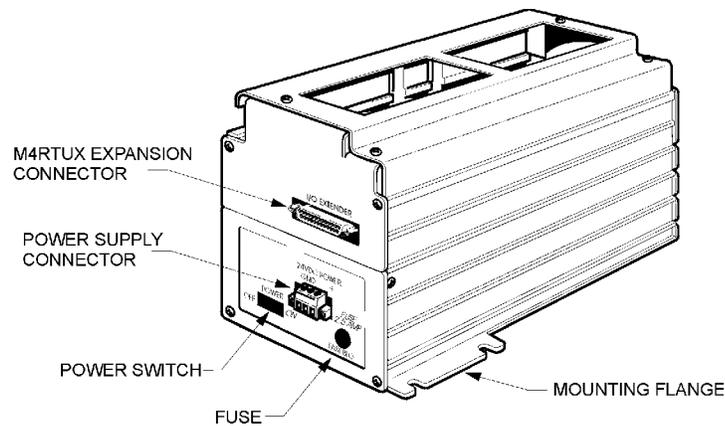
Hardware Diagrams

M4RTU/M4IO Base Unit Overview

The following diagram shows the basic components of the M4RTU/M4IO as viewed from the end of the unit with the expansion slot and serial connector.



The following diagram shows the basic components of the M4RTU/M4IO as viewed from the end of the unit with the power supply and M4RTUX expansion connector.



Quick Start

Overview

This chapter provides a brief explanation of how to get the M4RTU/M4IO up and running. You may need to refer to the *OptoControl User's Guide* for detailed instructions. Also refer to appropriate chapters in this manual for field wiring and communication setup instructions and diagrams.

A quick start installation consists of the following steps:

1. Unpacking the M4RTU/M4IO and power supply
2. Installing the power supply
3. Connecting the battery
4. Checking configuration jumpers
5. Installing optional expansion daughter cards and/or connecting cable to the I/O extender, as needed
6. Mounting the M4RTU/M4IO
7. Connecting power
8. Installing I/O modules
9. Connecting to a host PC
10. Verifying communications

Notes for Rev. 2 Controllers

The M4RTU/M4IO controller was re-engineered in June 2007 because older parts were no longer available. Re-engineered controllers can be recognized by the Rev. 2 sticker on the unit. Please note the following changes.

- **You must use OptoTerm version 4.1b or higher** to inspect this controller or install new firmware. Older versions of OptoTerm will not recognize the controller correctly and may cause you to install the wrong firmware.
- **Firmware version 4.1d or higher is required** for any M4RTU/M4IO with the Rev. 2 sticker.
- The Rev. 2 controller has **1 MB RAM** and **1MB Flash memory**, so upgrades are not necessary.
- Rev 2. controllers do not support the obsolete Ethernet daughter cards M4SENET-U and M4SENET-C. **Use the current M4SENET-100 Ethernet card** with these controllers.

1. Unpacking

Remove the M4RTU/M4IO from its packaging, making sure the M4RTU/M4IO and the following components are included:

Component:	Use:
Bag of extra jumpers	Can be installed as M4RTU/M4IO configuration jumpers
Two RS-485/RS-232 7-position connectors	Connect wiring to serial ports
Connector key disk, containing six connector keys	Prevents non-keyed connectors from plugging into the serial port
Mounting template	Serves as a guide for preparing a mounting site for the M4RTU/M4IO
CD	Contains OptoControl and Cyrano firmware (kernels), plus OptoTerm, a utility used to download OptoControl firmware. IMPORTANT: Earlier versions of OptoTerm (4.0 or lower) cannot recognize M4RTU/M4IO controllers manufactured after June 2007. Make certain you use OptoTerm 4.1 or higher to communicate with these M4RTU/M4IO controllers.
Customer update sheet	Contains latest product information

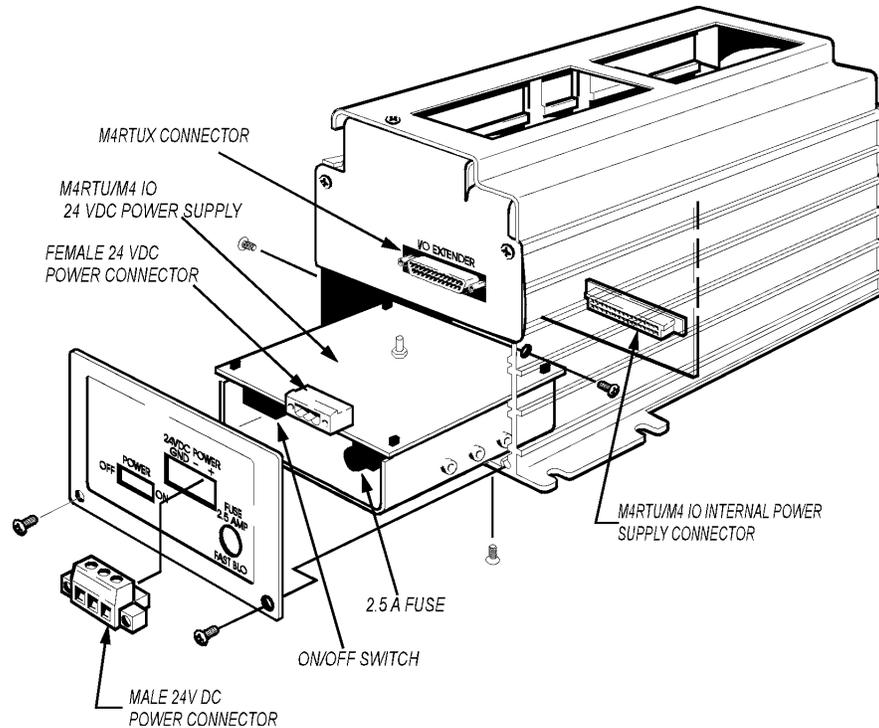
Note: If any of the above items is missing or damaged, contact Opto 22 immediately at 1-800-321-6786.

The M4RTU/M4IO requires a power supply, packaged separately. The following table lists input power and frequency specifications for the power supplies currently available.

Power Supply Part Number	Input Voltage	Frequency
M4PS12D	12 VDC (–15 V)	n/a
M4PS24D	24 VDC (18–30 V)	n/a
M4PS48D	48 VDC (36–60 V)	n/a
M4PS125D	125 VDC input (94–156 V)	n/a
M4PS120A	120 VAC input (95–130 V)	47–63 Hz
M4PS240A	240 VAC (190–250 V)	47–63 Hz
M4PSF	Line Filter; requires 24 VDC and 5 VDC	n/a

2. Installing the Power Supply

1. Place the M4RTU/M4IO on a flat surface with the top cover containing the I/O module connectors facing up, and orient the M4RTU/M4IO as shown below.

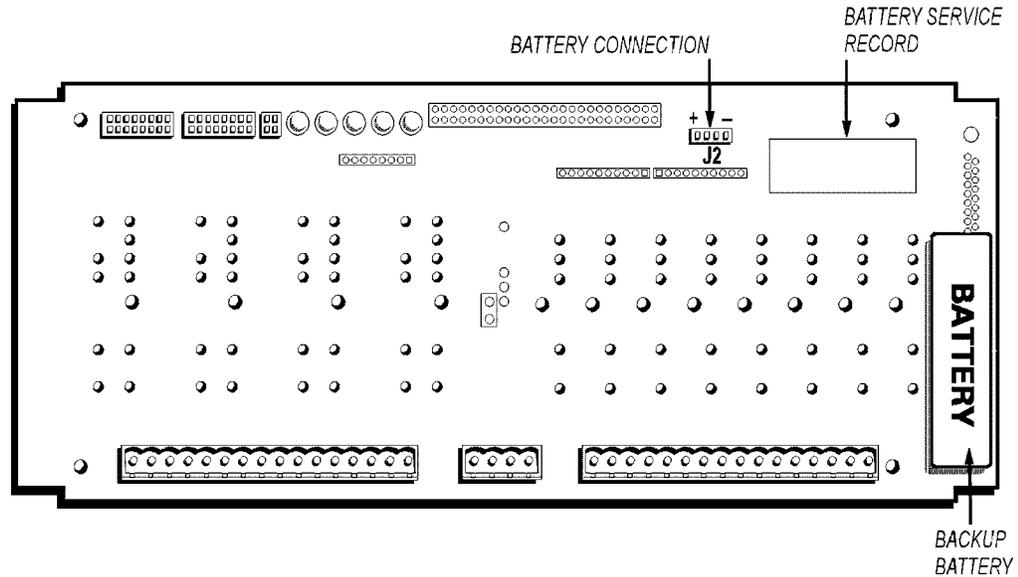


2. Unplug the removable power connector from the power supply. Slide the power supply into the cavity of the M4RTU/M4IO until it seats firmly against the power supply 32-pin DIN connector.
3. Use the four screws provided to fasten the power supply from the underside of the M4RTU/M4IO.
4. Secure the power supply end cap to the end of the M4RTU/M4IO using the four screws provided. Use the 8-32 x 1/2 screws on the front and the 4-40 x 1/4 screws on the sides.
5. Plug the power connector back into the power supply through the controller's end cap.

3. Connecting the Battery

To save battery power, the M4RTU/M4IO backup battery is not connected at the factory. You will need to connect it yourself.

1. Remove the four corner screws on the top cover of the M4RTU/M4IO, and remove the top cover.



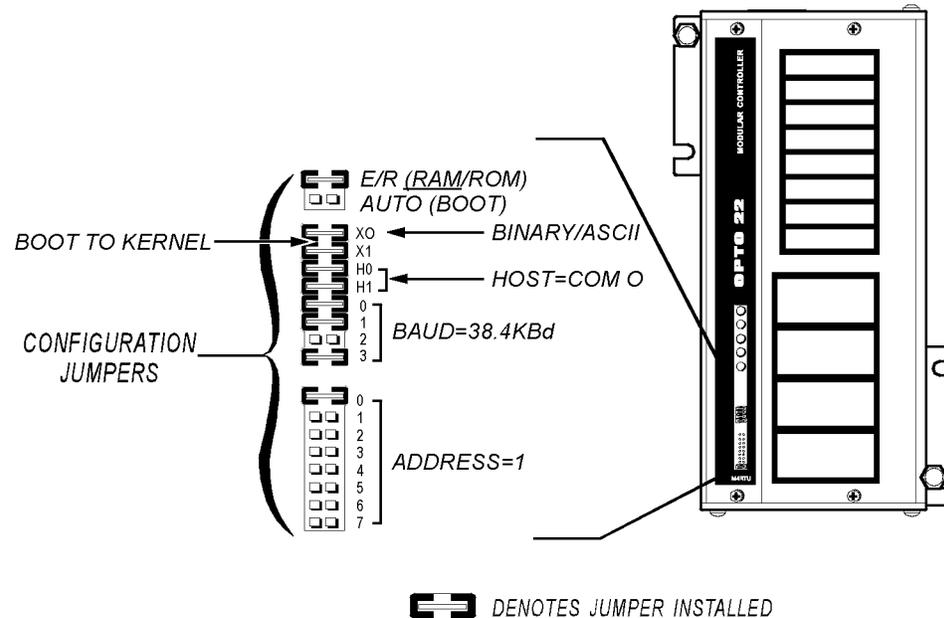
2. Attach the battery connection wire to the battery connection labeled J2. The red wire connects to the positive lead.

NOTE: This 3.6-volt lithium backup battery features a shelf life of up to 10 years and an operational life of two to five years. The Battery Service Record adjacent to the J2 battery connection includes the Opto 22 part number of the battery (G4BATT32), the date the battery was installed, and the date the battery should be replaced (five years after installation). If the M4RTU/M4IO is subjected to temperature extremes, you should replace the battery after as little as two years.

To comply with Factory Mutual section 3.2.7, replacement of the lithium battery must be done by the factory. Contact Opto 22 Product Support for assistance.

4. Checking Configuration Jumpers

The M4RTU/M4IO configuration jumpers are already configured by the factory for connection to a host PC using the M4RTU's COM0 RS-232 serial port, set at a baud rate of 38.4 Kbps. The M4RTU/M4IO's default address is 1 and the default communication mode is binary. Refer to the diagram below for the default configuration of all jumpers.



If you need to change the factory defaults, see [“Setting Configuration Jumpers and Switches” on page 24](#). For a chart of address jumper configurations, see [page 25](#).

5. Installing Daughter Cards and/or I/O Extender

If you have purchased optional expansion daughter cards for the M4RTU/M4IO, you will now need to install them. Refer to the appropriate document listed below for detailed installation instructions:

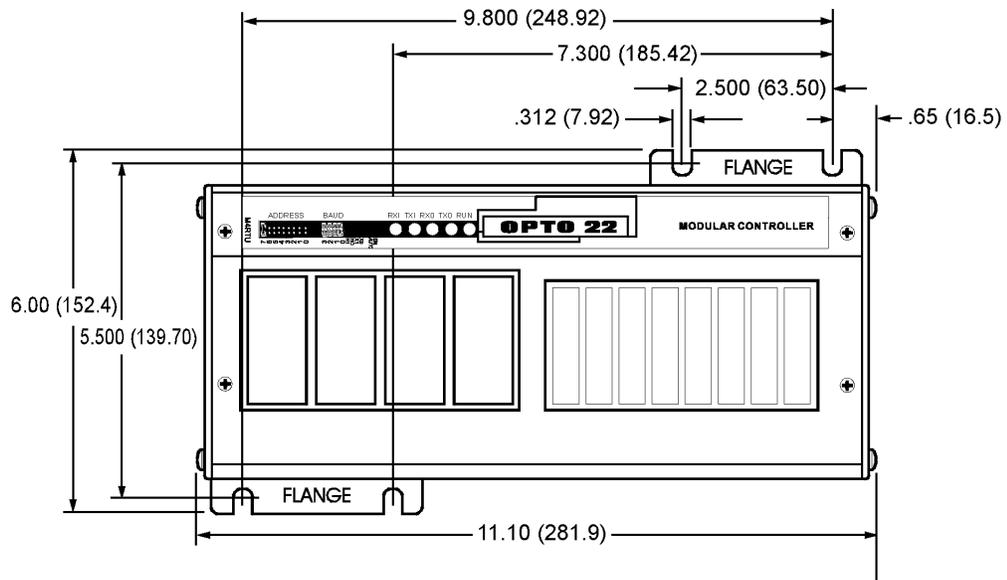
- M4SSER—see M4 Serial Adapter Card Data Sheet (form 664)
- M4SARC—see M4 ARCNET Adapter Data Sheet (form 631)
- M4SARCF/M4SARCFR—see M4 ARCNET Adapter Fiber Optic Data Sheet and M4 ARCNET Repeater Fiber Optic Data Sheet (form 673)
- M4SENETU/M4SENETC—see M4SENETC and M4SENETU Data Sheet (form 718)
- M4SENET-100—see M4 Controller Ethernet Card Data Sheet (form 1154)
- M4DUALARC—see M4DUALARC Data Sheet (form 990)

In addition, if you have purchased the M4RTUX I/O Extender, it is advisable to install the M4RTUXCAB extender cable after installing daughter cards, but before mounting the M4RTU/M4IO. See Opto 22 Modular Controller I/O Extender Data Sheet (form 671) for detailed instructions.

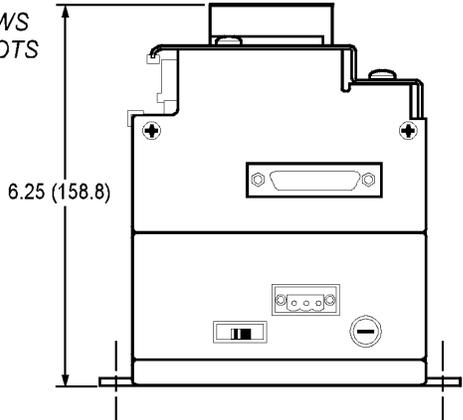
6. Mounting the M4RTU/M4IO

You can affix the M4RTU/M4IO to any enclosure or panel, either vertically or horizontally, using the mounting flanges shown in the diagram below and user-supplied 1/4-20 screws.

1. Determine panel mounting site and orientation (horizontal or vertical). Be sure to allow room for external connectors.
2. Tape the supplied mounting template onto the M4RTU/M4IO panel and prick-punch mounting locations.
3. Remove template and drill preliminary pilot holes, then drill and tap (or drill through holes) for 1/4-20 screws.
4. Place M4RTU/M4IO onto mounting site and fasten with 1/4-20 screws or screw and nut assemblies.



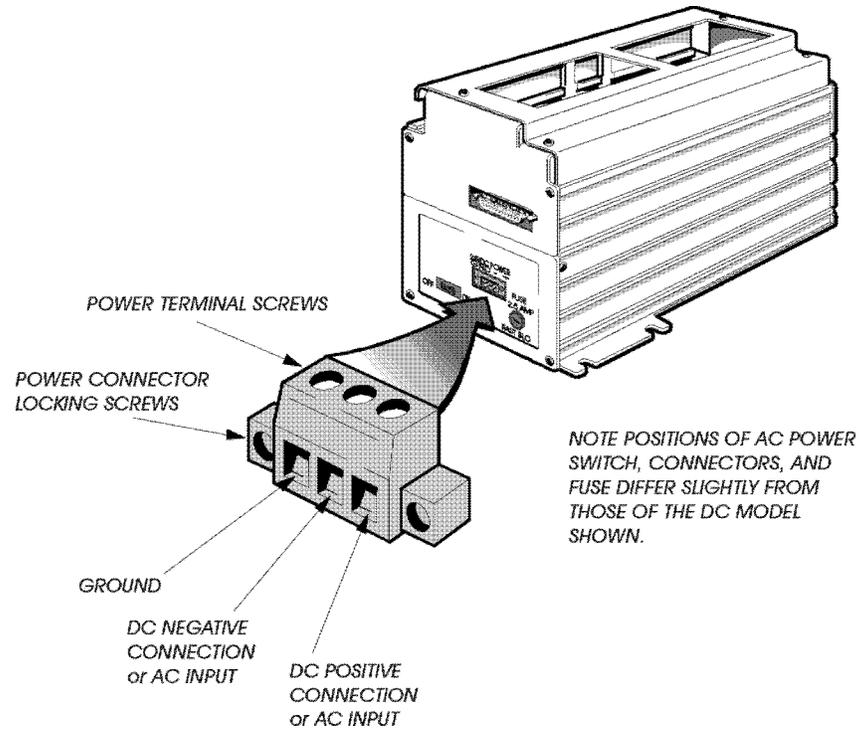
USE 1/4-20 SCREWS
IN MOUNTING SLOTS



Dimensions are in: inches (millimeters)

7. Connecting Power to the M4RTU/M4IO

Once you have mounted the M4RTU/M4IO, you are ready to connect power to the unit.

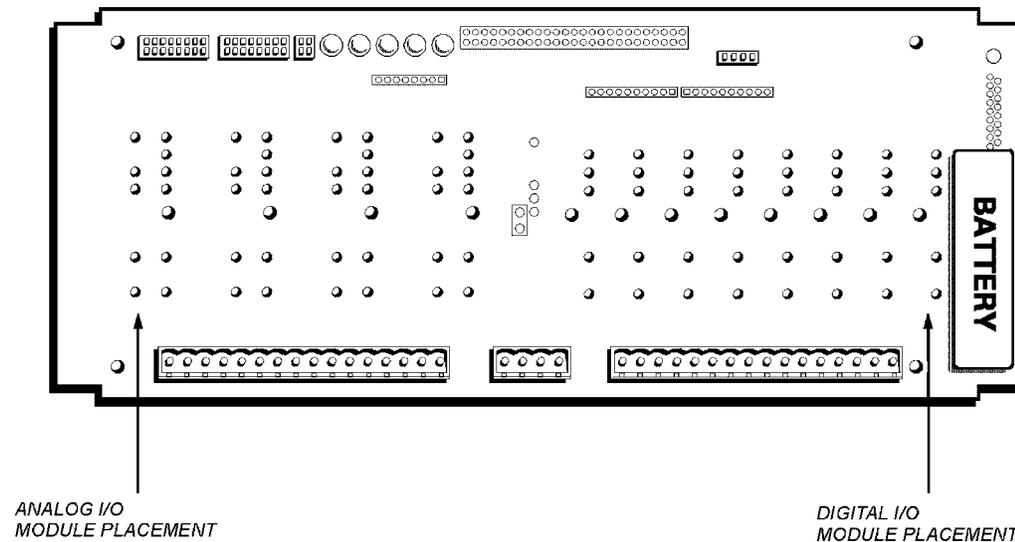


1. Turn off the power supply switch. Unplug the power supply connector if desired.
2. Turn the power terminal screws counterclockwise to make sure all power supply terminal block connections are completely open.
3. Prepare each power supply wire, being careful not to strip back the insulation too far.
4. Insert each wire into the appropriate terminal block location and tighten by turning the power terminal screw clockwise. Make sure the terminal block is clamping the wire and not the insulation.
5. If you removed the power supply connector, plug it back in. Tighten the power connector locking screws.

8. Installing I/O Modules

CAUTION: TURN OFF POWER to the M4RTU/M4IO before installing or removing I/O modules.

The M4RTU/M4IO board, located at the top of the unit just below the top cover, accommodates eight digital and four analog G4 input/output modules. The placement for these modules is shown below.



To install I/O modules, you do not need to remove the top cover unless you will be changing field wiring at the same time.

Install each digital or analog module as follows:

1. Choose the appropriate location on the M4RTU/M4IO board and carefully line up the I/O module pins with the sockets on the I/O board.
2. Press the module firmly into place until it seats all the way down on the I/O board.
3. Use a Phillips screwdriver to tighten the screw and secure the I/O module.

For field wiring, see [Chapter 5, "Field Wiring,"](#) on [page 45](#).

9. Connecting to a Host PC

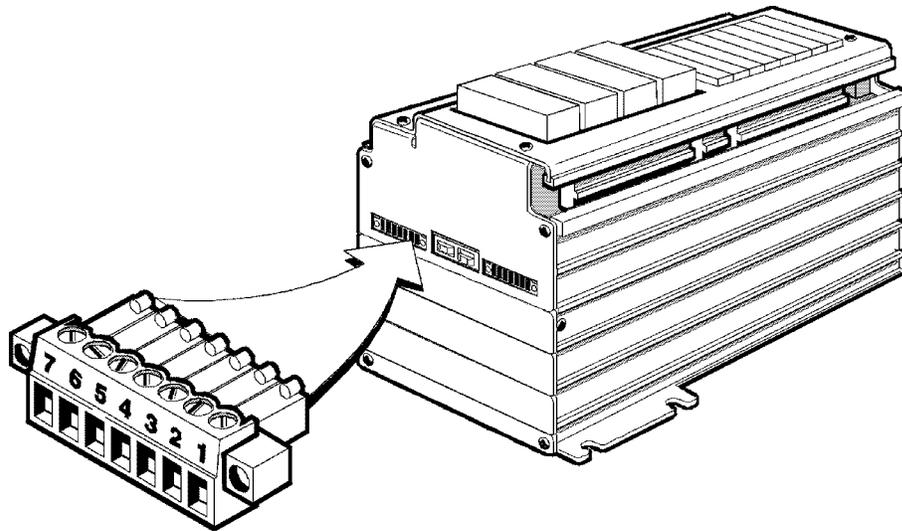
Wiring

IMPORTANT: Serial port connectors wired for other Opto 22 controllers may not be compatible with the M4RTU/M4IO. Use the M4RTU/M4IO connectors provided and refer to the diagrams in this manual for wiring information.

For additional wiring options, see [page 32](#) and following.

RS-232 Pin Connections

The following diagram shows the pin positions for the M4RTU/M4IO COM0 serial port:



Refer to the table below to determine the function of each COM0 pin connection.

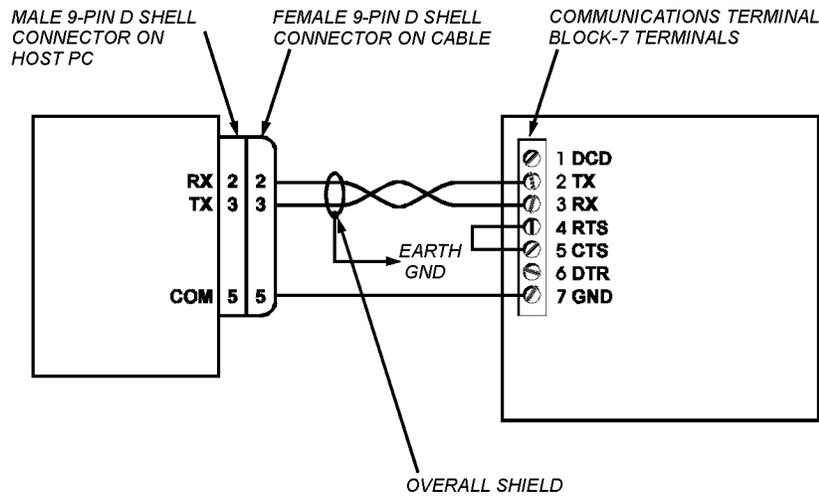
Pin	COM0
1	Data Carrier Detect (DCD)
2	Transmit (TX)
3	Receive (RX)
4	Request-to-Send (RTS)
5	Clear-to-Send (CTS)
6	Data Terminal Ready (DTR)
7	Ground (GND)

RS-232 Wiring Scheme

Use the default host port (COM0) of the M4RTU/M4IO to connect to the host PC. Follow the diagram below to wire the M4RTU/M4IO RS-232 serial port to the serial connector on the PC. Verify that the

pin connections at the host PC are the same as those called out in the diagram. See [Appendix B, "Cable and Connector Specifications,"](#) for a list of recommended cables.

IMPORTANT: If RTS and CTS are not used, be sure to connect RTS to CTS on the M4RTU/M4IO as shown below.

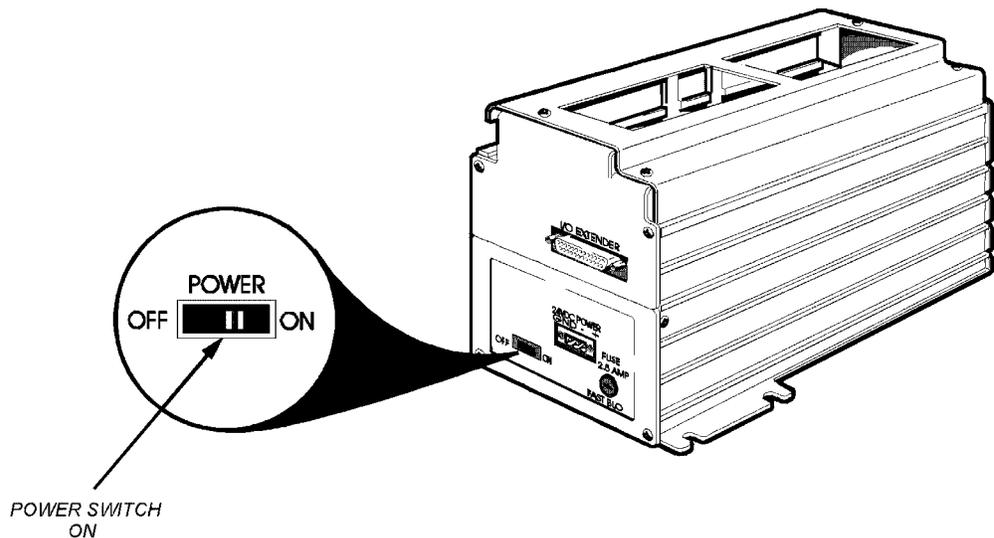


Configuring Communication

Communications between the host PC and the M4RTU/M4IO must be configured using the graphical flowchart language OptoControl, which must be installed on the PC. For details, consult the *OptoControl User's Guide*.

To configure communications between the PC and M4RTU/M4IO, do the following:

1. Make sure configuration jumpers and switches are set.
2. Cycle the M4RTU/M4IO power by flipping the power switch off and then on.



3. Open OptoTerm.

If you are using a controller with a **Rev. 2** sticker, see [“Notes for Rev. 2 Controllers” on page 11](#).

4. Configure a controller in OptoTerm with the communication settings that correspond to your configuration. Consult the *OptoControl User's Guide* for more information.

10. Verifying Communications

To verify communications between the M4RTU/M4I/O and the host PC, use the OptoTerm utility, which is included with FactoryFloor. In OptoTerm, highlight the controller to communicate with, and then select VIEW and then STATUS from the menu bar. If the PC can successfully communicate with the M4 controller, a window will pop up on the PC screen and display information about the M4 controller, for example, the M4 controller's firmware (kernel) version, the name of the current strategy, and the controller's current date and time. If the communication is working correctly, the time should be updated every one or two seconds, which can be verified by observing the seconds portion of the time field.

If you have not established successful communications between the two devices:

- Make sure you powered down and powered up the M4RTU/M4I/O after changing any configuration jumpers. Refer to [Chapter 3, “Installation and Setup,”](#) to verify wiring connections and jumper settings.
- Check PC hardware and the physical connection between the M4RTU/M4I/O and the PC.
- If you are using a controller with a **Rev. 2** sticker, see [“Notes for Rev. 2 Controllers” on page 11](#).

Installation and Setup

Overview

This chapter expands upon the quick start information in [Chapter 2](#) with additional information for installing and configuring the M4RTU/M4IO:

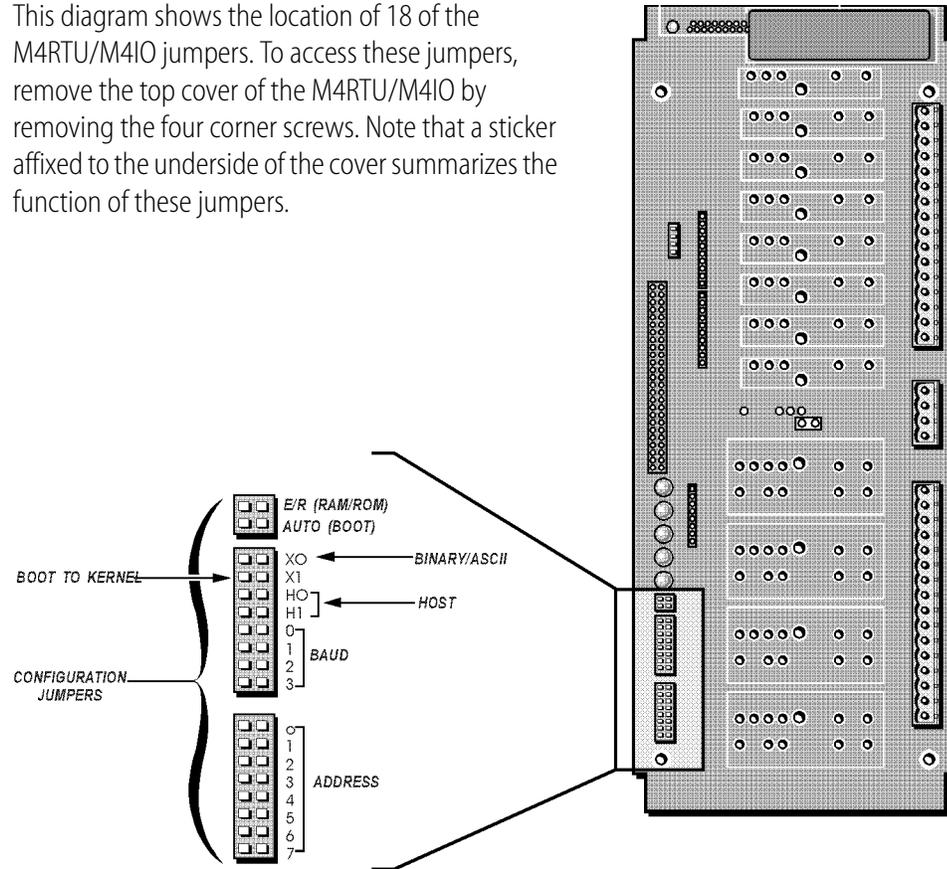
- Setting configuration jumpers and switches [page 24](#)
- Connecting field wiring [page 30](#)
- Connecting to a host PC or modem [page 32](#)
- Connecting to Opto 22 I/O [page 37](#)
- LED Indicators [page 39](#)

Setting Configuration Jumpers and Switches

The M4RTU/M4IO includes jumpers and switches that allow you to configure the M4RTU/M4IO based on your individual application requirements. This section describes these configuration jumpers and switches.

I/O Board Jumpers

This diagram shows the location of 18 of the M4RTU/M4IO jumpers. To access these jumpers, remove the top cover of the M4RTU/M4IO by removing the four corner screws. Note that a sticker affixed to the underside of the cover summarizes the function of these jumpers.



The following table shows all I/O board jumpers. When a jumper is installed, the setting corresponding to the “In” position is in effect. When a jumper is not installed, the setting corresponding to the “Out” position is in effect. Jumpers are described in the following pages.

M4RTU/M4IO Board Jumpers (factory defaults are highlighted)

Jumper(s)	Description	Position				Setting
E/R	EEPROM/RAM	In				Run from RAM
		Out				Run from EEPROM
Auto	Autoboot	In				Autoboot enabled
		Out				Autoboot disabled
X0	Communication	In				Binary
		Out				ASCII
X1	Boot Loader	In				Boot to kernel
		Out				Boot to loader
H0, H1	Host Port	H0		H1		
		In		In		COM0
		Out		In		COM1
		In		Out		ARCNET
		Out		Out		Ethernet
Baud 0–3	Baud Rate	0	1	2	3	
		Out	In	In	In	115.2 KBd
		In	Out	In	In	76.8 KBd
		Out	Out	In	In	57.6 KBd
		In	In	Out	In	38.4 KBd
		Out	In	Out	In	19.2 KBd
		In	Out	Out	In	9600 Bd
		Out	Out	Out	In	4800Bd
		In	In	In	Out	2400 Bd
		Out	In	In	Out	1200 Bd
		In	Out	In	Out	600 Bd
		Out	Out	In	Out	300 Bd
Address 0–7	Address Bits	Bit 0 In				1
		Bit 1 In				2
		Bit 2 In				4
		Bit 3 In				8
		Bit 4 In				16
		Bit 5 In				32
		Bit 6 In				64
		Bit 7 In				128

EEPROM/RAM Jumper (E/R)

Use this jumper to choose the source of the M4RTU/M4IO's control program. When the jumper is in (the default), the control program will run from RAM; when the jumper is out, the control program is copied from Flash EEPROM into RAM and run from RAM.

Normally, application programs are downloaded from your PC workstation to battery-backed CMOS RAM in the M4RTU/M4IO. The programs are then executed from RAM. Unless application programs are stored in Flash EEPROM, the E/R jumper should be installed to allow the control program in RAM to run.

Autoboot Jumper (AUTO)

Use this jumper to determine whether autoboot mode will be enabled (jumper in) or disabled (jumper out, the default).

When autoboot mode is enabled, at power-up the M4RTU/M4IO automatically executes the resident user program (RAM or Flash). Otherwise, it waits to receive a command to run the resident program.

Communication Mode Jumper (X0)

Use this jumper to select whether communication between the host computer and the controller will be in binary mode (jumper in, the default) or ASCII mode (jumper out). Generally, ASCII mode is used in applications requiring a modem. For ARCNET or Ethernet this jumper is ignored. For more detailed information, refer to the *OptoControl Command Reference Manual* — Communications Overview.

Boot Loader Jumper (X1)

Use this jumper to set the controller to either boot to the downloaded firmware, or *kernel* (jumper in, the default) or boot to loader (jumper out). This jumper should always remain in place for normal operations. See [Appendix A, "Troubleshooting,"](#) for more information.

Host Port Jumpers (H0, H1)

Use these jumpers to determine the primary host port used by the M4RTU/M4IO upon power-up or reset. Select from COM0 (both jumpers in, the default), COM1 (H0 jumper out, H1 jumper in), ARCNET (H0 jumper in, H1 jumper out), or Ethernet (both jumpers out).

COM0 is dedicated for RS-232 communications and COM1 is dedicated for RS-485 communications. Select ARCNET only if an optional M4SARC, M4SARCF, or M4SARCFR ARCNET expansion card is installed. Select Ethernet only if an optional M4SENET-100 expansion card is installed.

Baud Rate Jumpers (BAUD 0–3)

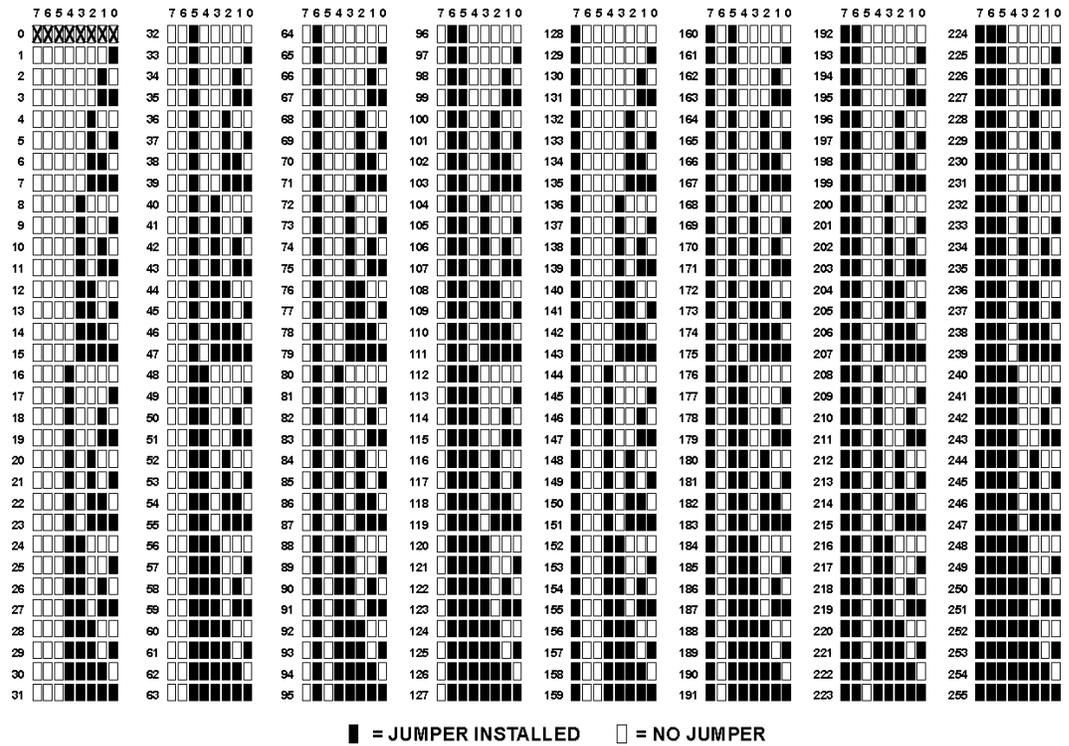
Use these jumpers to set the baud rate for the host serial port (COM0 or COM1) on power-up or reset. Select the appropriate jumper settings based on the baud rates in Table 3-2. (These baud rates also appear on the sticker on the underside of the M4RTU/M4IO's top cover.) The default baud rate is 38.4 Kbps.

Note that if an optional ARCNET or Ethernet expansion card is installed and ARCNET or Ethernet is configured as the host, the baud rate jumper settings are irrelevant.

Use the Configure Controllers - Setup Controller Ports dialog box in OptoControl to set the baud rate for any M4RTU/M4IO serial port that is not being used as the primary host port. Consult the *OptoControl User's Guide* for more information.

Address Jumpers (ADDRESS 0–7)

Use these jumpers to select an 8-bit address from one to 255 (one to FF hexadecimal). The factory default is one (jumper zero in, all others out). The most significant bit is seven and the least significant bit is zero; address zero is reserved and should not be used. The following diagram shows the jumper configurations for all addresses.

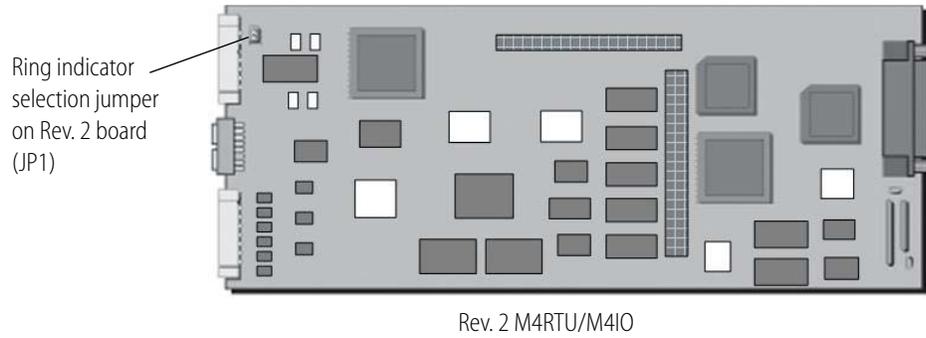


Ring Indicator Jumper (JP1)

NOTE: For newer M4RTU/M4IO base units only, which are identified by a Rev. 2 sticker on the unit. If you have a Rev. 1 base unit, see the next section, "Processor Board Jumpers for Rev. 1 Units".

By default, this jumper is installed, establishing a ground on COM0 Pin 7 of the M4RTU/M4IO base unit. The jumper should remain installed under most circumstances. For the location of JP1, see the illustration below.

If you need an extra programmable RS-232 input (such as a ring indicator), remove this jumper. Since this will eliminate the ground on COM0, it will be necessary to wire your RS-232 device ground to COM1 Pin 3 to prevent common mode problems and resulting damage.



Processor Board Jumpers for Rev. 1 Units

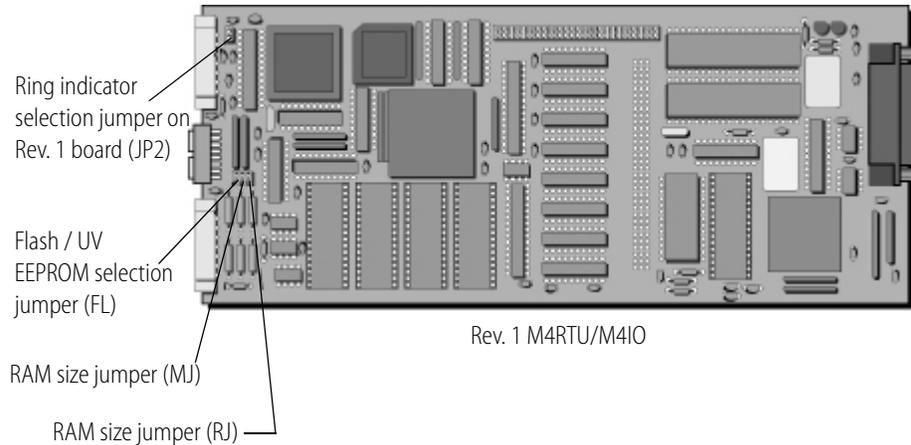
NOTE: For earlier M4RTU/M4IO base units only. For Rev. 2 units, see the previous section, “Ring Indicator Jumper (JP1)”.

Four additional jumpers are located on the main processor board, as shown below.

The following table describes the use and default settings of all jumpers for Rev. 1 M4RTU/M4IO base units. When a jumper is installed, the setting corresponding to the In position is in effect. When a jumper is not installed, the setting corresponding to the Out position is in effect. The factory defaults are indicated in bold.

Jumper	Description	Position	Setting
FL	EPROM Type	In	UV EPROM (not used)
		Out	Flash EEPROM
MJ	RAM Size	* In	2 x 1 Mb (256 KB)
		* Out	2 x 4 Mb (1 MB)
RJ	EPROM Size	In	1 Mb Flash EEPROM (256 KB)
		Out	4 Mb Flash EEPROM (1 MB) (Opto 22 P/N M4RTUF1M)
JP2	Ring Indicator	In	COM0 Pin 7 is ground
		Out	COM0 Pin 7 is ring indicator

Locations of jumpers and chips on a Rev. 1 M4RTU/M4 I/O:



Each jumper is described below.

Flash Jumpers (FL)

FL identifies the TYPE of firmware EPROMS (either FLASH or UV EPROMS). FL removed indicates FLASH EPROMS. FL installed indicates UV EPROMS. The default setting is for this jumper to be removed. All M4RTU/M4 I/O controllers have FLASH EPROMS, so this jumper should NEVER be installed.

*RAM Jumper (MJ)

MJ identifies the AMOUNT of RAM installed (and hence the TYPE of RAM chips). MJ installed indicates 256 KB (Kbytes) which is in the form of 2 chips that are 1 megabit each. MJ removed indicates 1 MB (megabyte) which is in the form of 2 chips that are 4 megabits each. If the M4RTU/M4 I/O has a "1 MB RAM Installed" sticker, the default setting is for this jumper to be removed. If the M4RTU/M4 I/O does not have this sticker, the default setting is for this jumper to be installed.

ROM Jumper (RJ)

RJ identifies the AMOUNT of EPROM memory installed (and hence the TYPE of EPROM chips) or vice versa. RJ installed indicates 256 KB (Kbytes) which is in the form of 2 chips that are 1 megabit each. RJ removed indicates 1 MB (megabyte) which is in the form of 2 chips that are 4 megabits each. The default setting is for this jumper to be installed.

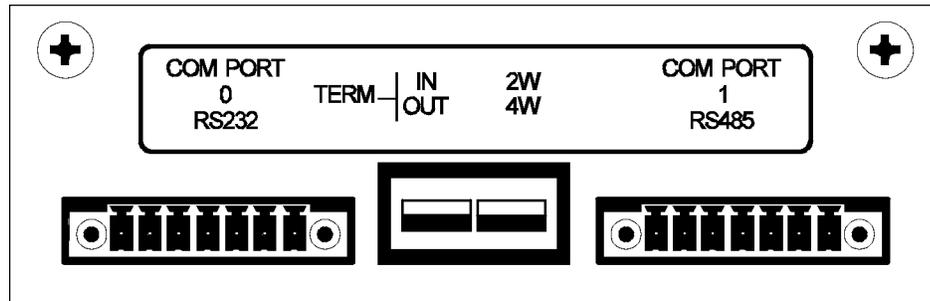
Ring Indicator Jumper (JP2)

By default, this jumper is installed, establishing a ground on COM0 Pin 7 of the M4RTU/M4 I/O base unit. The jumper should remain installed under most circumstances.

If you need an extra programmable RS-232 input (such as a ring indicator), remove this jumper. Since this will eliminate the ground on COM0, it will be necessary to wire your RS-232 device ground to COM1 Pin 3 to prevent common mode problems and resulting damage.

Serial Port Switches (COM1)

The M4RTU/M4IO base unit comes standard with one RS-485 serial port COM1. This port includes configuration switches. The following diagram shows the serial port COM1 switches as they appear on the end cap of the M4RTU/M4IO. See below for details on configuring these switches.



TERM IN/TERM OUT

This switch selects termination for the RS-485 port. In the IN position, the RS-485 lines are terminated and biased. Terminate the port when it is physically the first or last unit in an RS-485 multi-drop serial network application.

In the OUT position, the RS-485 lines will be floating. This setting should be used when the port is part of a multi-drop serial network application and is not physically the first or last unit in the network. The default is TERM IN.

2-WIRE/4-WIRE

This switch selects the wiring method used to connect to the RS-485 serial port. The choices are 2-wire and 4-wire. The default is 4-wire. If you are using COM1 as an RS-485 serial link (remote), select 2-wire mode.

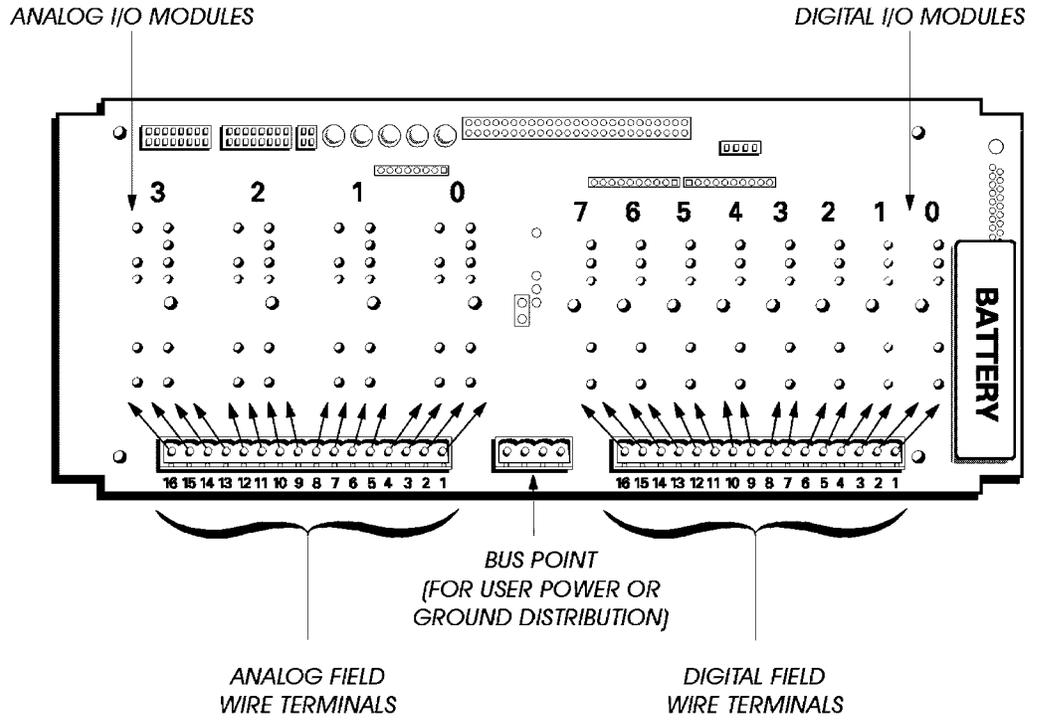
Connecting Field Wiring

To access the field wiring terminals, you will first need to remove the top cover of the M4RTU/M4IO by removing the four corner screws at the top of the unit.

The pluggable field wiring terminals are located on the top of the M4RTU/M4IO board next to the corresponding digital or analog channels. These terminals allow field wires to be connected to the installed I/O modules.

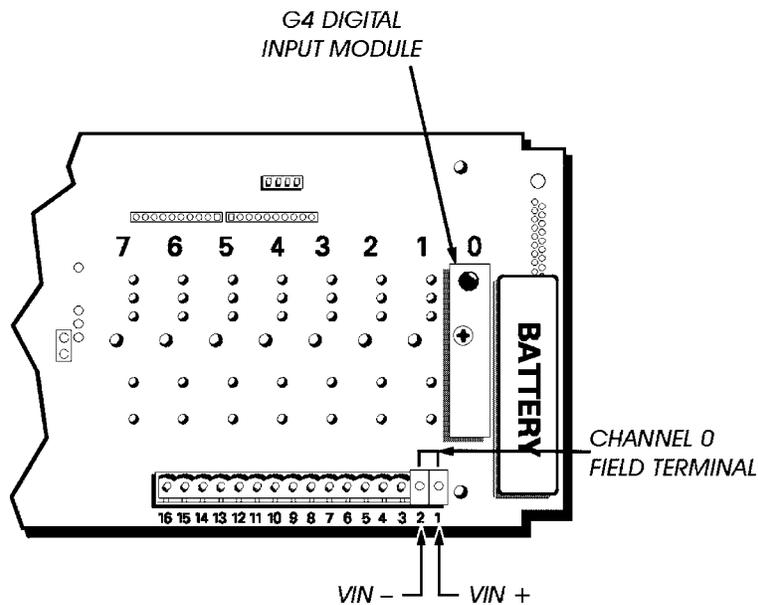
The following diagram shows the location of the terminals on the unit and the layout of the terminal points as they correspond to each I/O module.

Specific information on wiring digital and analog modules follows. For more detailed wiring information, refer to [Chapter 5, "Field Wiring,"](#) on [page 45](#).



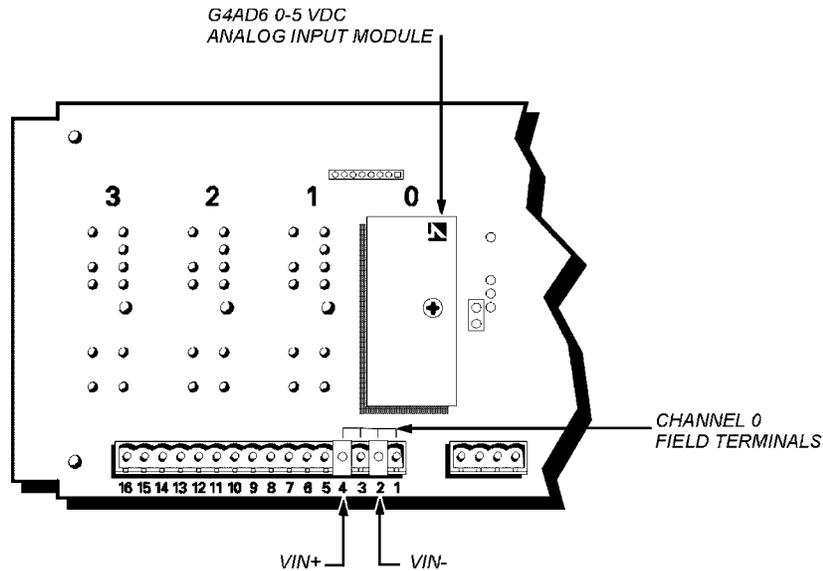
Digital Modules

Digital modules have two terminals corresponding to each module. The following diagram shows a G4IDC5 digital input module in channel zero wired with VIN + on terminal #1 and VIN - on terminal #2.



Analog Modules

Analog modules can use up to four terminals per I/O point. The following diagram shows a G4AD6 0-5 VDC analog input module in channel zero wired with VIN - on terminal #2 and VIN + on terminal #4. Refer to [page 50](#) for wiring other analog modules.



Connecting to a Host PC or Modem

The M4RTU/M4IO features two built-in serial ports, COM0 (RS-232) and COM1 (RS-485), with a data transfer rate of 300 Bd to 115.2 Kbps. Two additional serial ports are available by installing an optional M4SSER serial expansion card into one of the M4RTU/M4IO expansion card slots.

IMPORTANT: *Serial port connectors wired for other Opto 22 controllers may not be compatible with the M4RTU/M4IO. Use the M4RTU/M4IO connectors provided and refer to the diagrams in this manual for wiring information.*

The following sections describe wiring for the serial ports found on the M4RTU/M4IO base unit.

RS-232 COM0 Pin Connections

The M4RTU/M4IO has one built-in RS-232 COM0 serial port. The following table describes COM0 pins.

Pin	COM0
1	Data Carrier Detect (DCD)
2	Transmit (TX)
3	Receive (RX)
4	Request-to-Send (RTS)
5	Clear-to-Send (CTS)
6	Data Terminal Ready (DTR)
7	Ground (GND)

IMPORTANT: If RTS and CTS are not used, RTS must be connected to CTS (COM0 only) on the M4RTU/M4IO.

RS-485 COM1 Pin Connections

An RS-485 COM1 port is also built into the M4RTU/M4IO base unit. The following table contains descriptions for each COM1 pin for both 2-wire and 4-wire modes.

Note that the interrupt lines can be used to add interrupt capability to Opto 22 I/O units connected to an M4RTU/M4IO via an RS-485 serial link (remote).

Pin	COM1 2-Wire Mode	COM1 4-Wire Mode
1	Transmit/Receive Plus (TX/RX +)	Transmit Plus (TX +)
2	Transmit/Receive Minus (TX/RX -)	Transmit Minus (TX -)
3	Common Ground (GND)	Common Ground (GND)
4	No Connection (N/C)	Receive Plus (RX +)
5	No Connection (N/C)	Receive Minus (RX -)
6	Interrupt Plus (IRQ +)	Interrupt Plus (IRQ +)
7	Interrupt Minus (IRQ -)	Interrupt Minus (IRQ -)

Wiring to a Host PC

This section provides information on wiring connections between an M4RTU/M4IO and a host personal computer. Examples show connections to a standard PC serial port and an Opto 22 AC37.

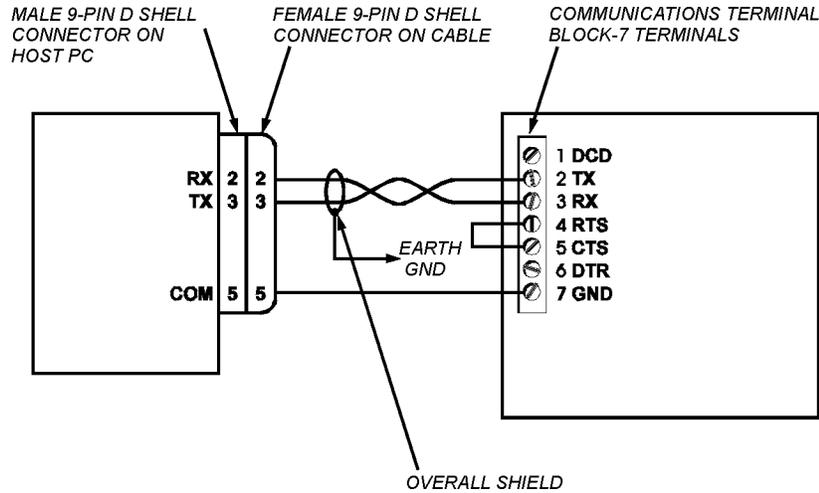
Be sure to use cable appropriate to your application. See [Appendix B, "Cable and Connector Specifications,"](#) for a complete list of recommended cables.

RS-232 COM0

Make RS-232 communication connections to a host PC by using the RS-232 COM0 default host connector on the M4RTU/M4IO.

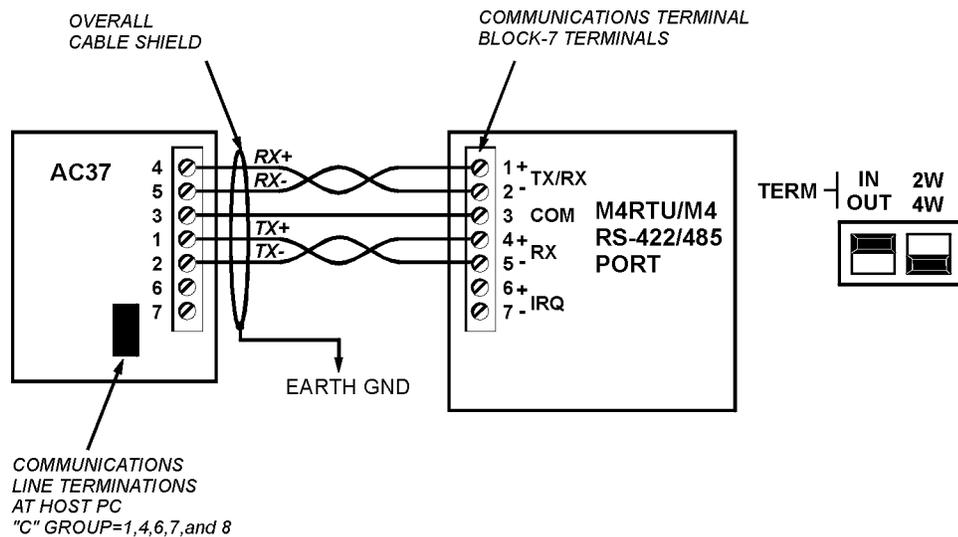
The following diagram shows how to connect the M4RTU/M4IO to the serial port of a host PC. Verify that the pin connections at the host PC are the same as those called out in the diagram.

Important: If RTS and CTS are not used, RTS must be connected to CTS (COM0 only) on the M4RTU/M4IO, as shown below.

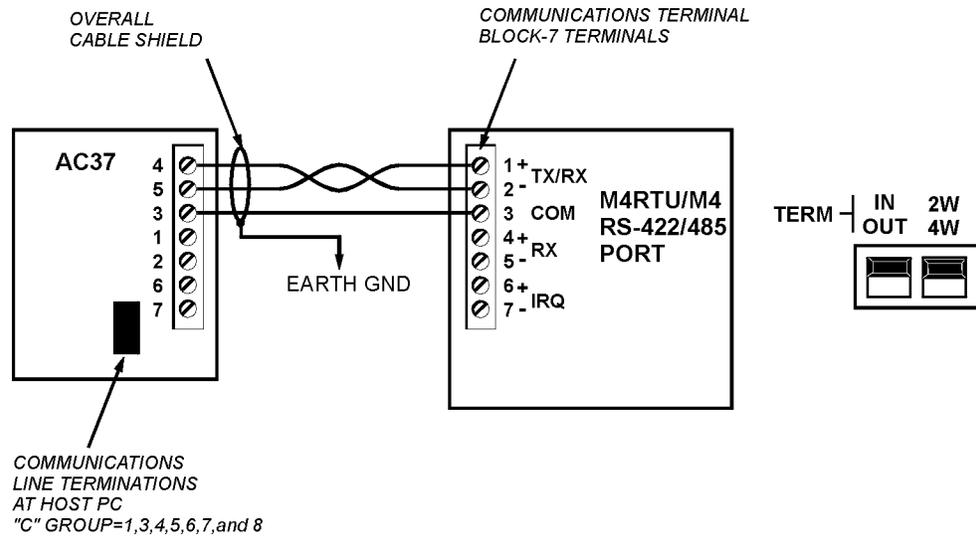


RS-485 COM1

4-Wire Mode Using an AC37. If you are using an Opto 22 AC37, connect the end of the cable with a male 9-pin D-shell connector to the converter and the other end with a pluggable terminal block to the M4RTU/M4IO. The following diagram shows how to wire to a host PC in 4-wire mode using an AC37.



2-Wire Mode Using an AC37. The AC37 also supports a 2-wire mode. See the following diagram for wiring.

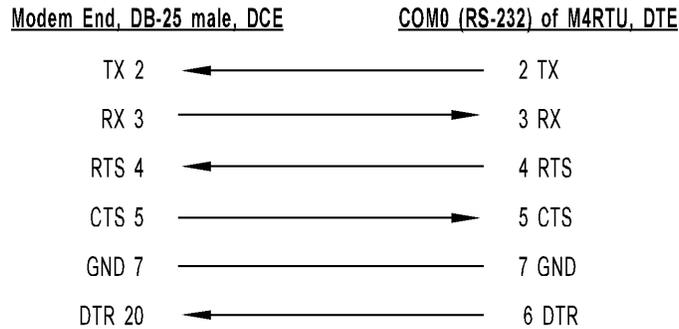


Wiring to a Modem (a DCE device)

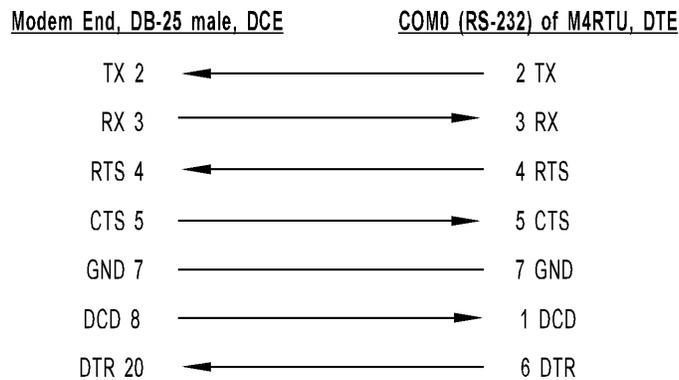
Refer to your modem documentation for detailed wiring information, possible jumper configuration, and initialization setup.

Most standard external PC modems can be used with the M4RTU/M4IO. However, a custom (or special) communications cable must be used between the modem and the M4RTU/M4IO. Wiring diagrams for this cable are shown below.

Suggested Modem to M4RTU Cable (without carrier detect):



Suggested Modem to M4RTU Cable (with carrier detect):



Computer (DTE) RS-232 COM Port Pin Assignments

RS-232 25-pin

Pin	Name	Abbreviation
1	Protective Ground	--
2	Transmitted Data	TD
3	Received Data	RD
4	Request to Send	RTS
5	Clear to Send	CTS
6	Data Set Ready	DSR
7	Signal Common	--
8	Data Carrier Detect	DCD
20	Data Terminal Ready	DTR
22	Ring Indicator	RI

RS-232 9-pin

Pin	Name	Abbreviation
1	Data Carrier Detect	DCD
2	Received Data	RD
3	Transmitted Data	TD
4	Data Terminal Ready	DTR
5	Signal Ground	--
6	Data Set Ready	DSR
7	Request to Send	RTS
8	Clear to Send	CTS
9	Ring Indicator	RI

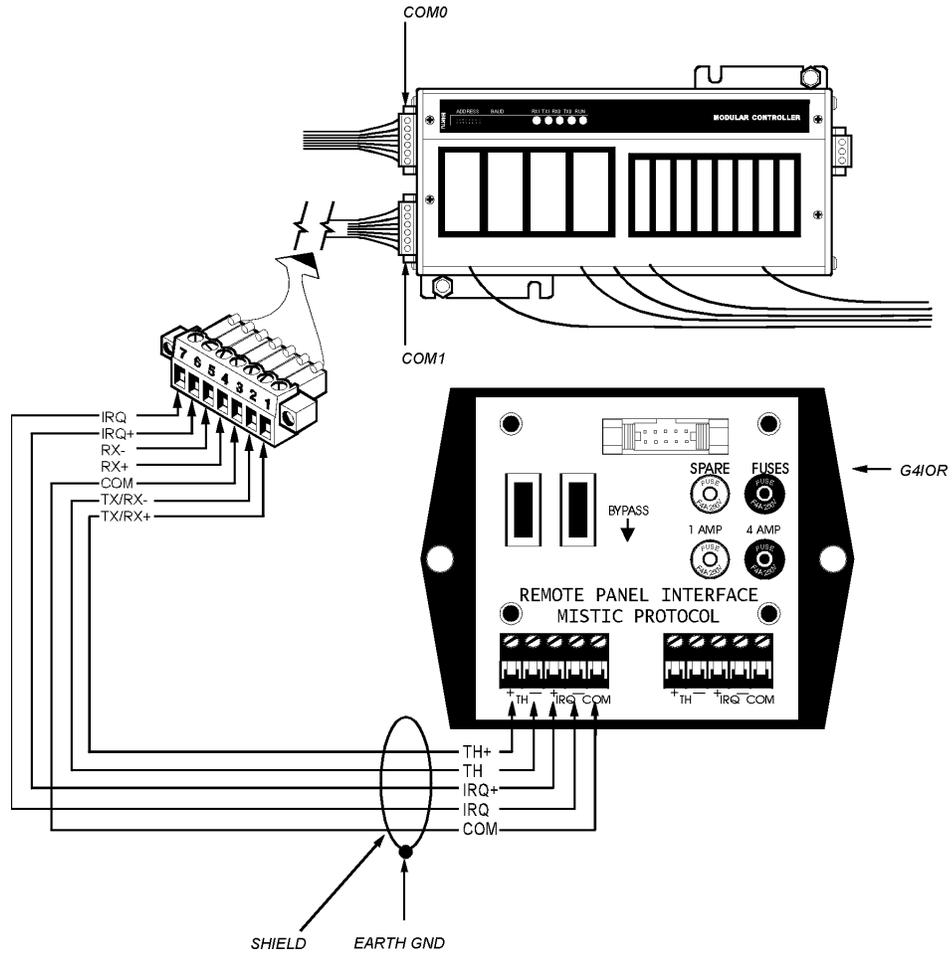
Connecting to Opto 22 I/O Units

The built-in RS-485 COM1 port can be used as a serial link (remote) to communicate with Opto 22 digital or analog I/O. A M4SSER serial expansion card installed in the M4RTU/M4IO can also be used for this purpose.

One method for doing this is to use a Mystic 200 I/O Remote Interface board (G4IOR) as illustrated below. This method allows the use of Opto 22 I/O equipment (G4 panels, cables, etc.).

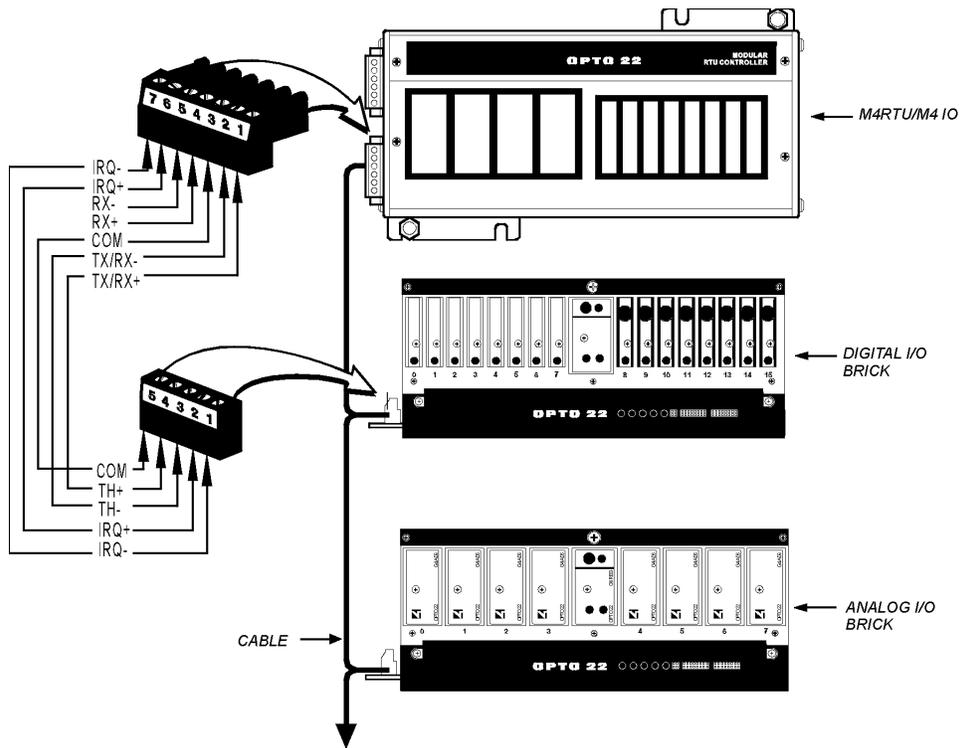
This diagram shows a 2-wire RS-485 shielded connection from COM1 on the M4RTU/M4IO to the G4IOR Remote Interface board. Connect Pin 1 (TX/RX+) to G4IOR "TH+," Pin 2 (TX/RX-) to G4IOR "TH-," and Pin 3 to "COM." If you are using the interrupt lines, connect Pin 6 to "IRQ+" and Pin 7 to "IRQ-."

Communications to a Remote Interface (G4IOR)



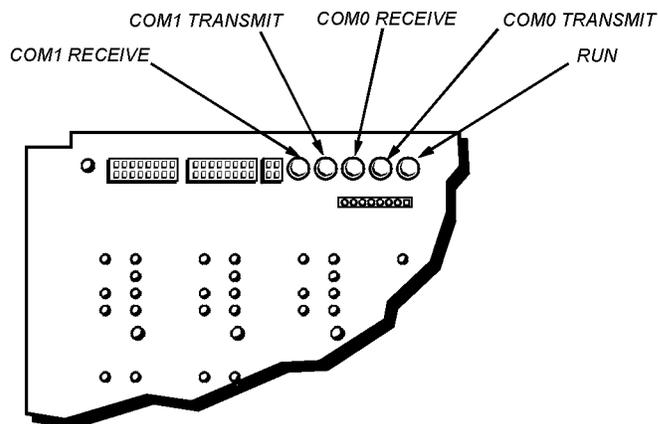
Another method for using the RS-485 COM1 port as an RS-485 serial link (remote) is to use Opto 22 I/O units installed with an SBTA, as illustrated in the following diagram. This allows you to accommodate your own installation practices, application requirements, and cables. Simply mount your I/O units throughout your installation and daisy chain communication cable between them. Refer to the Mystic 200 Systems Installation Guide for more SBTA details.

Opto 22 I/O Units Installed with SBTA



LED Indicators

Five LEDs are located on the top of the M4RTU/M4IO, in line with the configuration jumpers, as shown below. These LEDs perform the functions displayed in the table on the following page.



LED	Indication	Details
RUN	Processor status	Light ON: Normal function Light OFF: Processor powered down. Light blinking: Processor malfunction or low power supply voltage.
TX0	COM0 transmit	Light ON: COM0 transmitting serial data Light OFF: Port is idle, wiring problem, or CTS is low.
RX0	COM0 receive	Light ON: COM0 receiving serial data Light OFF: Port is idle or wiring problem exists.
TX1	COM1 transmit	Light ON: COM1 transmitting serial data Light OFF: Port is idle or wiring problem exists.
RX1	COM1 receive	Light ON: COM1 receiving serial data Light OFF: Port is idle or wiring problem exists.

Software and Firmware

Overview

This chapter provides information on using OptoControl, OptoDisplay, and OptoServer with the M4RTU/M4IO. OptoControl is used to program and debug M4RTU/M4IO control strategies. OptoDisplay is used to create M4RTU/M4IO process operator interfaces running on the PC. OptoServer allows the user to construct complex client/server architectures running multiple OptoDisplay sessions, DDE-aware applications (such as Microsoft Excel), or third-party software packages with OptoServer driver capability. The tight integration between OptoControl, OptoDisplay, and OptoServer not only makes all three software packages easy to use, it also prevents multiple database entry errors, allows tag name validation, and takes full advantage of the M4RTU/M4IO's hardware capabilities.

The sophisticated firmware of both the main and I/O processors of the M4RTU/M4IO, along with flash technology, enables a user to update the M4RTU/M4IO remotely with a new set of operating systems for the main and I/O processors. The firmware also supports the ability to store a user's strategy permanently into flash memory.

Note: It is not the intent of this chapter to teach OptoControl programming and debugging, OptoDisplay configuration and runtime operation, or overall OptoServer usage. Instead, this chapter presents an overview of these topics, with enough details to get you started. For detailed information on these subjects, refer to the appropriate Opto 22 user guides.

OptoControl

OptoControl is used to configure communications between the PC and the M4RTU/M4IO, configure the I/O units and points, and develop and run your control strategy.

Configuring Communications to the M4RTU/M4IO

To download OptoControl strategies to the M4RTU/M4IO and debug them, you must first configure the communication link between the host PC and the M4RTU/M4IO. Begin by deciding what type of physical communication link will be used (ARCNET, RS-232, RS-485/422, or Ethernet). Next, install

and configure communication hardware between the host PC and the M4RTU/M4IO. (Refer to the appropriate PC and M4RTU/M4IO documentation for communication hardware installation details.)

Once the hardware has been installed, OptoControl must be configured to communicate over the physical communication link. Refer to the *OptoControl User's Guide* to configure PC communications to the M4RTU/M4IO.

Configuring the M4RTU/M4IO and M4RTUX

Before writing OptoControl strategies for the M4RTU/M4IO, you must inform OptoControl about the I/O installed on or connected to the M4RTU/M4IO and, if applicable, the M4RTUX.

OptoControl must know how the I/O units are connected to a controller (that is, via the parallel I/O bus [local] or RS-485 serial link [remote]) as well as what type of module will be installed into each I/O channel on each unit. Once OptoControl has this information, you may use the assigned I/O tag names to reference the I/O within an OptoControl strategy.

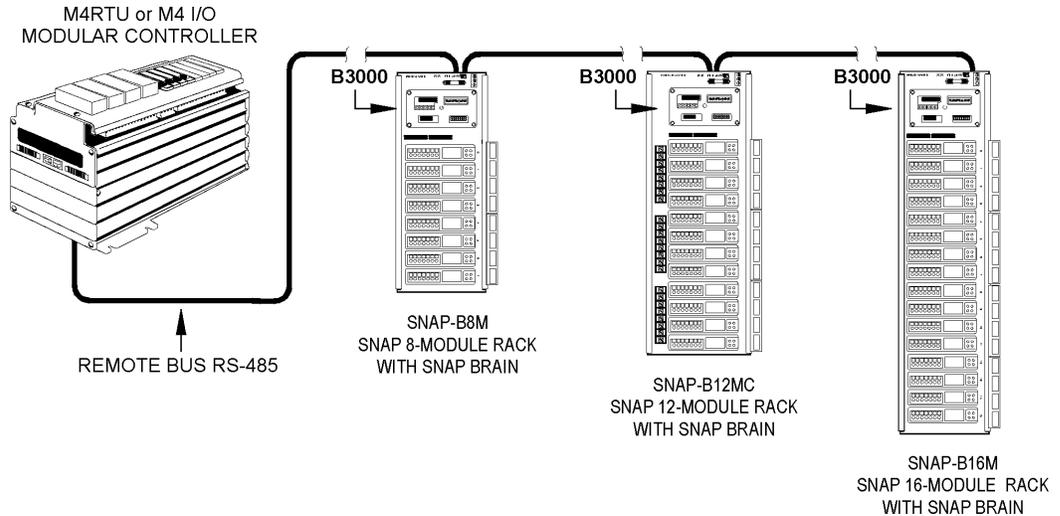
Note that the multifunction digital I/O unit (M4RTU/M4IO digital I/O) is addressed as 0 and the multifunction analog I/O unit (M4RTU/M4IO analog I/O) is addressed as 1 on the parallel I/O bus (local). Since there is no external local bus on the M4RTU/M4IO, these are the only two valid local bus addresses. These addresses are important during I/O configuration within OptoControl.

Configuring M4RTU/M4IO and M4RTUX I/O Units

The first step in configuring I/O is adding the I/O units. Follow the procedure listed in the *OptoControl User's Guide* to add an I/O unit. For the digital unit, the Type is G4 Digital Multifunction, the Port is Local, and the Address is 0. For the analog unit, the Type is G4 Analog Multifunction, the Port is Local, and the Address is 1. Remember that the digital I/O on the M4RTUX is on the same unit as the digital I/O on the M4RTU/M4IO, and the analog I/O on the M4RTUX is on the same unit as the analog I/O on the M4RTU/M4IO.

Configuring Additional I/O Units

Your system may have additional I/O units connected via the RS-485 serial link. Follow the procedure listed in the *OptoControl User's Guide* to add an I/O unit. For the configuration of these units, the Port is Remote 1, 2, or 3 depending on where the I/O is located. The Type and Address will depend on the hardware used and the jumper settings.



Configuring the I/O Points

Follow the procedure listed in the *OptoControl User's Guide* to add an I/O point. Notice that the Configure I/O Points dialog box shows 16 analog channels even though the M4RTU/M4IO and M4RTUX together support a maximum of only eight analog channels. This is because the M4RTU/M4IO electronics does not support the analog extender capability of an analog multifunction I/O unit. Simply ignore analog channels 8 through 15 of the Configure I/O Points dialog box.

Storing User Strategies into M4RTU/M4IO Flash EEPROM

User OptoControl strategies may be stored into flash memory instead of residing in RAM backed up by a battery. Flash memory has the same robust attributes of EEPROM for remote installations. Strategies may be developed for the M4RTU/M4IO in RAM, remotely downloaded and debugged, and then stored remotely in flash memory. If the M4RTU/M4IO has been set up to boot automatically from flash memory, the OptoControl strategy stored in flash will be executed upon power-up.

To store an OptoControl strategy into flash memory, refer to the *OptoControl User's Guide*.

To configure the M4RTU to run the program automatically from flash, see [“EEPROM/RAM Jumper \(E/R\)” on page 26](#).

OptoDisplay and OptoServer

Both OptoDisplay and OptoServer share the database generated by OptoControl. This database contains the configuration information for communicating to the M4RTU/M4IO and referencing any strategy data items, such as variables, I/O, PIDs, and event/reactions. This information is used by OptoDisplay to dynamically drive a given graphic's attributes. It is also used by OptoServer to

communicate to an M4RTU/M4IO or an Opto 22 Controller Network of M4RTU/M4IOs and other Opto 22 controllers.

To attach OptoDisplay or OptoServer to an M4RTU/M4IO (or to an Opto 22 Controller Network containing M4RTU/M4IOs), follow the standard procedures outlined in the OptoDisplay and OptoServer online help or user's guides for adding controllers. In short, you will be telling OptoDisplay and OptoServer which OptoControl database to open to access the communication information and strategy data items.

For more details regarding OptoDisplay and OptoServer, refer to the *OptoDisplay User's Guide* and *OptoServer User's Guide*.

Updating the M4RTU/M4IO Firmware

Use the OptoTerm utility, included on the CD with this controller, to update the firmware. For details on using OptoTerm, consult online help or the *OptoControl User's Guide*.

IMPORTANT: *If your M4RTU/M4IO controller was manufactured in June 2007 or later, it will have a **Rev. 2** sticker. For Rev. 2 controllers, make sure you use OptoTerm version 4.1b or higher (included on the CD that came with the controller) to update firmware. Older versions of OptoTerm will not recognize the unit accurately. For more information, see "Notes for Rev. 2 Controllers" on page 11.*

Field Wiring

Overview

This chapter provides detailed information on digital and analog field wiring for the M4RTU/M4IO and M4RTUX. It includes examples of how to wire all currently-available G4 digital and analog I/O modules. (If a particular module is not represented, please contact Opto 22 Product Support (see [page 2](#).)

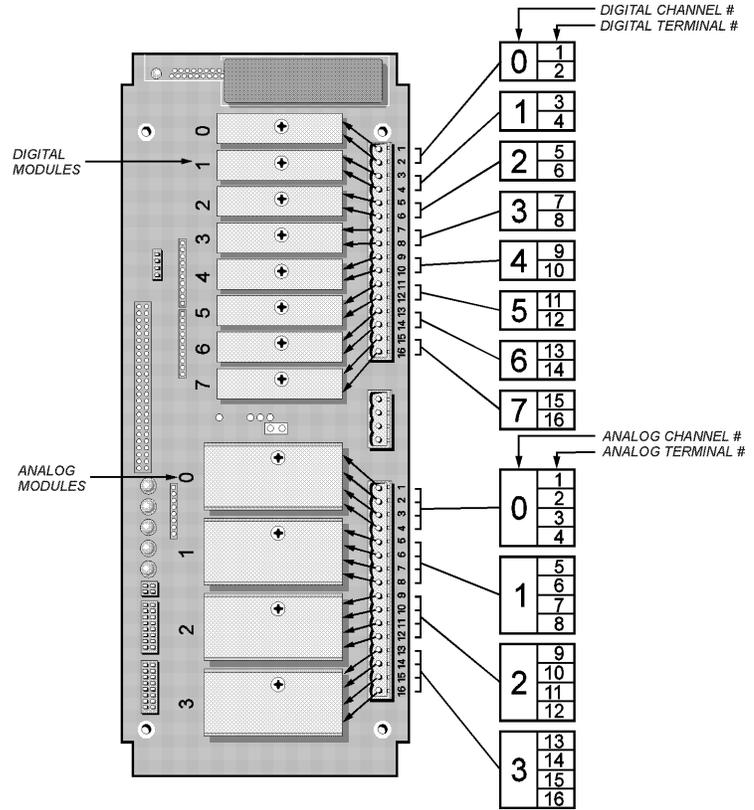
The M4RTU/M4IO and M4RTUX, shown on the following pages, use pluggable screw-style terminal blocks for field wiring. This type of terminal block gives you the advantages of both a terminal block and a connector. Terminal blocks furnish a robust individual wire attachment, while connectors enable quick multi-wire disconnection. Hence, the pluggable screw-style terminal blocks provide easy installation of field wiring and easy removal of the M4RTU/M4IO and M4RTUX, should the need arise.

A bused four-position pluggable terminal block is provided on both the M4RTU/M4IO and M4RTUX. This bused terminal block is located between the two field wire terminal blocks and can be used to bus user power or commons. It is not connected to any power source or ground plane on the M4RTU/M4IO or M4RTUX.

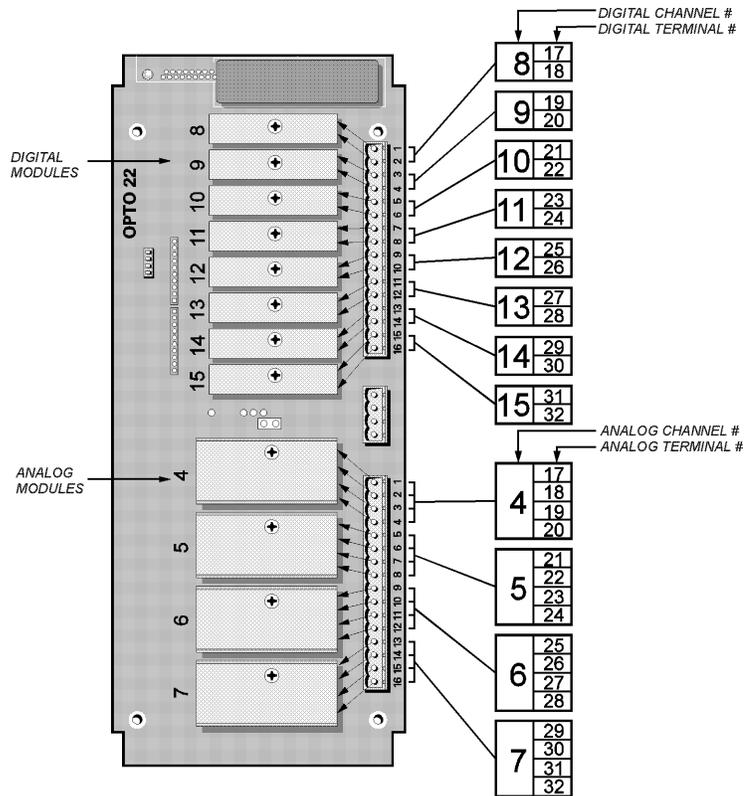
The terminal blocks for each unit reside under a cover, preventing removal without the use of a tool. When attaching field wiring, make sure that the M4RTU/M4IO is off and that field wiring is not powered, especially in hazardous environments. Field wiring should be properly prepared for terminal block installation, it should be accurately labeled, and it should be neatly dressed. Allow for adequate service loops in all field, power, and communication wiring.

If you will be connecting the M4RTU/M4IO to additional I/O units via the RS-485 serial link (remote), refer to the *Mistic 200 Systems Installation Guide* and the *Mistic 200 Family Data Book*.

**Locations of Terminals
on M4RTU/M4IO
Showing Logical
Representation of
Modules**



**Locations of Terminals
on M4RTUX Showing
Logical Representation
of Modules**



Field Wiring Terminals

The M4RTU/M4IO and M4RTUX field wiring terminals are located at the top of each unit, next to their corresponding digital and analog channel locations. Together, the M4RTU/M4IO and M4RTUX represent a full complement of 16 digital and 8 analog channels, equivalent to the number of channels on a standard set of one digital and one analog brick. (Although the M4RTU/M4IO electronics can support a full complement of digital and analog channels, the unit does not have enough space to support these channels; hence the need for the M4RTUX I/O Extender.)

Look at the diagrams on the previous page, and note that although the I/O channels on the M4RTU/M4IO and the M4RTUX are labeled identically, these channels actually represent different modules logically. On the M4RTU/M4IO, the digital channels labeled 0–7 and the analog channels labeled 0–3 correspond correctly to digital modules 0–7 and analog modules 0–3, while on the M4RTUX, the channels with the same labels correspond logically to digital modules 8–15 and analog modules 4–7.

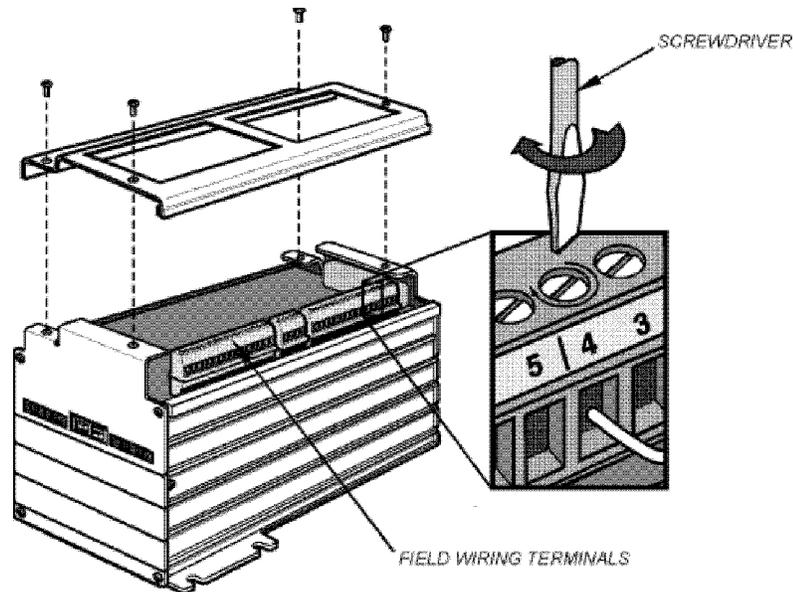
Each digital channel has two terminals, and each analog channel has four terminals. As with the I/O channels themselves, the terminals corresponding to these channels are also labeled identically on the M4RTU/M4IO and M4RTUX, even though they represent different terminal connections. Therefore, on the M4RTU/M4IO, the terminals labeled 1–16 correspond correctly to terminal connections 1–16, while on the M4RTUX, these terminals correspond logically to terminal connections 17–32.

The diagrams on the previous page show the location of the digital and analog channels, as well as their corresponding terminals for both the M4RTU/M4IO and M4RTUX. Also see [Appendix D, “Worksheets,”](#) for field wiring worksheets.

For additional wiring and module specification information, refer to the Mystic 200 Systems Installation Guide and the Mystic 200 Family Data Book.

Connecting Field Wiring

To connect field wiring to the M4RTU/M4IO and M4RTUX terminals, follow the diagram and procedures below.



1. Access the field wiring terminals by removing the four corner screws at the top of the M4RTU/M4IO or M4RTUX and removing the top cover.
2. Refer to the appropriate section in this chapter for the specific model of G4 digital or analog module for which wiring will be connected. Also, refer to [Appendix D, "Worksheets,"](#) for a field wiring worksheet.
3. Ensure that each terminal is completely open by turning the captive screw counterclockwise until it stops.
4. Insert each wire into the appropriate terminal block location and tighten by turning the power terminal screw clockwise. Make sure the terminal block is clamping the wire and not the insulation.

Wiring Digital Modules

Each digital I/O channel has two terminals corresponding to each installed digital module. Terminals 1 and 2 correspond to a module in channel 0, terminals 3 and 4 correspond to a module in channel 1, and so on. For polarized modules, the positive connection goes to the first terminal of the pair and the negative connection goes to the second. This wiring scheme is identical for the M4RTUX, starting with channel 8.

Most Input and Output Modules

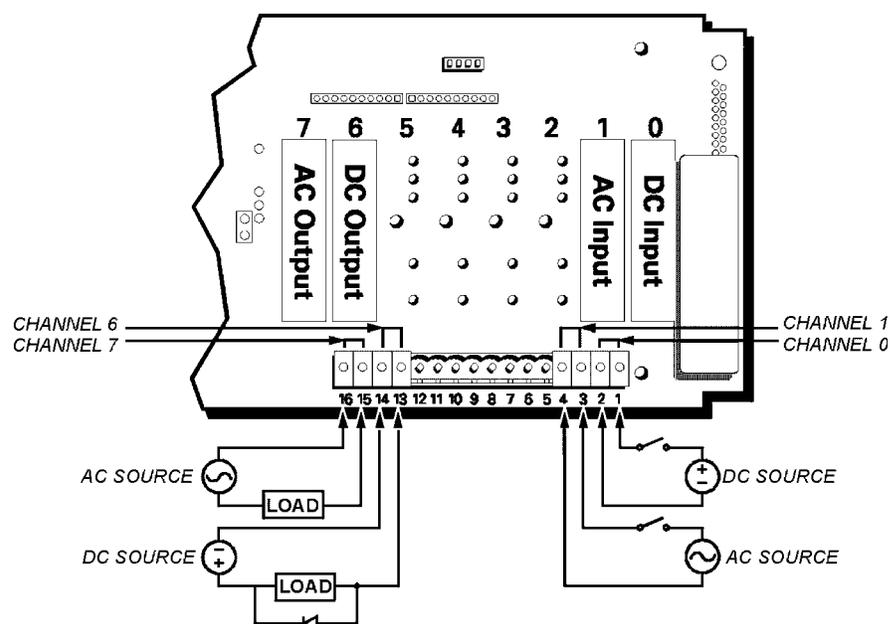
Use the following diagram to wire the digital DC and AC input and output modules listed below:

DC Input Modules	AC Input Modules	DC Output Modules	AC Output Modules
G4IDC5	G4IAC5	G4ODC5	G4OAC5
G4IDC5K	G4IAC5A	G4ODC5A	G4OAC5A
G4IDC5D	G4IAC5MA	G4ODC5MA	G4OAC5A5
G4IDC5B		G4ODC5R	G4OAC5MA
G4IDC5G		G4ODC5R5	G4OAC5AMA
G4IDC5MA			

For the digital input modules listed above, the input device may be wired to either terminal. The polarity of the power does not matter except for the G4IDC5K and G4IDC5D.

For the digital output modules listed above, the load may be wired to either line. For DC output modules used with inductive loads, add a commutating diode (typically a 1N4005) to the circuit as shown on the channel 6 connection to the M4RTUX.

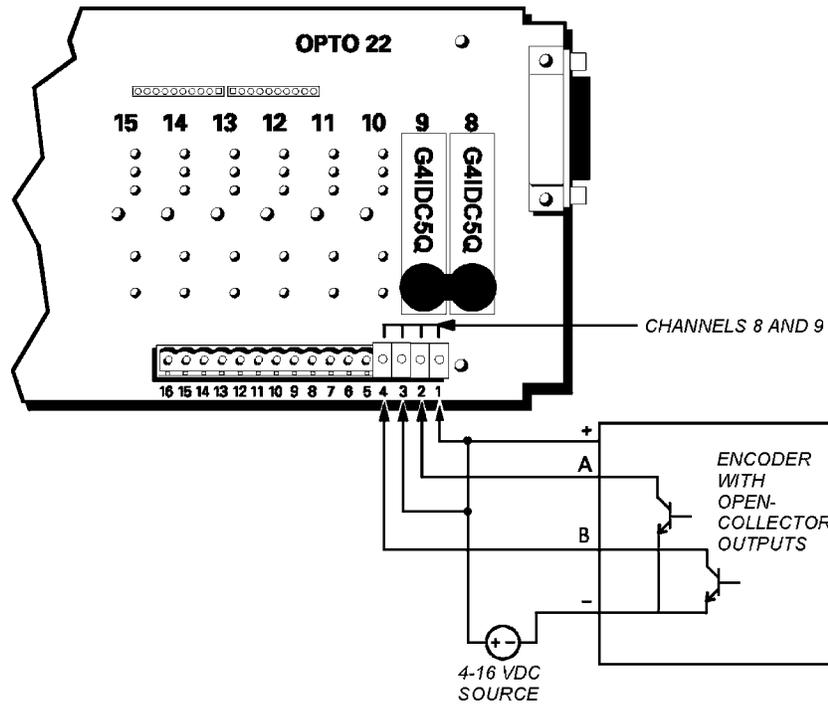
The diagram shows a DC input module wired to channel 0, an AC input module wired to channel 1, a DC output module wired to channel 6, and an AC output module wired to channel 7 on the M4RTU/M4IO.



Quadrature Input Module

Use the following diagram to wire the digital quadrature input module (model G4IDC5Q). The example shows the module connected to channels 8 and 9 on the M4RTUX.

Note: This module requires two digital channels.

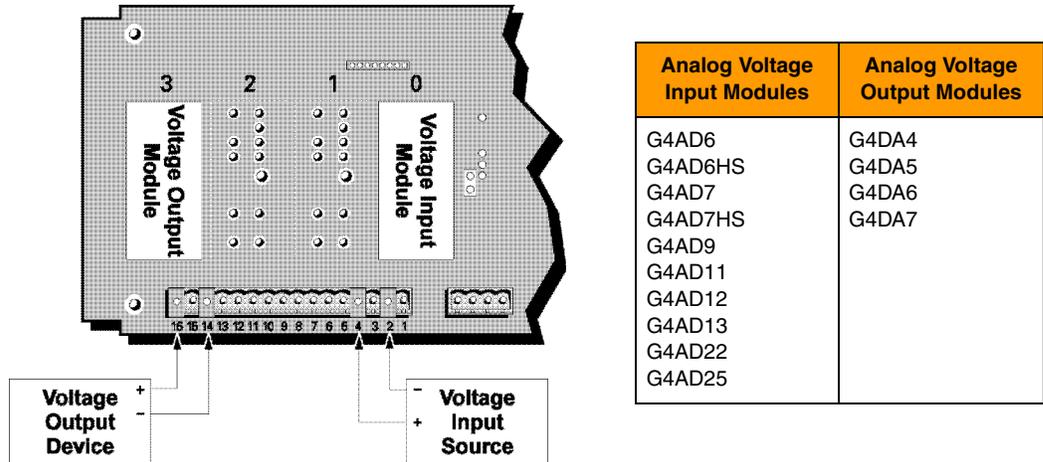


Wiring Analog Modules

Analog modules use up to four terminals per analog I/O channel. The following wiring diagrams illustrate field wiring schemes for each type of analog I/O module.

Voltage Input and Output Modules

Use the following diagram to wire the analog voltage input or output modules listed in the table below. The diagram shows a voltage input module wired to channel 0, and a voltage output module wired to channel 3 on the M4RTU/M4IO.

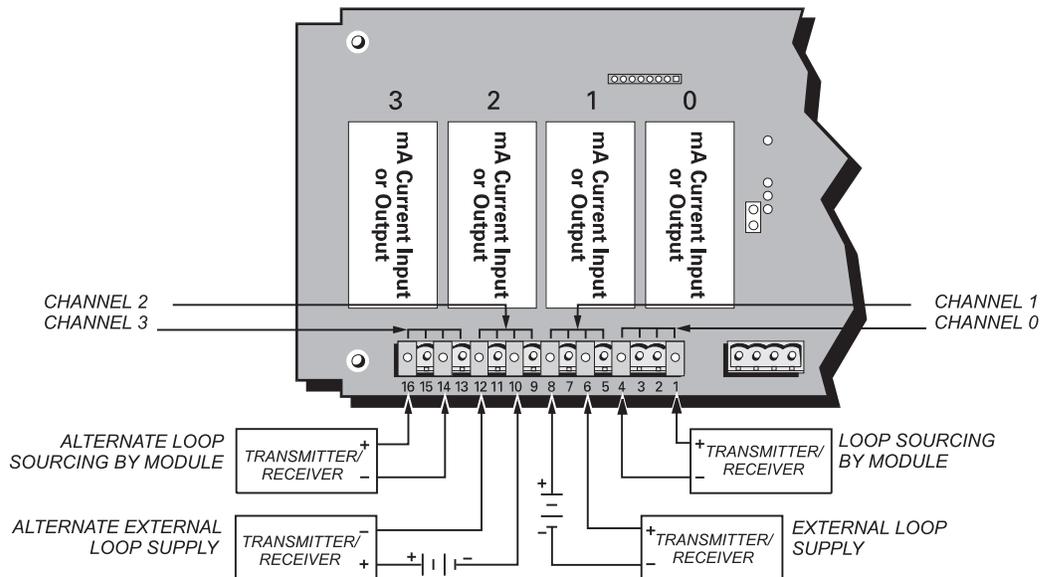


Milliamp Current Input and Output Modules

Use the following diagram to wire the analog milliamp current input or output modules listed in the table below. The example shows wiring to the M4RTU/M4IO on channels 0 through 3.

The current loop for an input or output current device can be powered either by your own external supply or by the module. Using the module reduces wiring expense.

Analog mA Input Modules	Analog mA Output Modules
G4AD3	G4DA3 G4DA8

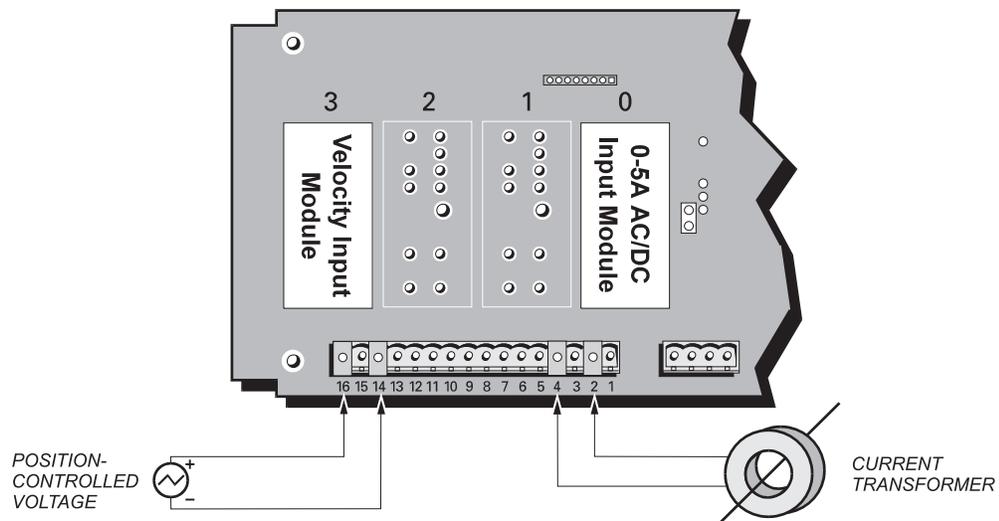


0 to 5 Amp AC/DC Current Input or Velocity Input

The 0–5A AC/DC current input module (model **G4AD16**) can be used to measure current directly or indirectly through a standard current transformer. Applications include measuring or monitoring current through a field device such as a motor, solenoid, or lamp.

The velocity input module (model **G4AD26**) indicates a change in voltage by providing the first derivative of voltage with respect to time (dV/dt). Typically, potentiometer-based transducers are attached. An example of an application would be a transducer measuring piston velocity in an air/hydraulic cylinder.

Use the following diagram to wire these modules. The example shows wiring of the G4AD16 to channel 0 and the G4AD26 to channel 3 on the M4RTU/M4IO.



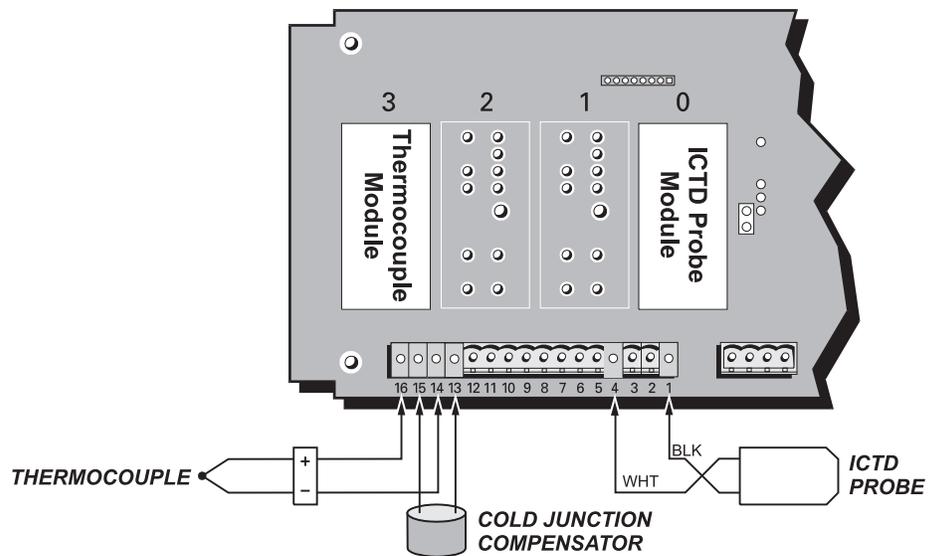
Thermocouple Input or ICTD Temperature Input Module

Use the following diagram to wire the analog thermocouple and ICTD temperature input modules listed in the table below. The example shows a thermocouple input module wired to channel 3 and an Opto 22 ICTD probe wired to channel 0 on the M4RTU/M4IO.

When wiring thermocouples, verify that you are using the proper polarity and wire color according to the table below. Also ensure that the wire type from the thermocouple to field terminals is consistent and does not introduce other thermocouples.

Note: Do not use a cold junction compensator with a G4AD24.

Model	T/C Type	Polarity/Color	
		+	-
G4AD5	J	white	red
G4AD8	K	yellow	red
G4AD17	R	black	red
G4AD18	T	blue	red
G4AD19	E	purple	red
G4AD23	S	black	red
G4AD24	B	gray	red

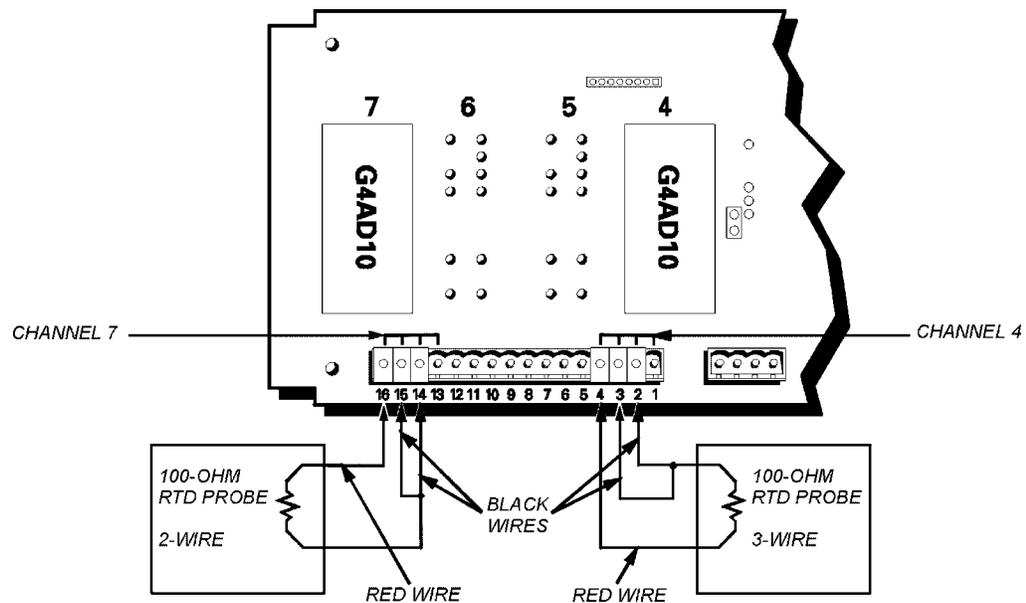


100-Ohm RTD Input Module

Use the following diagram to wire an analog 100-ohm RTD input module (model **G4AD10**). Wire colors may vary, but make sure two wires of the same color are connected as shown. The example shows a three-wire RTD probe connected to channel 4 and a two-wire RTD connected to channel 7 on the M4RTUX.

For a four-wire RTD probe, do not connect the fourth wire. Connect three wires as shown for the three-wire RTD example.

For a two-wire RTD probe, add a second wire of the same type and gauge to one end, connecting it as you would a three-wire RTD. The example shows this type of connection to channel 7 on the M4RTUX.

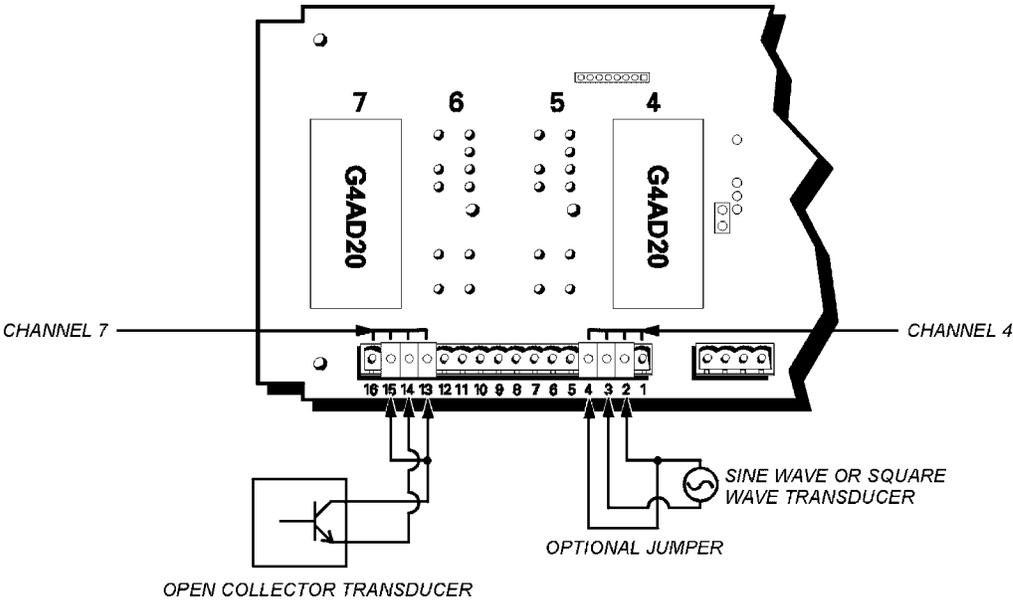


Rate Module

The rate module (model **G4AD20**) measures the frequency of an incoming signal and produces a count based on the number of cycles per second (Hertz). For example, a count value of 1,000 indicates a frequency of 1,000 Hz. This module is ideal for directly reading the frequency of a signal or a rotating disk for RPM calculations, for example.

The input amplitude range from a transducer generating a square or sine wave can be changed by adding a jumper to the hookup. Refer to the wiring example connected to channel 4. The square wave input range changes from 0.5 to 24 V_{p-p} to 0.25 to 24 V_{p-p} . The sine wave input range changes from 5 to 24 V_{p-p} to 2.5 to 24 V_{p-p} .

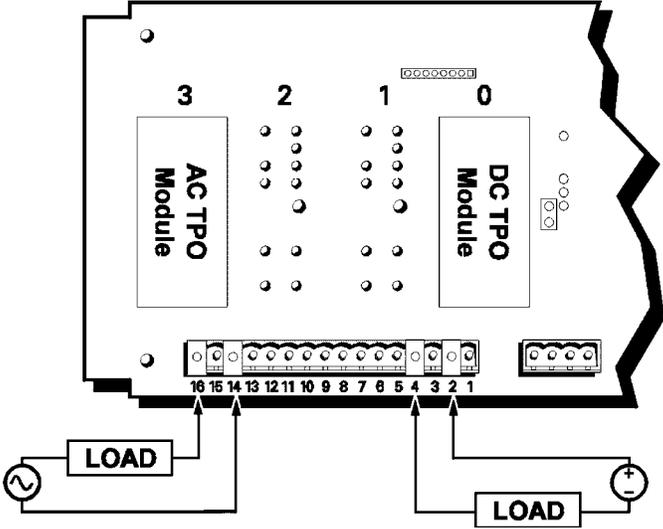
Use the following diagram as a guide to wiring the G4AD20 analog rate module. The example shows the possible wiring options to channels 4 and 7 on the M4RTUX.



Time Proportional Output Module

The time proportional output modules switch either 5–60 VDC (**G4DA9**) or 12–280 VAC (**G4DA10**). Together with power SSRs, they are ideal for temperature control applications, such as heating.

Use the following diagram to wire either of the analog time proportional output modules. The example shows a G4DA10 wired to channel 3 and a G4DA9 wired to channel 0 on the M4RTU/M4IO.



Troubleshooting

M4RTU/M4IO Troubleshooting Chart

Indication	Condition/Problem	Action
RUN LED stays off.	Power not applied to processor.	Check power supply connections.
RUN light flashes.	Not enough power or malfunction.	Verify power supply voltage.
RUN LED flashes after a kernel (firmware) is downloaded or power failure occurred during EEPROM firmware installation.	Kernel (firmware) is corrupted.	Remove Boot Loader jumper so that M4RTU/M4IO boots to loader. Reinstall EEPROM firmware, then reinstall Boot Loader jumper.
TX0 (COM0 transmit) LED stays off.	Port not transmitting.	Cycle power to unit. Check CTS connection; must be connected to RTS if not used. Check jumper settings and/or controller communications setup.
RX0 (COM0 receive) LED stays off.	Port is idle. Wire or connection is bad.	Check wiring for polarity transposition. Check connections at terminals.
Host does not receive a response from the M4RTU/M4IO, and RX0 or RX1 (COM0 or COM1 receive) LED flashes communications setup, during program download.	PC to M4RTU/M4IO connections are incorrect. Incorrect setup in the OptoControl controller configurations.	Check wiring connections for correct polarity and wire integrity. Check controller configurations; specifically baud rate, address, and binary/ASCII settings.
TX1 (COM1 transmit) LED stays off.	Port not transmitting.	Cycle power to unit. Check jumper settings and/or controller communications setup.
RX1 (COM1 receive) LED stays off.	Port is idle. Wire or connection is bad.	Check wiring for polarity transposition. Check connections at terminals.
M4RTU/M4IO controller cannot transmit to PC.	Configuration jumpers were changed without cycling power. Wiring to serial port is incorrect.	Cycle power and retry transmission. Check wiring for possible polarity transposition.
Digital output is not working.	Bad module fuse. Wrong module type. Incorrect wiring.	Replace fuse. Make sure module is 5V (G4ODC5 is correct, G4ODC24 is incorrect) Match the output module with the load. Use G4SWOUT module to troubleshoot. If G4SWOUT works, contact Opto 22 Product Support (see page 2).
Output does not work with G4SWOUT module installed.	Load does not work with voltage applied. Output is wired wrong.	Check field wiring worksheets (see Appendix D) and rewire, if necessary.

Indication	Condition/Problem	Action
Digital input is not working.	Input device is not working properly. Wrong module type. Voltage on input is not compatible with module voltage range. I/O or processor board is bad.	Check input device wiring and power source. Rewire, replace, or fix power source as needed. Make sure module is 5V (for example, [G4IDC5 is correct, G4IDC24] is incorrect). Change voltage to match module or module to match voltage. Use G4SWIN module and OptoControl or G4TEST to send commands to the M4RTU/M4IO to verify that the processor board and I/O board are working properly.
Digital input test with G4SWIN module installed.	I/O or processor board is bad.	Contact Opto 22 Product Support (see page 2).
Analog output is not working.	Output is wired incorrectly. Device is not properly matched to module type. I/O or processor board is bad.	Check wiring to output device. Test module using meter and test software (OptoControl or G4TEST). Change voltage to match module or module to match voltage. Contact Opto 22 if meter reading does not change with value change in test software.
Analog input is not working.	Voltage output device is wired incorrectly. Thermocouple has a break. RTD has open or incorrect wiring. I/O or processor board is bad.	Check device and wiring. Connect voltage source or current source (depending on input type) and use test software to determine if input is functioning. For a thermocouple, check for continuity across test points next to module. For an RTD input, check resistance across test points next to module. Contact Opto 22 Product Support (page 2) if any of the following occurs: - If value in test software does not change with input when testing input voltage or current with test software. - If thermocouple has continuity across test points. - If resistance across test points is about 100 ohms for RTD input.

Cable and Connector Specifications

Serial Communication Cables

The following cables are recommended for both RS-232 and RS-485/422 serial communications. Although you may elect to use other cables, keep in mind that low capacitance (less than 15 pF/ft.) is important for high-speed digital communication links. The cables listed below are all 24-gauge, 7x32 stranded, with 100-ohm nominal impedance and a capacitance of 12.5 pF/ft.

Select from the following two-, three-, and four-pair cables, depending on your application needs. All will yield satisfactory results. It is recommended that you choose a cable with one more pair than your application requires. Use one of the extra wires, rather than the shield, for the common.

Two-Pair:

- Belden P/N 8102 (with overall shield)
- Belden P/N 9729 (individually shielded)
- Belden P/N 8162 (individually shielded with overall shield)
- Manhattan P/N M3475 (individually shielded with overall shield)
- Manhattan P/N M39249 (individually shielded with overall shield)

Three-Pair:

- Belden P/N 8103 (with overall shield)
- Belden P/N 9730 (individually shielded)
- Belden P/N 8163 (individually shielded with overall shield)
- Manhattan P/N M3476 (individually shielded with overall shield)
- Manhattan P/N M39250 (individually shielded with overall shield)

Four-Pair:

- Belden P/N 8104 (with overall shield)
- Belden P/N 9728 (individually shielded)
- Belden P/N 8164 (individually shielded with overall shield)
- Manhattan P/N M3477 (individually shielded with overall shield)
- Manhattan P/N M39251 (individually shielded with overall shield)

M4RTU/M4IO Connectors

The following connectors are included with the M4RTU/M4IO:

Green Pluggable 7-Position Terminal Mini-Plug

- Used for RS-232 and RS-485/422 connections from the M4RTU/M4IO (COM0 and COM1) and the M4SSER (COM2 and COM3)
- Manufactured by Phoenix Contact (P/N MC1, 5/7-ST-3, 81)

Green Pluggable 3-Position Terminal Plug

- Used for M4RTU/M4IO power connection
- Manufactured by Phoenix Contact (P/N MSTB 2, 5/3-STF-5, 08)

Green Pluggable 16-Position I/O Connector

- Used for wiring from the M4RTU/M4IO and M4RTUX to field application hardware
- Manufactured by Phoenix Contact (P/N MVSTBR 2, 5/16-ST-5, 08)

Product Specifications

M4RTU/M4IO Base Unit Hardware Specifications

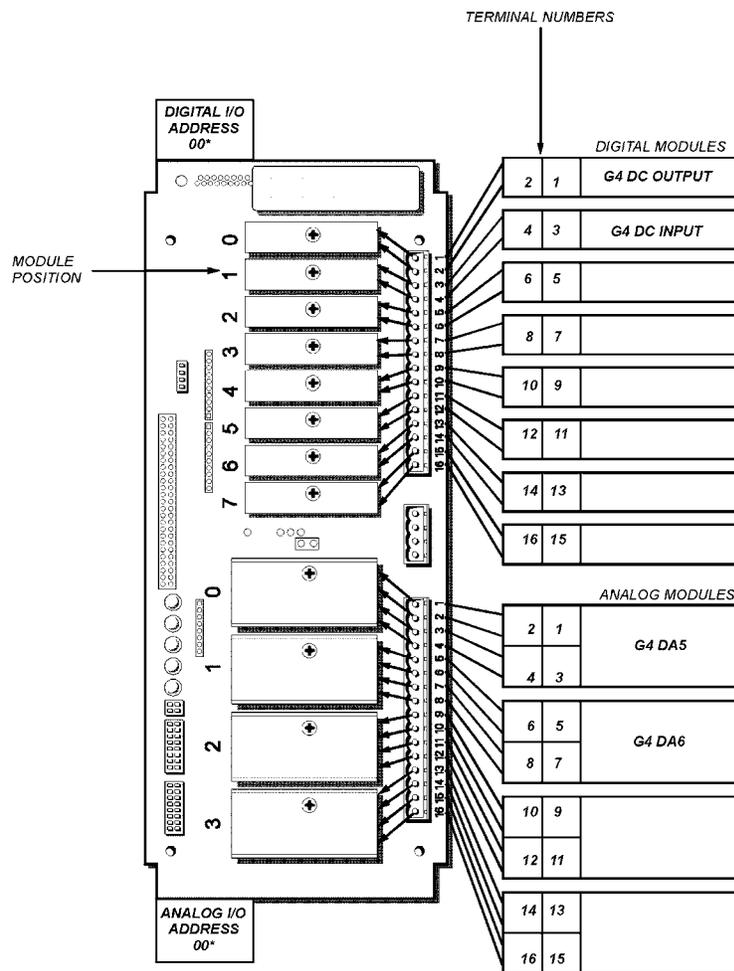
Item	Specification
CPU	32-bit Motorola 68020 processor 16-bit 80C196 I/O processor IEEE floating-point math
CPU clock frequency	16.67 MHz
Memory: RAM Flash EEPROM on controller Flash EEPROM on brain board	1 MB with battery backup (user programs & data) 1 MB (firmware and user programs) in Rev. 2 controllers (256 KB in older ones.) 128 KB (I/O firmware)
RAM/clock battery	3.6-volt lithium, non-rechargeable
I/O: Base unit Extender unit Expansion	8 digital, 4 analog, multifunction Adds 8 digital, 4 analog, multifunction Via RS-485 ports, using Opto 22 I/O
Communication: Base unit Expansion Modem support	1 RS-232 and 1 RS-485/422 port Via daughter cards: configurable serial ports, Ethernet, ARCNET Direct, lease, and radio
Real-time clock	Clock/calendar, Epson 62421A with battery backup
Power requirements	5 VDC at 3.5 A (maximum) 24 VDC at 300 mA (maximum)
Typical operating temperature	-20 °C to 70 °C
Storage temperature	-40 °C to 85 °C
Humidity	5% to 95% relative humidity
Software	FactoryFloor (OptoControl, OptoDisplay, and OptoServer) Classic Software (Cyrano, Mystic MMI, and MDS)
System monitors: Host communications Watchdog timers RAM battery backup low Operating temperature	Detect communication errors from processor, I/O, etc. Detect main power supply operation Detects program corruption (checksum RAM test) Detects temperature

Worksheets

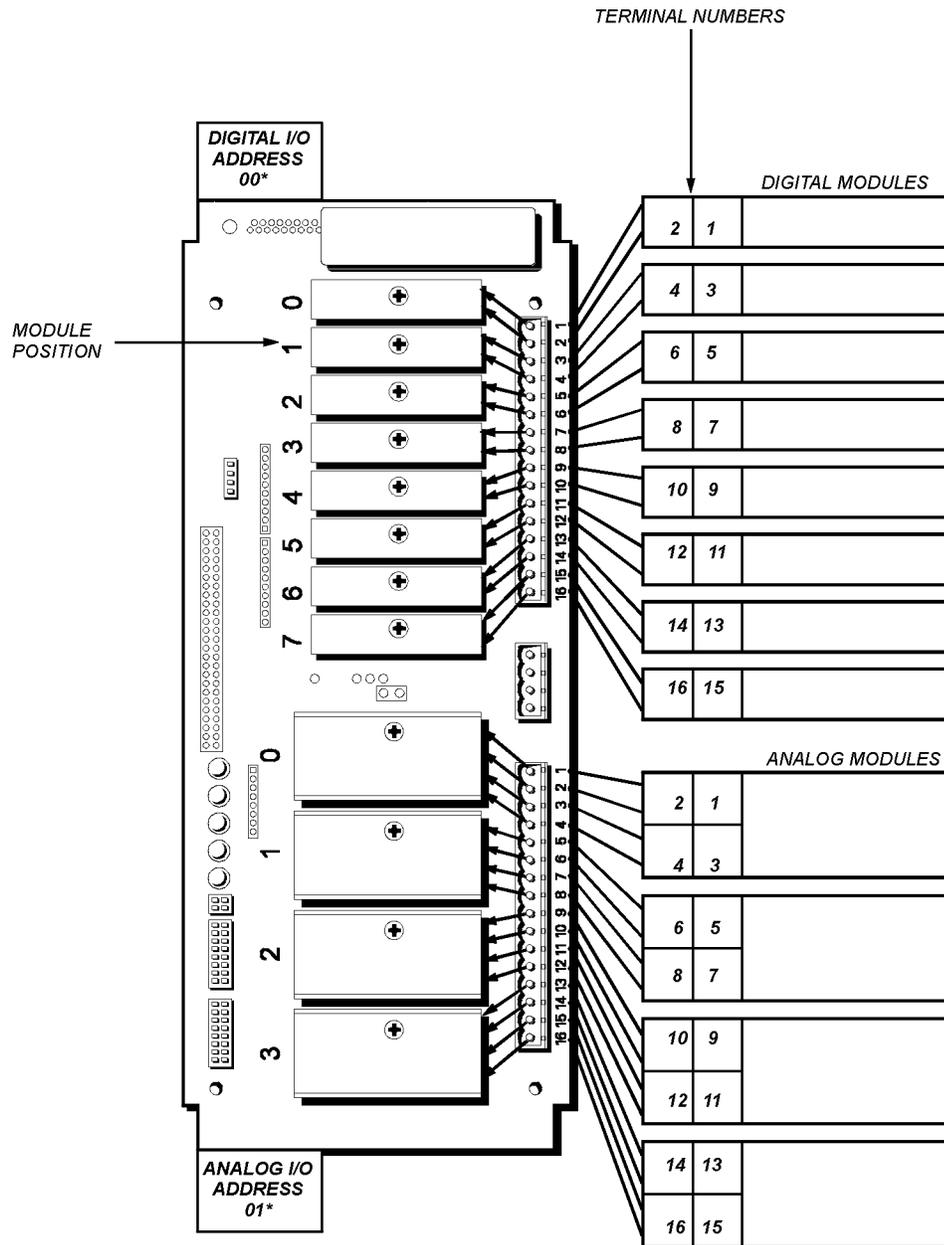
I/O Module Worksheets

The following worksheets can be used to plan I/O module installation for the M4RTU/M4IO base unit and M4RTUX I/O extender unit.

Fill in the digital or analog I/O type in the box to the right of each I/O channel shown on the worksheet. The following is an example of a completed worksheet:

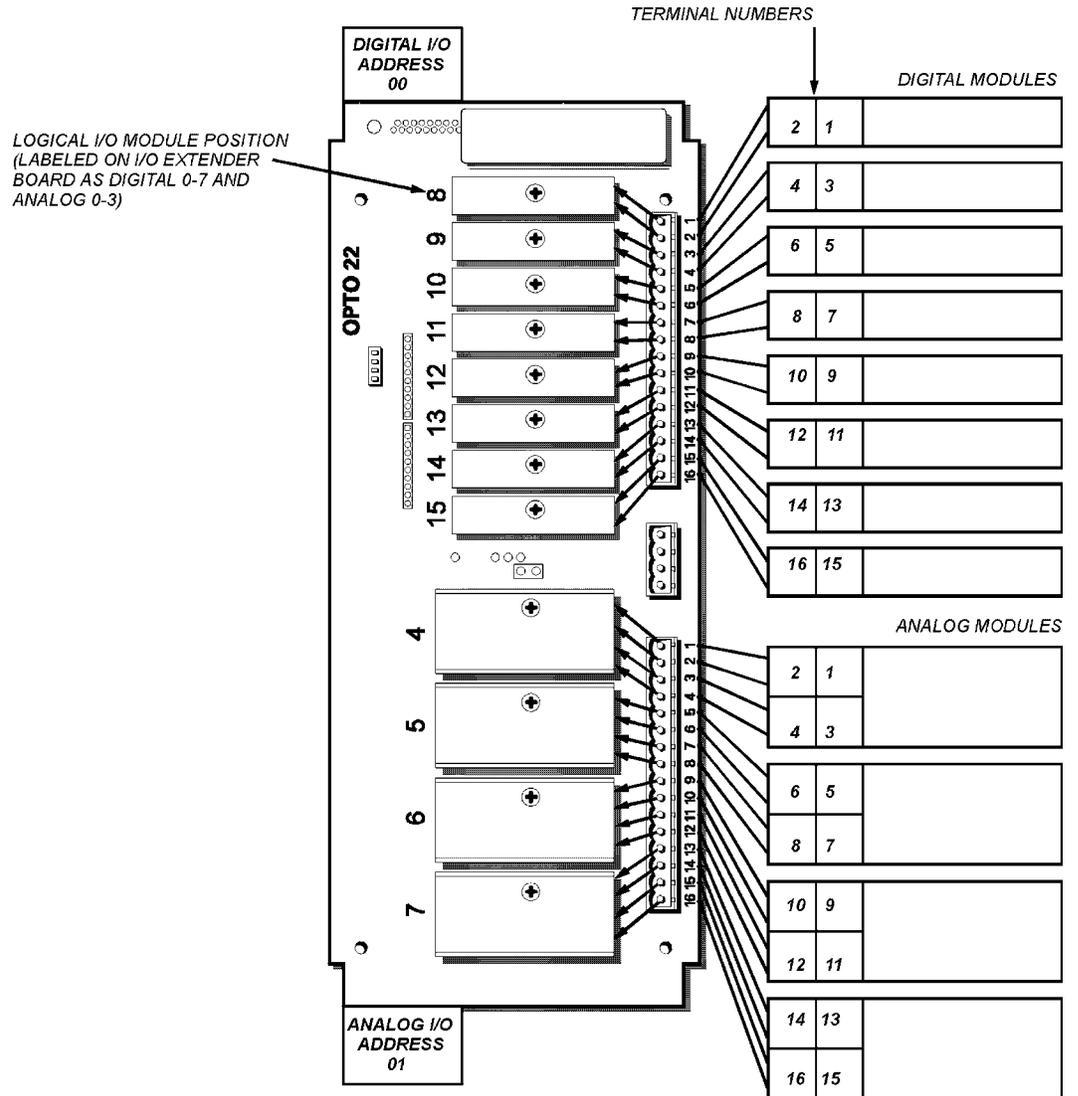


M4RTU/M4IO Base Unit—I/O Module Worksheet



* When configuring digital or analog I/O for the M4RTU/M4IO base unit using OptoControl, use these addresses and make sure the PORT type is LOCAL. See [Chapter 4, "Software and Firmware,"](#) for more information.

M4RTUX I/O Extender—I/O Module Worksheet

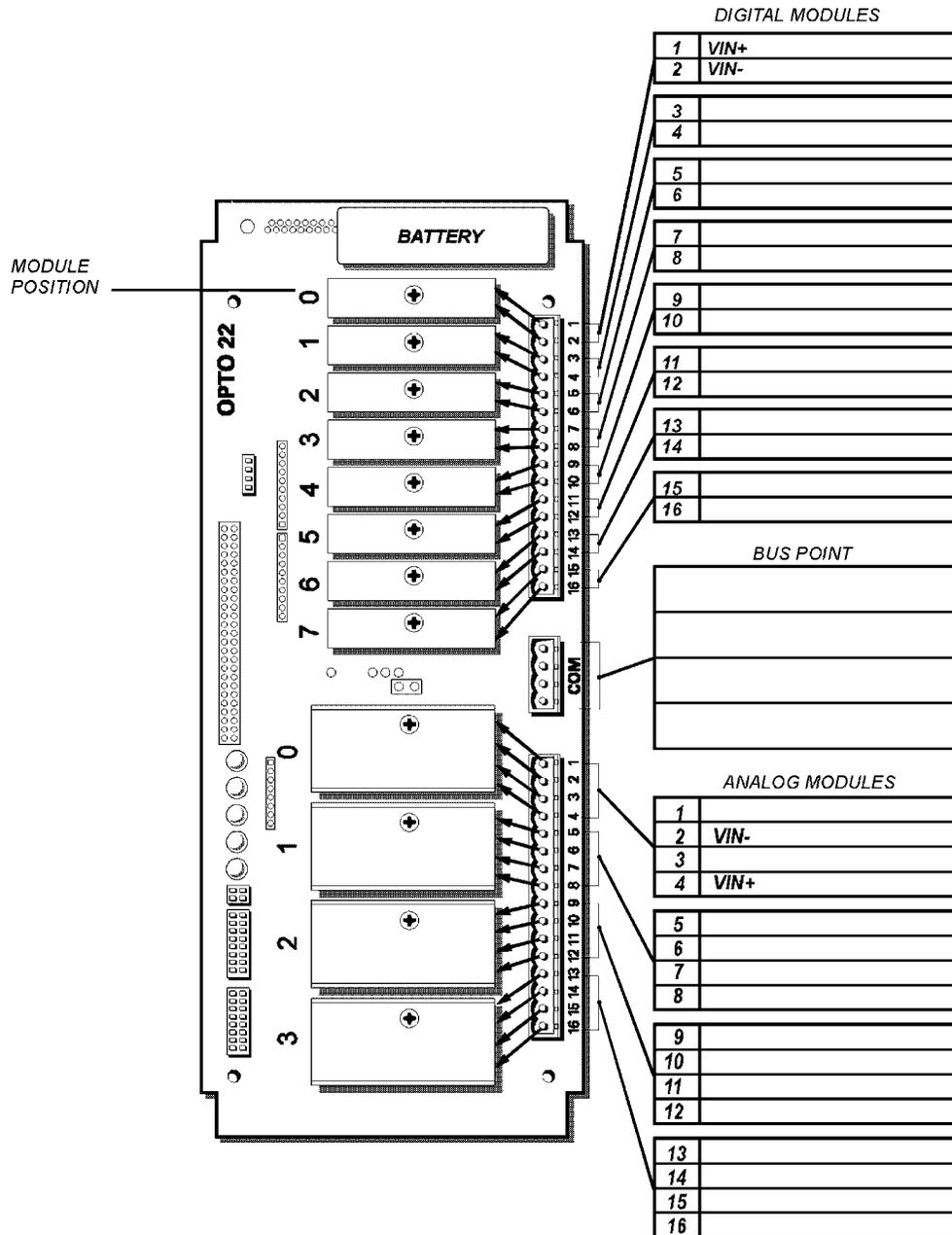


Field Wiring Worksheets

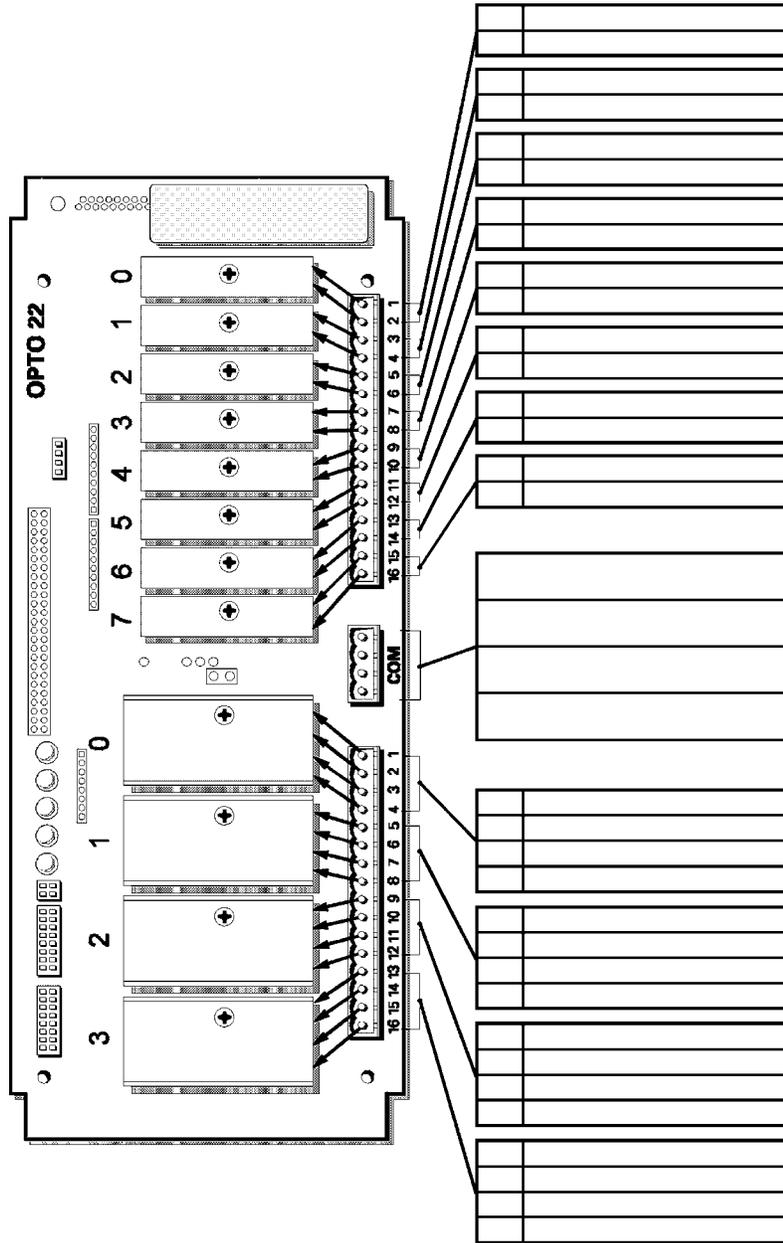
The following worksheets can be used to plan and implement field wiring installation for the M4RTU/M4IO base unit and M4RTUX I/O Extender.

Fill in the wire name boxes for each terminal. The Field Wiring Worksheet can be used by your installer during RTU installation. If you need additional worksheets, make copies before filling these out.

Field Wiring Worksheet 1



Field Wiring Worksheet 2



M4RTU/M4IO Power Consumption Worksheet Instructions

1. On the following worksheet, locate the daughter cards and digital and/or analog modules you will be using with the M4RTU/M4IO. Enter a quantity for each item in the “Quantity” column. Also, fill in the quantity and wattage of any RS-232 devices on the line provided.
2. Multiply the value in the “Watts” column by the quantity entered in the “Quantity” column and enter the result in the “Total” column for each component used.

Example: Eight G4 digital module totals 0.688 W. Four G4ADX analog modules total 6.4 W.

3. Add the values in the “Total” column, including the value entered for the M4RTU/M4IO base unit, and enter the result on the “Total Watts” line.

Example: 0.688 W (digital modules) + 6.4 W (analog modules) + 7.5 W (base RTU) = 14.588 W.

4. Enter the supplied input voltage for your installation on the “Your supplied input voltage” line.

Example: 24 VDC.

5. Divide the total on the “Total Watts” line by the number entered on the “Your supplied input voltage” line to calculate your total input current requirements. Enter this number on the last line of the worksheet.

Example: 14.588 W (total watts)/24 VDC (supplied input) = 0.6 A required input current for the M4RTU/M4IO.

Power Consumption Worksheet

Hardware	Watts (W)	Quantity (Q)	Total (W X Q)
M4RTU/M4IO Base Unit	7.5	1.0	7.5
M4RTUX I/O Extender Unit	0		0
Daughter Cards¹			
M4SSER	1.6		
M4SARC	1.0		
M4SARCF	1.1		
M4SARCFR	1.6		
M4SENETC	3.1		
M4SENETU	1.50		
M4DUALARC	0.7		
M4SENET-100	4.1		
Digital I/O Modules:			
G4 Digital AC/DC Input/Output ²	0.086		
G4ODC5R, G4ODC5R5	0.10		
G4IDC5Q	0.43		
Analog I/O Modules:			
G4ADX ³	1.6		
G4AD3 Sourcing: Non-Sourcing:	2.6 1.6		
G4DA4 Sourcing: Non-Sourcing:	2.2 1.1		
G4DA3, G4DA8 Sourcing: Non-Sourcing:	2.6 1.2		
G4DA9, G4DA10	0.18		
Powered RS-232 devices (e.g., barcode reader)			
Total Watts (TW):			_____ W
Your supplied input voltage:			_____ V
TW/Your supplied input voltage = Input Current			_____ A

1 If the daughter card you are using does not appear above, call Opto 22 for a data sheet or contact Opto 22 Product Support for wattage specifications.

2 If the digital module you are using does not appear above, use the G4 Digital AC/DC Input Output module wattage.

3 If the analog module you are using does not appear above, use the G4ADX wattage.

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