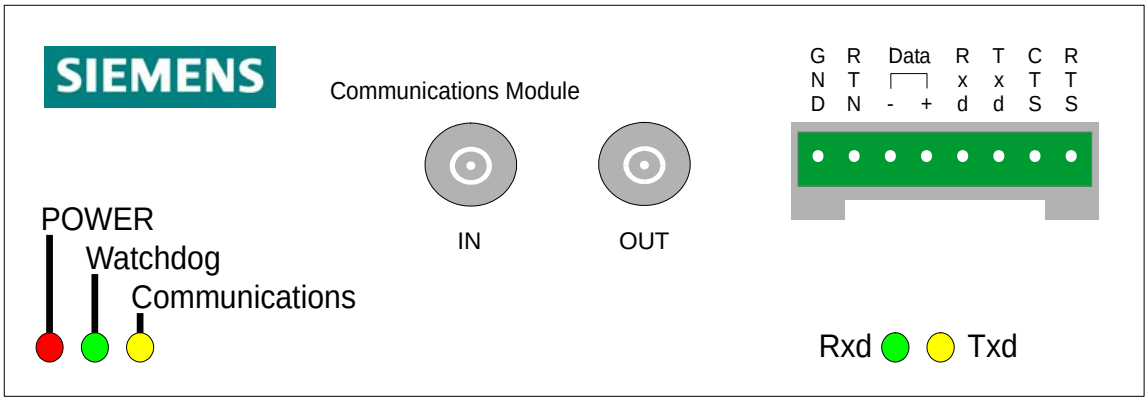
SIEMENS

MJ-4™ Communications Module

Fiber Optic and RS-232/485

Installation Manual for MJ-4A™, MJ-X^{L} ™ and MJ-X™ Control Panels



MJ-4 Communications Module

Manual No. 21-115-527-024 rev02

DANGER

Hazardous Voltage.

Will cause death, serious injury, or equipment damage.

De-energize and ground the equipment before maintenance.

Only qualified personnel should work on this equipment after becoming thoroughly familiar with all warnings, safety notices, instructions and maintenance procedures contained herein. The successful and safe operation of this equipment Is dependent upon proper handling, installation, operation and maintenance.

The information contained herein is general in nature and not intended for specific application purposes. It does not relieve the user of responsibility to use sound practices in application, installation, operation, and maintenance of the equipment purchased. Siemens reserves the right to make changes in the specifications shown herein or to make improvements at any time without notice or obligations. Should a conflict arise between the general information contained in this publication and the contents of drawings or supplementary material or both, the latter shall take precedence.

NOTE

Authorized and qualified Personnel

For the purpose of this manual a qualified person is one who is familiar with the installation, construction or operation of the equipment and the hazards involved. In addition, he has the following qualifications:

(a) **Is trained and authorized** to de-energize, clear, ground, and tag circuits and equipment in accordance with established safety practices.

(b) **Is trained** in the proper care and use of protective equipment such as rubber gloves, hard hat, safety glasses or face shields, flash clothing, etc., in accordance with established safety practices.

(c) **Is trained** in rendering first aid.

SUMMARY

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the local sales office, listed on the back of this instruction guide.

The contents of this instruction manual should not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens Power Transmission & Distribution Inc. The warranty contained in the contract between the parties is the sole warranty of Siemens Power Transmission & Distribution Inc. Any statements contained herein do not create new warranties or modify the existing warranty.

DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Table of Contents

Figures

Tables

1 Introduction

This manual describes the installation and connection procedures for the MJ-4A™ & MJ-4B™ (here after referred to collectively as MJ-4 ™) Communications Module which has the Fiber Optic and the RS-232/485 interfaces combined in one single printed circuit board. The operation and functionality of the Fiber Optic and the RS-232-/485 interfaces are quite similar, only one of the interfaces can be used at a time. The manual covers the procedures for connecting the module to a system of networked MJ-4 Tap Changer Control Panels.

1.1 Description

The Siemens MJ-4 Communications Module is the communication interface used to connect the MJ-4 Control Panel to a network of regulator controllers, control devices, and supervisory equipment. Figure 1-1 illustrates the MJ4 Communications Module.

The fiber optic interface enables connection of the tap changer control panel to the supervisory equipment via multimode fiber optic cable. The RS-232/485 interface enables connection of the tap changer control panel to the supervisory equipment via electrical wire.

The MJ-4 Communications Module is installed in MJ-4 Tap Changer Control Panels. This allows you to easily network the control panels and other field devices to a remote terminal unit (RTU) or other supervisory device. An adapter kit is available for mounting MJ-4 Communications Modules in MJ-X Control Panels.

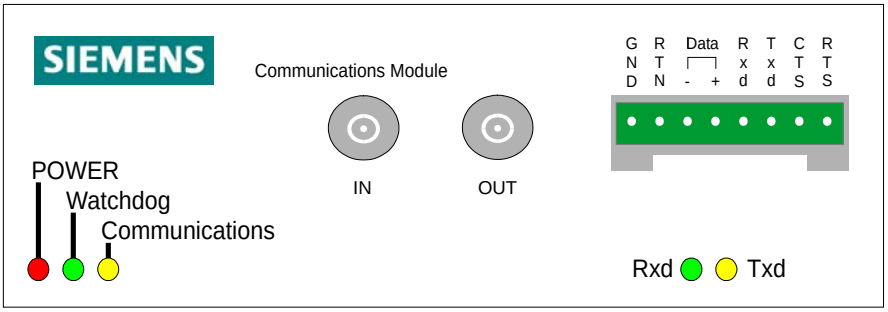


Figure 1-1 MJ-4 Communications Module.

1.2 LED Indicators

The MJ-4 Communications Module has five LED indicators.

- **Power** indicates the MJ-4 Communications Module is powered on.
- **Watchdog** when blinking steadily, indicates the MJ-4 Communications Module microprocessor and software are functioning properly.
- **Communications** indicates communications activity with this module. (The Communications Module turns on this indicator when it receives a valid message with a valid address.)
- **Rxd** indicates the communications module is receiving data.
- **Txd** indicates the communications module is transmitting data.

2 Transmission Methods

There are two transmission mediums available for sending data to the RTU:

- fiber optic
- wire

2.1 Fiber Optic Transmission

The primary benefits of fiber optic communications are its immunity to induced electrical interference and relatively low signal loss. Electrical noise cannot be induced into the cable to generate transient spikes that disrupt data communications.

The Fiber Optic interface on the Communications Module uses multi-mode fiber optic cable. The electrical signals are converted to optical signals by the communication unit. The optical signals are then transmitted via the fiber optic cable to the RTU. Communications modules in the path between the transmitting communications module and the RTU act as repeaters and simply regenerate the signals and forward them to the next device, Figure 2-1.

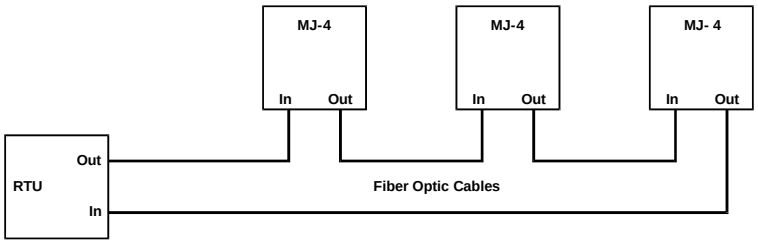


Figure 2-1 Fiber Optic Network.

2.2 Wire Transmission

The advantage of wire transmission is simple installation. The MJ-4 supports two popular wire interfaces: RS-232 and RS-485. The screw terminal block connector supplied with the module can be wired for either interface. Connection to the supervisory device is typically accomplished using either a DB-9 or DB-25 connector for RS-232, while the connector used for RS-485 will vary with the application.

2.2.1 RS-232

Direct RS-232 connections are limited to a maximum distance of 50 feet, Figure 2-2. The RS-232/485 interface on the MJ-4 Communications Module supports RS-232 multi-drop configurations.

The distance between devices may be extended with modems, Figure 2-3. Modem connections are either dial-up, short-haul, or radio-based. Dial-up modems are typically deployed when there is easy access to the telephone connections, while short-haul modems are useful within a facility where there is access to the wiring. Consider using a radio modem when laying cable for a land-line modem is impractical.

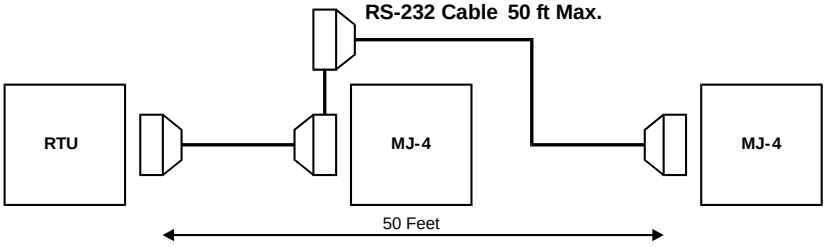


Figure 2-2 RS-232 Connection.

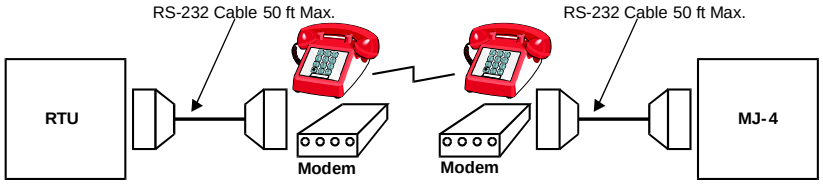


Figure 2-3 Modem Connection.

2.2.2 RS-485

The maximum distance for RS-485 is 4000 feet, either from device to device or for an entire loop. The recommended cable for RS-485 is shielded, two twisted-pair, 22 AWG. This type of cable consists of jacketed wire that is twisted together and wrapped in a shield to prevent electromagnetic interference from affecting the data signal. A maximum of 32 devices can be connected to an RS-485 network. Typical network configurations are loop, star, and open-ended. These are shown in Figures 2-4 to 2-6. The recommended network configuration is a loop. This will ensure that all devices remain connected to the master unit in the event of a line break. If the loop configuration does not allow you to place the equipment in the desired location, connect the network open ended.

If either the star or open-ended configurations are used, termination resistors must be installed at the end devices. For more information on installing RS-485 networks, refer to Section 7.2 RS-485 Twisted-pair Cable. The following characteristics determine the maximum length and data rate of an RS-485 network.

Impedance: The maximum transfer of energy occurs when the cable's terminating impedance matches the characteristic impedance of the cable. If the cable's characteristic impedance is 120 ohms, use a 120 ohm terminating resistor.

Capacitance: Wire capacitance affects the rise and fall times of a transmitted signal and, as a result, limits the signaling (baud) rate of the data. The higher the capacitance, the lower the maximum baud rate. Additionally, higher capacitance requires higher output current to drive the line. Since capacitance is proportional to wire length, it can limit the maximum cable length for a given baud rate.

Cable Size: Cable size along with capacitance and DC resistance determine whether the cable is suitable for the application. A 22-gauge cable will provide a proper balance of capacitance and resistance.

DC Resistance: DC resistance determines the maximum length of wire allowed for an application. The maximum length is determined by the resistance of each twisted pair along with the device termination resistance. The use of surge protectors with series resistance also contributes to loop resistance.

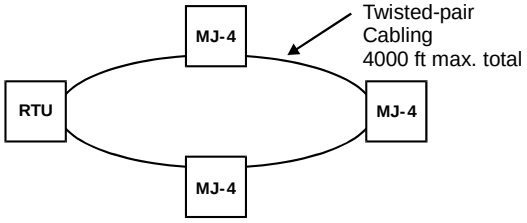


Figure 2-4 RS-485 Configuration – Loop Network.

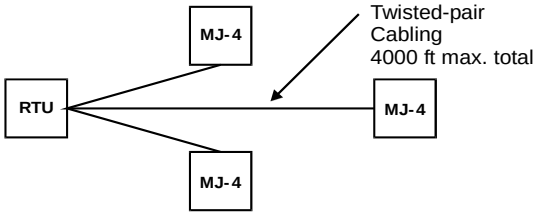


Figure 2-5 RS-485 Configuration – Star Network.

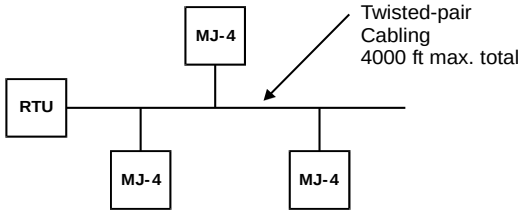


Figure 2-6 RS-485 Configuration – Open-Ended Network.

3 Communication Protocols

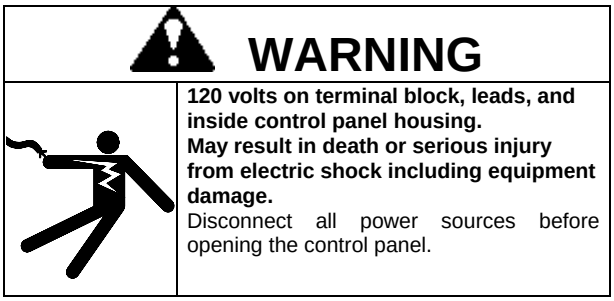
The MJ-4 Control Panel is designed to be used in a network of intelligent power control devices communicating with a supervisory device or remote terminal unit (RTU). Each device on the network has a specific communications address assigned to allow messages to be directed to and from the device. Messages are transmitted from the RTU to all devices and only the device with the specified address will respond. The MJ-4 Communications Module supports the following protocols. Refer to the documents listed for details about the protocols.

- Distributed Network Protocol (DNP 3.0). (See User's Group website: www.dnp.org)
- The Cooper 2200 Protocol (with or without address byte)
- The 2179 Protocol (Based on the PG&E Protocol)
- MJ-3A Format "A", "B1", and "B2"

4 Installing the Communications Module in MJ- 4 Control Panels

The MJ-4 Communications Module is mounted directly on the MJ-4 Main Processor Board. Follow these steps to install the communications module. Details are provided in the sections below.

1. Turn off power to the MJ-4.
2. If in a regulating device, then disconnect the polarized disconnect switch (PDS).
3. Remove the MJ-4 rear cover.
4. Install the communications module.
5. Set the communications module jumpers.
6. Remount the MJ-4 rear cover.
7. Install the communications module label.



4.1 Removing the MJ-4 Rear Cover

Turn off the power to the MJ-4 and remove the four screws holding the rear cover to the case, see Figure 4-1 below. Uncurl the cable clamp at the center of the rear cover and slide the cable out.

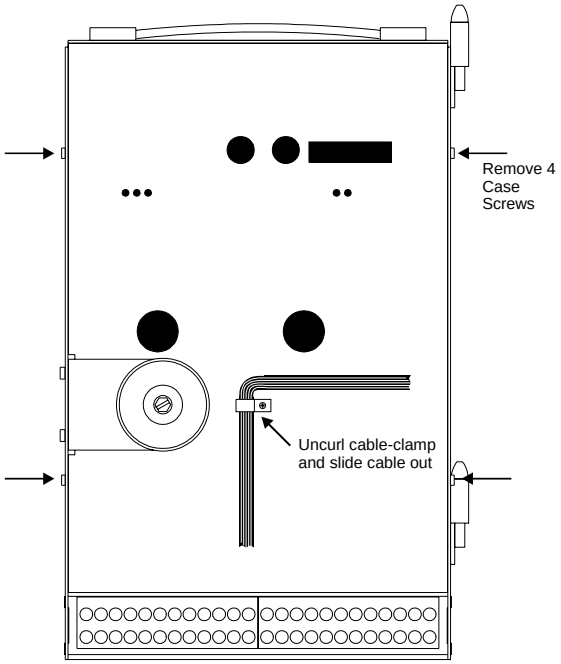


Figure 4-1 MJ-4 Rear Cover.

4.2 Mounting the Communications Module

Hold the communications module in place over the five standoffs on the main PCB and insert the 24-pin connector on the ribbon cable into the 24-pin connector (P8) on the main PCB. See Figure 4-2 below. Mount the communications module on the threaded standoffs on the main PCB using the five screws provided.

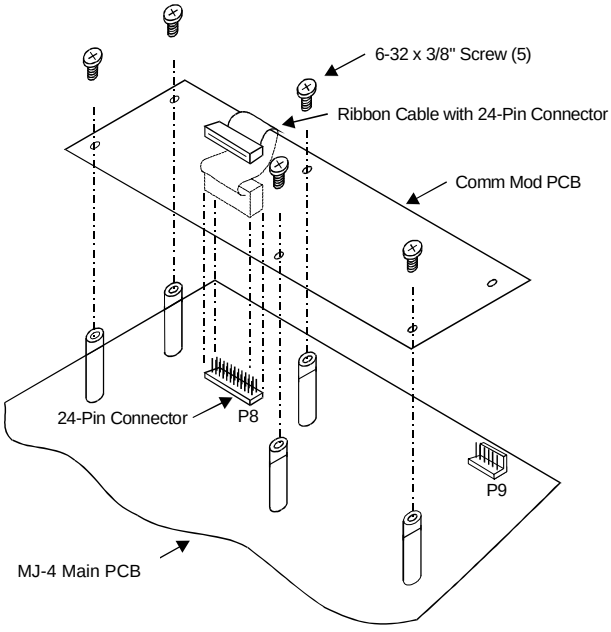


Figure 4-2 Communications Module Installation.

4.3 Setting the Communications Module Jumpers

Prior to installing the Communications Module into the MJ-4 Control Panel, ensure that the jumpers are properly installed on the printed circuit board. Jumper selections for the Fiber Optic interface and RS232/485 interface are described in separate sections below.

4.3.1 Fiber Optic Interface

The jumper locations for the fiber optic interface are shown in Figure 4-3. The view of the module is from the component side. The fiber optic receiver (RX) and transmitter (TX) are shown for reference. The jumper settings are listed in Table 4-1.

Set Auto Repeat to "No Repeat" when only one unit is installed in the network.

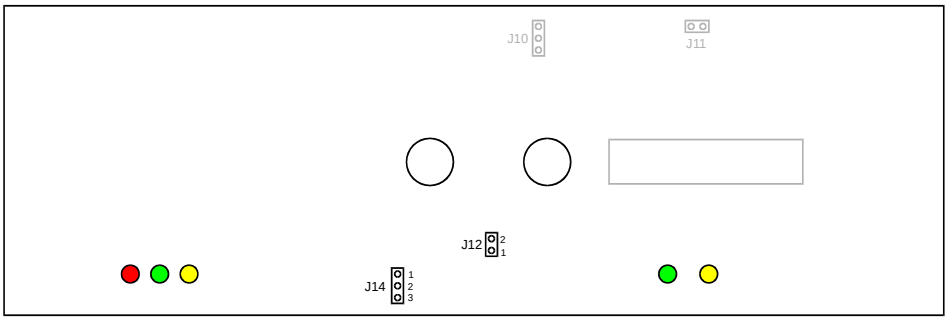


Figure 4-3 Fiber Optic Interface Jumper Locations.

Table 4-1 Fiber Optic Interface Jumper Settings

Jumper	Name	Position	Function Selected	State Description
J14	Auto Repeat	**1-2**	Auto Repeat	Repeat message from Host and any responses from other IEDs (Auto repeat for mark 0 or mark 1)
		2-3	No Repeat	Transmit continuously ON (for testing) (Force 0)
		Out	No Repeat	Only transmit a response if being addressed by Host (no jumper installed at 1-2 or 2-3) (Force 1)
J12	Range	**Out**	Normal	Set Low Power Transmitter Output
		In	Long	Set High Power Transmitter Output (See Note 2)

Note 1: Default pin settings are shown in bold text.
Note 2: If 50/125 μm cable is used, J12 must be jumpered (In).

4.3.2 RS-232/485 Interface

Figure 4-4 shows the jumper locations for the RS-232/485 interface, viewed from the component side. Jumpers and their default settings are listed in Table 4-2.

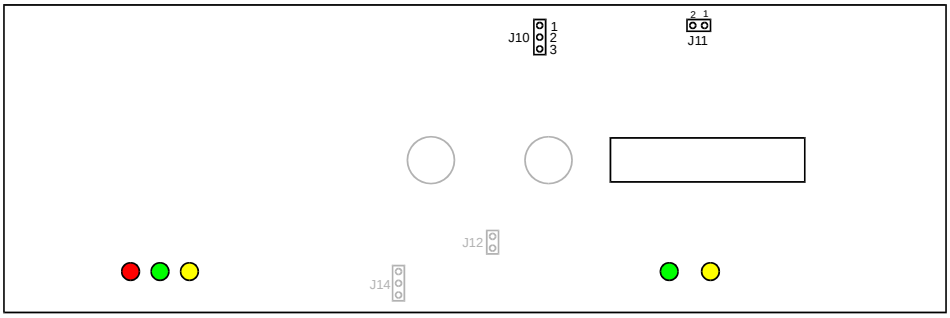


Figure 4-4 RS-232/485 Interface Jumper Locations.

In an RS-485 application, connect Signal Return (RTN) between the communication devices when there is a ground potential rise between the connected devices. When the device RTN pins are connected, jumper J11 should be Out (unless required by safety codes) to prevent ground loop currents. (If it is necessary to connect the RTN to GND after the Communications Module is installed, you can make this connection at the 8-pin terminal block connector with a wire jumper.)

Table 4-2 RS-232/485 Interface Jumper Settings

Jumper	Name	Position	Function Selected	State Description
J10	RS-485 RCV EN	1-2	Receive Enable	RS-485 receiver is always enabled
		2-3	Auto Enable	RS-485 receiver is automatically enabled by MJ-X Communications Module microprocessor control.
J11	Safety Ground Strap	**Out**	Not grounded	Signal Return not connected to frame ground
		In	Grounded	Signal Return connected to frame ground

Note: Default pin settings are shown in bold text.

The Jumpers for the Fiber Optic and RS-232/485 interfaces are specific to their operation or functionality, i.e. J14 and J12 (Fiber Optic interface Jumpers) will not affect the working of the RS-232/485 interface and J10 and J11 (RS-232/485 Jumpers will not affect the working of the Fiber Optic interface. Though the jumpers J14 & J12 and J10 & J11 may be placed in the required operational position, only one interface can be used at a time.

4.4 Replacing the MJ-4 Rear Cover

Remove the adhesive strip covering the rectangular opening for the RS-232/485 Connector, and remove the two plastic caps covering the holes for the Fiber Optic "In" and "Out" connectors. Make sure that all of the cables and wires are inside the enclosure and carefully place the rear cover over the communications module and main PCB and fasten with the four case screws. Uncurl the cable clamp and slide the cable into place.

4.5 Mounting the Communications Module Label

Remove the backing from the label and place it on the rear cover. Make sure that the holes in the label are lined up with the indicator and connector holes on the rear cover. When the label is in place, rub the label to secure it in position. The rear cover with labels installed is shown in Figures 4-5 below.

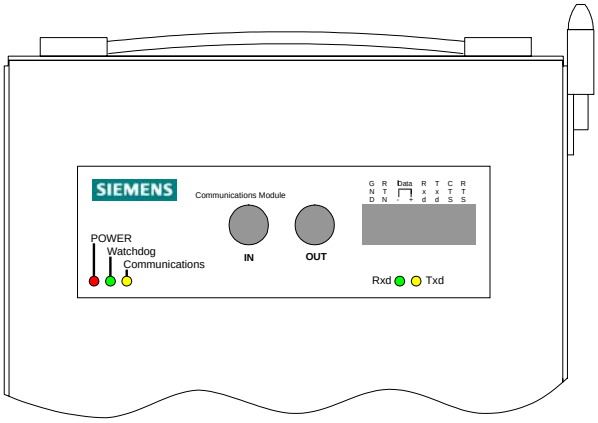


Figure 4-5 MJ-4 with MJ-4 Communications Module Label Installed.

5 Installing the Communications Module in MJ-X Control Panels

The MJ-4 Communications Module is installed in the Accessory Section on the back of the MJ-X Control Panel. Before installing the communications module, set the jumpers on the communications module printed circuit board for proper operation. Install the communications module in the MJ-X, connect the cables, and test the unit. Once these tasks have been performed the system is ready for operation. The following sections describe how to set the jumpers and install the communications module.

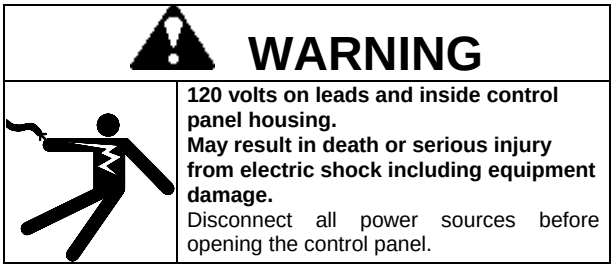
5.1 Setting the Communications Module Jumpers

Prior to installing the Communications Module into the MJ-X Control Panel, ensure that the jumpers are properly installed on the printed circuit board. Jumper selections for the Fiber Optic interface and RS232/485 interface are described in Section 4.3.1 and Section 4.3.2 respectively.

5.2 Mounting the Communications Module in MJ-X Control Panels

Follow these steps to install the communications module in the MJ-X Control Panel.

1. If the control panel is installed on a Siemens regulating device, first turn off the power to the MJ-X, then disconnect the polarized disconnect switch (PDS) terminal block and remove the control panel from the control box.



2. Loosen the PDS cable strain relief on the rear cover and rotate the strain relief plate to the open position, Figure 5-1.

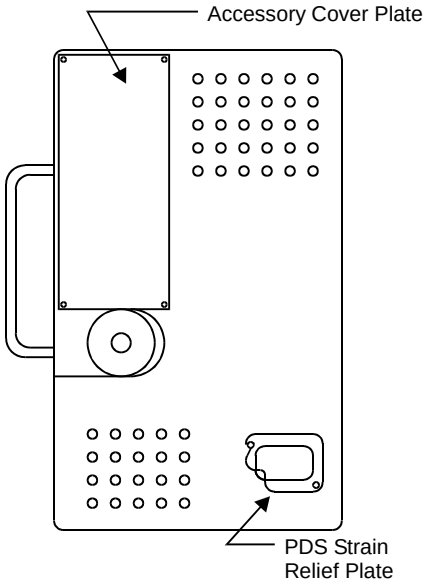


Figure 5-1 MJ-X Control Panel Rear Cover.

3. Remove the six screws on the side of the rear cover that hold it to the control panel.

4. Feed the PDS cable harness through the strain relief cutout while removing the rear cover.
5. Remove the accessory cover plate from the rear cover. Discard the accessory cover plate and mounting hardware. If an Expansion Rack is installed in the accessory area, remove the rack and discard.
6. Mount the communications module printed circuit board to the MJ-X base with six 6-32 x 7/16” standoffs, Figure 5-2. Ensure that the membrane switch cable is folded over itself and under the communications module printed circuit board as shown in Figure 5-3.

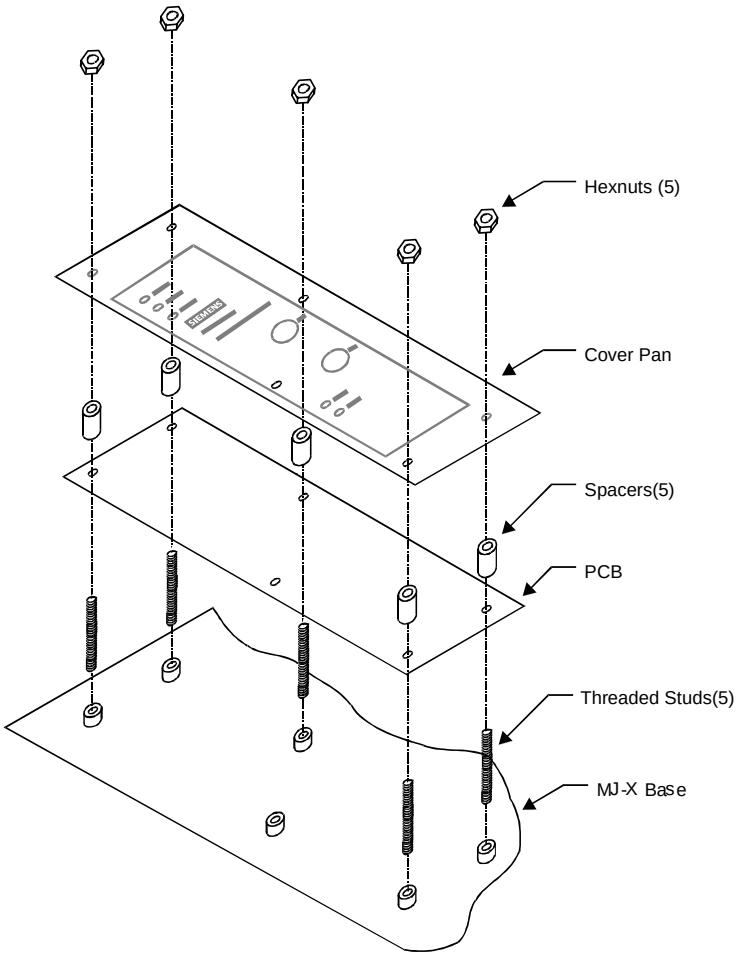


Figure 5-2 Communications Module Installation in MJ-X.

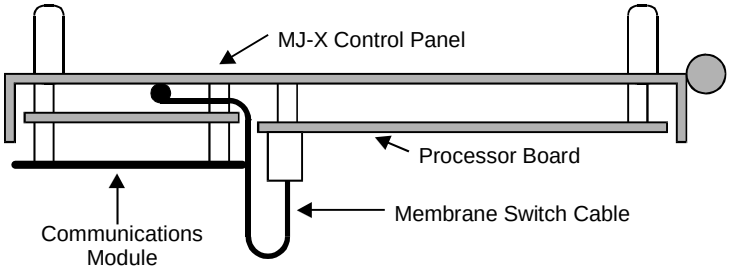


Figure 5-3 Membrane Switch Cable Routing (top down view).

7. Mount the communications module pan cover (if provided) with six 6-32 x 3/8” screws as shown in Figure 5-2.
8. Plug the ribbon connector into J105 on the MJ-X Processor Board as shown in Figure 5-4.

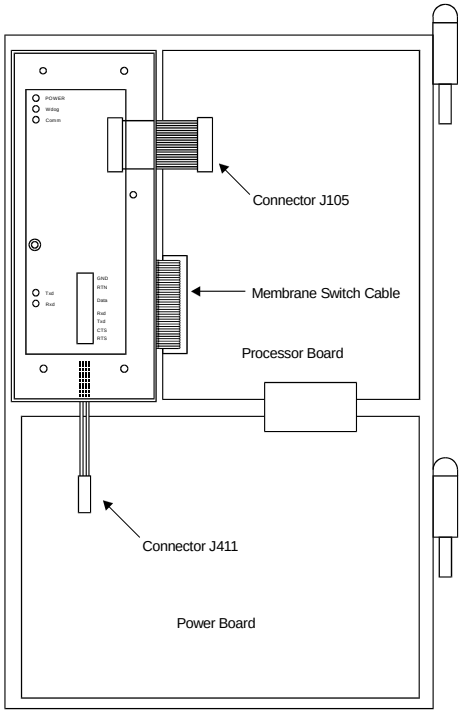


Figure 5-4 MJ-X Communications Module Cable Routing.

9. Feed the PDS cable through the PDS strain relief opening in the rear cover.
10. Reinstall the rear cover of the control panel, attaching it using the six screws.
11. Rotate the PDS strain relief plate to the closed position and tighten the screws for the strain relief plate.
12. Follow the procedure in section 6 to test the communications module.

6 Verifying the Communications Module Installation

Once the MJ-4 Communications Module is installed in the MJ-4 control panel, test the module as follows to ensure proper operation and performance.

1. Visually inspect the MJ-4 Communications Module for proper mechanical assembly and cable connections.
2. Apply power to the MJ-4 Control Panel and observe the LEDs on the communications module. The Power LED should light immediately and stay lit. After 10 to 15 seconds, the Watchdog LED should start flashing without a long pause between flashes, that is, about twice per second.

   If this does not occur, check for the following:

   - The MJ-4 Control Panel is receiving power. Check that the front panel display is active.
   - The communications module is installed properly. Connections between the MJ-4 and the Communications Module are correct. Disassemble, inspect, and reassemble the unit as required.
3. After verifying that the communications module is receiving power, perform the diagnostic tests described in Section 6.1 and 6.2.

6.1 Performing the Initial Diagnostic Checkout

Prior to performing these tests, become familiar with operating and configuring the MJ-4 Control Panel. See the *MJ-4A & MJ-4B Voltage Regulator Control Panel Installation and Operations Manual* (Siemens manual no. 21-115527-023).

1. On the MJ-4 Control Panel, under the < DIAGNOSTICS > menu, go to the "CM Test?:" screen.
2. Press the Change key and toggle from "OFF" to "INTERN," and then press the Save key. (If the password is requested, enter the password as described in the note below and proceed.) The "CM Test:?" screen should display "INTERN" for several seconds before changing to "OFF." If the display does not change to "OFF," then check the physical installation of the communications module before proceeding.

   Note: When you try to change the "CM Test?:" value, the MJ-4 Control Panel may request that the password be entered. If the default passwords are in effect, then the password for the Diagnostics menu is "3333." For more information refer to the MJ-4A & MJ-4B Installation and Operations Manual.
3. Once the "CM Test?:" screen value has returned to "OFF," press the down arrow key to display the next data item, "CM TestStat." This screen indicates the status of the Communications Module test. The possible test value results are shown below. **A value of xxx2 (where x may be 0-9 or a-f), indicates that the test passed.** A value of xxx0 or xxx1indicates a failure. (Note that in firmware versions of 2.xx (e.g., 2.13, 2.44, etc) xxx3 indicates the test passed and xxx2 indicates an internal problem.)

   - **xxx0** indicates the test did not run at all. Run the test again, allowing extra time for the communications module to power up. This should take about 15 seconds. The Watchdog LED will blink after the module successfully completes self test and initialization.
   - **xxx1** indicates an internal problem with the MJ-4 Communications Module. Contact Siemens for assistance.

6.2 Performing the Loopback Diagnostic Test

The loopback test evaluates the MJ-4 for communications readiness. For this test, connect the transmit output to the receive input of the communications module. When testing the fiber optic interface, ensure that the cable used meets the requirements outlined in section 7.1. When testing the RS-232/485 interface, only the RS-232 portion of the circuit can be tested by connecting a wire from the transmit pin (Txd) to the receive pin (Rxd) of the screw terminal block connector.

1. To Perform the Loopback Test on the Fiber Optic Interface, ensure that the Jumper J14 is in the 1-2 position.
2. Scroll to the "CM Test?:" data item in the <DIAGNOSTICS> menu on the MJ-4 Control Panel display.
3. Press the Change key, then the up arrow key to select "LOOPBK." If the password is requested, enter the password and proceed.
4. Press the Save key. "LOOPBK" will display for several seconds before changing automatically to "OFF." If this does not occur, then recheck the physical installation of the communications module and retry.
5. Once the "CM Test?:" screen displays "OFF," press the down arrow key to display the "CM TestStat" data item. This screen gives the status of the communications module test. **A value of xxx6 (where x may be 0-9 or a-f), indicates that the loopback test passed.** A value of xxx0 – xxx5 indicates a failure. (Note that in firmware versions of 2.xx (e.g., 2.13, 2.44, etc) xxx7 indicates the test passed, xxx3 indicates failure, and xxx6 is a communication problem.)

   - **xxx0** indicates the test did not run at all. Run the test again, allowing extra time for the communications module to power up. This should take about 15 seconds. The Watchdog LED will blink after the module successfully completes self test and initialization.
   - **xxx1** indicates an internal problem with the MJ-4 Communications Module. Contact Siemens for assistance.
   - **xxx2** indicates the loopback test failed. Check the loopback connectors and repeat the test.

- **xxx3**, **xxx4**, or **xxx5** indicate a communication problem. Contact Siemens for assistance.

7 Cabling the Communications Module to the Power System

Connect the communications modules using the recommended cable as described in sections 7.1 to 7.3 below. The following sections provide some general guidelines for cable selection and explain the different cable parameters. Make connections between the device and the communications unit with the appropriate connector.

Typically, RS-485 requires custom wiring to the other devices. Consult the device's pin assignments to determine the applicable connections. Typically, a DB-9 or DB-25 will be needed for making RS-232 connections to the RTU, personal computer, or other device. Use the supplied Phoenix Contact Screw Terminal Block (MSTBT 2, 5/8-ST-5, 08) for connections to the RS-232/485 interface. Use an ST optical connector when making connections to the fiber optic interface.

Though the cabling for the Fiber Optic and the RS-232-/485 interfaces may be done and either interface may be made available for communication, only one of the interfaces may be used at a time.

7.1 Fiber Optic Cable Type

The recommended cable is 62.5/125 μm diameter fiber optic cable with a maximum attenuation of 5dB/km at a wavelength of 820-850 nm. If this is not available use 50/125 μm diameter glass cable, but only for cable lengths less than 1500 feet. Use of 50/125 μm diameter cable requires that the range jumper J12 be set for long range. This will provide protection against under driving the receiver. When using 50/125 μm cable, install the long range jumper (J12) even for very short cable lengths.

A 100/140 μm diameter cable can also be used for cable lengths less than 1500 feet. Use of this cable requires that the range jumper J12 be set to normal. This setting will provide protection against overdriving the receiver.

Plastic cable is not recommended due to the coupling efficiency of the cable, which at short lengths will overload the optical receiver. In addition, the large cable attenuation normally associated with plastic cable limits the useful link lengths to a fraction of that achievable with glass cable.

7.1.1 Fiber Optic Cable Lengths

Calculate cable length by determining the output power of the transmitter (P_{TX}) and the input receive level (Peak Input Power Logic Level Low Receiver Sensitivity, P_{RX}). The difference between the two numbers is the optical power budget (P_B').

$$P_B' = P_{TX} - P_{RX}$$

For example, if transmitter output power is -16 dBm and the input receive level is -24 dBm, the optical power budget is then 8 dBm. Subtract from this value the fixed losses (i.e. connector losses, splice losses, P_{Loss}) to obtain the real power budget (P_B).

$$P_B = P_B' - P_{Loss}$$

Divide the result by the cable attenuation (Att) in dB/km to arrive at the maximum cable length. Note that the transmitter output power data given in the specifications already includes connector loss when using precision ceramic ST connectors.

$$\text{Length} = P_B / \text{Att}$$

7.1.2 Fiber Optic Connector

The fiber optic cables (or "patch cords") used with the MJ-4 Fiber Optic Communications Module must be terminated with ST style connectors and have a numerical aperture of 0.275 ± 0.015.

(If pre-terminated cables are not used, follow the instructions supplied by the manufacturer to attach the connector to the fiber cable using the cable type recommended in section 7.1.)

7.1.3 Fiber Optic Connections

When making connections to the transmitter and receiver inputs/outputs, ensure that the transmit output from one device is connected to the receive input of the next device. Figure 7-1 shows how to insert the connector. The tip of the cable on the ST connector must be clean and free of dust. Dust on the tip of the cable will cause signal attenuation.

Use care when handling the fiber optic connector, especially the exposed ceramic ferrule.

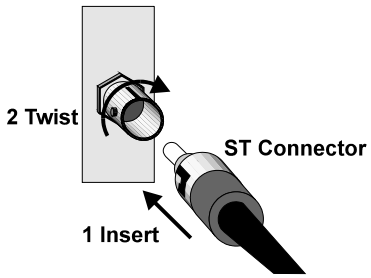


Figure 7-1 Fiber Optic Connections

7.2 RS-485 Twisted-pair Cable

The following sections provide the information necessary to select and install cable between an MJ-4 Control Panel, RTU, and other field devices in an RS-485 network.

7.2.1 RS-485 Cable Type

Listed in Table 7-1 are the cable characteristics necessary for proper electrical performance in an RS-485 communications network. Use cable with a shield that provides 100 percent RFI/EMI coverage.

Table 7-1 RS-485 Cable Specifications

Characteristic	Value	Maximum/Typical
Impedance	120 ohms	Typical
Capacitance (pF/ft)	35	Maximum
Cable Size	22 AWG	Typical
DC Resistance	17 ohms/1000 ft	Maximum
Velocity of Propagation	80%	Maximum

7.2.2 RS-485 Cable Grounding

Ground the cable shield for all devices on the network. Ground the cable shield at only one end to prevent induced interference that may result from circulating ground currents. If a cable shield is grounded at both ends, a ground loop can exist between the components. This ground loop can cause induced interferences that result in signal distortion. If there is a ground potential rise between the connected devices, connect the Signal Return (RTN) between the communication devices. Figure 7-2 illustrates the preferred field device connection method. See section 4.3.2 for jumper considerations.

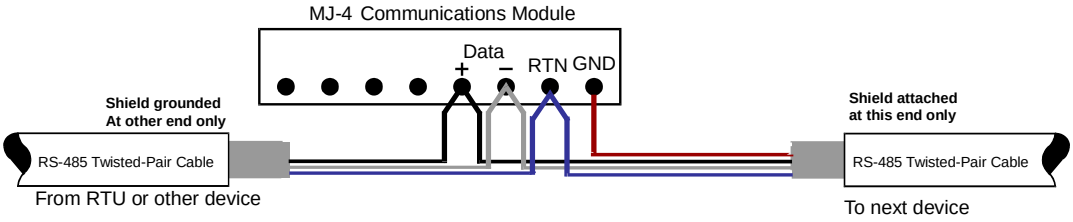


Figure 7-2 RS-485 Connection

7.2.3 RS-485 Connector

The required connector for connecting to the MJ-4 RS-232/485 Interface is the Weidmuller Contact Screw Terminal Block BLT 5.08/8/180 or equivalent. Wire the connector as shown in Figure 7-2. This connector is supplied with the communications module and is shown in Figure 7-3.

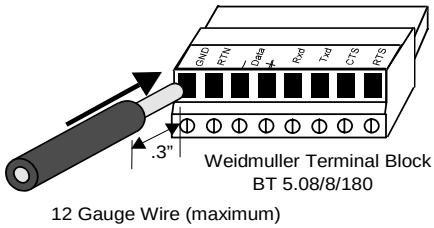


Figure 7-3 Screw Terminal Block Connector

7.2.4 RS-485 Cabling Considerations

The cable used for connecting the Communications Module to other communication devices is a twisted pair of insulated conductors. The pair is twisted to minimize pickup of random signals between the conductors, particularly those signals induced by electromagnetic interference (EMI).

To further protect against external electrical interference, the pair is shielded by a grounded outer covering. The shield conducts radio frequency interference (RFI) to the ground, thus reducing its effect on the twisted pair. Concern over RFI and EMI is important given the high electrical current and electrically noisy environment through which the communication wires are routed.

Follow the rules below to properly install the RS-485 cables.

1. Connect all field devices in a loop technology so that all devices are connected to the master in case of a line break. The basic loop topology is shown below.

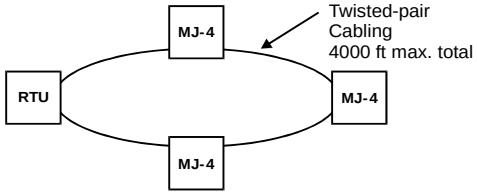


Figure 7-4 RS-485 Loop Topology

   One of the advantages of the loop topology is that if a line is cut, communication is not interrupted. By completing the loop in the RS-485 cable, one break can be made anywhere in the line without compromising communication with the master device (RTU). To maintain redundancy, avoid open ended runs of the bus.

   Each installation method (see Figures 2-4 to 2-6) has advantages and disadvantages. The loop method requires more cable than does the single-ended run method. This extra cable is needed to run from the last device on the run to the master device (RTU). The additional cable adds expense and shortens the total distance the farthest device can be located from the master device. The advantage of the loop method is in the ability to communicate with all devices when there is a break in the loop.

   The single-ended run allows larger distances between the master device and the farthest slave device, but it does not allow the master device to communicate with devices on the far side of a break. This method also requires the use of terminating resistors.

2. A maximum of 32 devices may be connected in a single RS-485 bus with a total cable run no longer than 4000 feet.

3. Always ground the shield at only one end of a cable segment. For all devices, ground the cable shield at one end only to prevent induced interference that may result from circulating ground currents. If a cable's shield is grounded at both ends, a ground lop can exist between the components. This ground loop can result in induced interference that causes signal distortion. Figure 7-2 shows the proper method for terminating the shield at the Communications Module connector.

4. When the Communications Module is mounted in the MJ-4 Control Panel, it is grounded internally through the MJ-4 to the equipment ground. A separate connection to the equipment ground is not required.

5. The recommended twisted-pair cable for an RS-485 bus has a characteristic impedance of 120 ohms. Any change in the type of cable, or an open-ended length of cable, creates a discontinuity in the impedance and causes a reflection. Placing resistors that match the characteristic impedance of the cable at the open end of a twisted-pair stub eliminates reflection.

   For long, single-ended runs (over 1000 Forwarding ft.), you may need to install a 120 ohm terminating resistor between the data (+) and (-) terminals of the farthest device from the RTU or master end. Adding the terminating resistor is not an absolute requirement, but using it minimizes reflected interference on the communication cable.

6. Do not route signal cabling parallel to power conductors. Wherever possible, place the communication cable perpendicular to the power conductor as shown below. Power conductors are any cables or bus conductors carrying currents greater than 20 amperes.

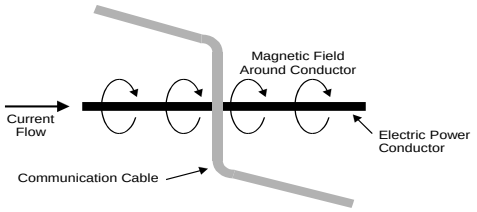


Figure 7-5 Communication Cable Routing

   Electrical current flowing through a conductor forms a magnetic field around the wire as shown above. Interference is coupled into the wires in the cable through electromagnetic fields. Just as current through a wire causes a magnetic field to form around it, a magnetic field can cause current to flow in a wire. This induction of current is a function of the geometry or orientation of the wires. If the communication cable is at a right angle with the power conductor, it is aligned with the direction of the magnetic field and no current is induced.

7. Follow these guidelines when you route communications cables between electrical equipment:

   - Run communications cables in the same cable raceways (cable routes, cable trays, or cable gutters) as unshielded digital and analog signal cables up to 60 V.
   - Run communications cables in the same cable raceway with shielded signal and supply cables up to 230 V.
   - Run communications cables 4 inches away from unshielded signal and supply cables of up to 230 V.
   - Run cables with voltages greater than 230 V in separate ducts (routes, conduits).

7.3 RS-232 Connections

The following section describes the connection requirements for RS-232 cable. This cable will allow you to connect the MJ-4 Control Panel to an RTU or personal computer.

Five of the standard RS-232 wires are used for this application.

- Signal Return (RTN)
- RXD
- TXD
- CTS
- RTS

Table 7-2 lists the connections that must be made to connect the RS232/485 interface to a personal computer, RTU, or other supervisory device. The MJ-4 Communications Module defaults to no-handshaking-required mode. However, the communications module asserts RTS while it transmits data, but the module will ignore the CTS input signal.

Table 7-2 RS-232 Intelligent Electronic Device Wiring

MJ-4 RS-232/485 Communications Interface	Personal computer, supervisory device, or other network device
RTN	Signal Ground
RXD	TXD
TXD	RXD

Table 7-3 lists the connections that must be made to connect the RS232/485 interface to a modem.

Table 7-3 Modem Wiring

MJ-4 RS-232/485 Communications Interface	Modem
RTN	Signal Return
RXD	RXD
TXD	TXD
RTS	RTS
CTS	CTS

"RXD" is an input for Data Terminal Equipment (DTE) and an output for Data Communications Equipment (DCE). "TXD" is an output for the DTE and an input for the DCE. Personal computer serial ports are configured as DTE and the modems are configured as DCE. The communications module RS-232 connections implement DTE.

7.3.1 RS-232 Multi-drop Wiring

Multi-drop configurations require that the respective pins of the DTE devices be connected in parallel, Figure 7-6. The standard pin assignments for RS-232 connectors are shown in Figure 7-7.

Note: For Figure 7-6, the RTU port is wired as "DTE". When networking devices together, make sure the RTU "data out" connects to the communications module Rxd, and the RTU "data in" connects to the communications module Txd.

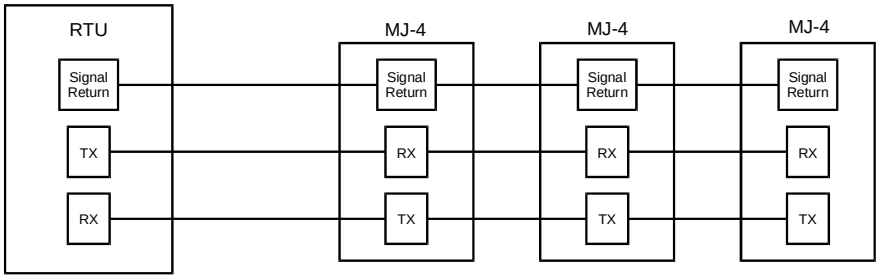
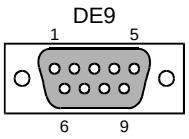
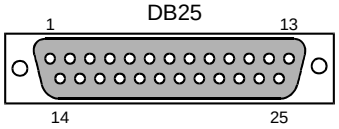


Figure 7-6 RS-232 Multi-drop Configuration



Pin	Signal
1	DCD
2	Rxd
3	Txd
4	DTR
5	Ground (Signal)
6	DSR
7	RTS
8	CTS
9	RI
*	Shell (Frame Ground)



* For Shielded Cable Connectors

Pin	Signal
1	Ground (Frame)
2	Txd
3	Rxd
4	RTS
5	CTS
6	DSR
7	Ground (Signal)
8	DCD
20	DTR
22	RI
*	Shell (Frame Ground)

Figure 7-7 RS-232 Connector Pinout

7.4 RS-232/485 Connections

The screw terminal block connector is keyed for proper insertion. Figure 7-8 shows the proper connector orientation. Align the keys and insert the connector to interface to the RS-232/485 interface.

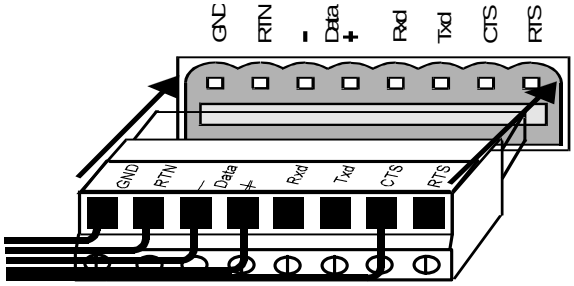


Figure 7-8 Screw Terminal Connection

7.5 Communications Module Configuration

Prior to using the MJ-4 Communications Module in the network, the communications module needs to be configured properly for communications. The < COMMUNICATIONS > menu of the MJ-4 Control Panel provides all the required communications configuration items for the communications module. Table 7-4 lists the communications menu items in the order in which they appear on the MJ-4 Control Panel; default settings are in bold.

1. Program the communications parameters of the MJ-4 Communications Module by pressing the Menu key twice to display the < METER > menu.
2. Then press the left arrow key until the < COMMUNICATIONS > menu appears. Use the up and down arrow keys to access the individual menu items.
3. To change the value of the parameter, press the Change key, and then use the arrow keys to toggle the choices or set the value for the parameter. Press the Save key after changing the value of a menu item to enter the changes, or press the Cancel Reset key to cancel the change.

Each time a configuration menu item is changed, the communications module is reset by the main MJ-4 Control Panel. This reset is part of the process of updating the communications module with the new configuration.

Table 7-4 Communications Menu Items

Menu Item	Description	Selections
Data Stat = XXXXX	Data Port status	Not Applicable (This is a Status Item)
DatPortBaud	Data Port baud (in bits/second)	300, 1200, 2400, 4800, **9600**, 19200
Data Parity	Data Port parity	None, **Even**
DataPortAddr	Data Port address enable	**OFF**, ON
Reg Id	Regulator Identification	**0** - 32,766

Protocol	Communications Module protocol	**DNP3.0**, 2200, 2200NOA, MJ3A A, MJ3A B1, MJ3A B2, 2179, 2179 MJ-X, 2179 5A, SPECIAL
Comm Baud	Communications Module baud (transmission rate)	300, 1200, 2400, 4800, **9600**, 19200
Comm Parity	Communications Module parity	**None**, Odd, Even
Comm Addr	Communications Module address	**0** – 65,535
Resync Time	Communications Module resync time (in characters)	**0**-250
Tx En Delay	Communications Module Transmit Enable Delay (in milliseconds)	**0**-250
DNP dl Confirm	Confirm DNP Data Link	**No**, Yes
CM SW Repeat En	Enable software auto-repeat in Comm Module	**No**, Yes
Host Addr	Host Address of RTU for unsolicited responses	**0** – 65,535
CM Unsolicited	Comm Module can send unsolicited response	**No**, Yes
AutoInhEnRemRL	Require Auto Inhibit to be active before a remote raise or lower request is acknowledged	**No**, Yes
DNPset	Choose to set up your own DNP points or use a preconfigured set	**DNPcfg**, 2.x4, 2.x3, small2.x3, Simple, Metering, Active, set7, set8, set9, set10, set11, set12, set13, set14, set15
CM Vers	Communications Module software version	X.XX

7.5.1 Communications Menu Item Descriptions

Data Stat, DatPortBaud, Data Parity, and DataPortAddr

These menu items apply only to the Data Port located on the front of the MJ-4 Control Panel, and do not require modification.

Reg Id *(Regulator Identification)*

This item allows you to uniquely identify each regulator in the system. The Regulator Id is accessible as a data item via the communications module for most of the protocol selections.

Protocol

This item defines the protocol selection for the MJ-4 Communications Module. The selections are listed in Table 7-4.

2200NOA is a variation of the 2200 protocol with the address field suppressed. It is provided for testing the MJ-4 Communications Module with the MJXplorer™ software. The SPECIAL item allows a new protocol handler to be included in the Communications Module code without forcing a modification to the Main Processor code (for the protocol selection front panel screen).

Comm Baud

This menu item defines the data rate for the MJ-4 Communications Module. The standard asynchronous communications data rates are available for selection. For proper communications, the Comm Baud setting must match the baud setting of the other communicating device(s) in the network.

Comm Parity

This configuration item defines the parity selection for the communications module. For proper communications, the Comm Parity setting must match the parity setting of the other communicating device(s) in the system.

This parity selection will override any default or inherent parity defined in the selected protocol. [For example, the 2200 protocol specification document defines the parity as even. The Comm Parity configuration item allows even parity to be selected, but it also permits the system designer/installer to use an alternate parity selection if desired.]

Comm Address

This configuration item defines the communications address for the communications module. Each device connected on the communications link must have a unique communications address. The Comm Address setting must correspond with the address programmed into the RTU or other supervisory device so that it can request information from and write data to a particular MJ-4 Control Panel.

Resync Time

This configuration item defines the Communications Module resync time (in characters). This item is used for Communications Module protocols 2200 and 2179 to determine when one message ends and another message begins. If a new character is not received within the period specified by this parameter, the control panel assumes that the next received character is the start of a new message.

Tx En Delay

This configuration item defines the Communications Module Transmit Enable Delay (in milliseconds), specifies the amount of time between the RTS output being activated and the start of transmit (output) data.

DNP dl Confirm

This configuration item defines whether or not to request confirmation from the master station for all responses for the DNP3.0 protocol

CM SW RepeatEn

This configuration item controls whether software repeat is used for the MJ3A A, B1, and B2 protocols.

Host Addr

This configuration item defines the communications address for the RTU or other supervisory device to which unsolicited responses are sent.

CM Unsolicited

This configuration item defines whether or not the communications module should send unsolicited responses. Note that if this parameter is “Y”, an “enable unsolicited responses” message must also be sent from the master station to start them.

AutoInhEnRemRL

This configuration item controls whether the auto inhibit must be active before a remote raise or lower request will be followed. Setting “Y” prevents accidental fighting against the automatic tap changes with remote commands.

DNPset

This configuration item selects what DNP points will be used. Choose “DNPcfg” to configure your own points with the DNP Configure program or choose from the preconfigured DNP point sets. See Section 8.

7.6 Troubleshooting Communications Problems

This section explains how to troubleshoot the MJ-4 Communications Module using the front panel LED indicators and the MJXplorer software. The MJXplorer software allows you to access the communications module parameters via the MJ-4 Control Panel.

7.6.1 Using LEDs to Help Diagnose Communications Problems

The communications module's Txd and Rxd LEDs can be useful indicators to help isolate system communications problems. The LEDs are directly activated by the transmit and receive signals and provide an immediate indication of line activity. If the Rxd LED is not illuminated, then no receive signal activity is being detected at the communications module Terminal Block connector.

If the Txd LED is not illuminated but the Rxd LED is illuminated, then the communications module is not responding to communication attempts. This may occur for a variety of reasons, including: 1) the communications module and/or MJ-4 Control Panel has not been configured properly, and 2) the unit is not being addressed.

If the Comm LED is not illuminated, then the communications module is not being addressed.

If the Rxd LED is illuminated but the Comm LED is not illuminated, this indicates that the module is receiving the transmission but does not detect its address in the message. Recheck the communications address, because it may not be set properly.

Verify that the MJ-4 communications configuration items have been set to match the system settings. (See section 7.5, *Communications Module Configuration*.)

7.6.2 Using MJXplorer to Troubleshoot Communications Problems

The MJXplorer software is a menu-driven application program that allows interfacing to the MJ-4 Communications Module. Up to three MJ-4 units may be connected at a time. When connecting the Fiber Optic interface to MJXplorer, the auto repeat function must match the setting in the Configure→Configure MJXplorer menu. See section 4.3.1 for setting the Fiber Optic interface jumpers.

A Fiber Optic to RS-232 driver/receiver is required in order to perform these tests on the fiber optic interface. The driver/receiver is an optical to electrical signal converter with an ST connector interface and an RS-232 interface. Connect the optical side to the fiber optic interface via ST fiber optic patch cords. Connect the RS-232 interface to the personal computer, Figure 7-9.

Use MJXplorer to help pinpoint communications problems in a system. MJXplorer permits testing of the MJ-4 communications functions independent of other system components.

Once the physical connections are complete, from the MJ-4 front panel select the "2200NOA" protocol for connecting to only one panel or select "2200" protocol and set comm addresses for connections to multiple panels. In addition, match the Comm Parity and Comm Baud with the MJXplorer settings. Use MJXplorer to verify that data can be retrieved from as well as written to the MJ-4 Control Panel.

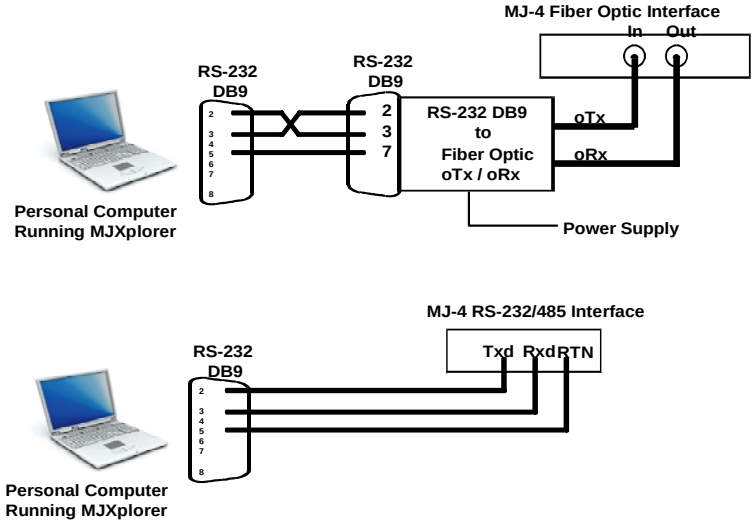


Figure 7-9 MJXplorer Troubleshooting Connections

8 Setting the DNP points

This section describes how to set the DNP points that will be used on the control panel, You can use the DNP Configure program to customize your DNP point set or you can use one of the predefined point sets listed in section 8.2.

In order to use a customized point set, an MJ-X^L must have version 3.06 and the MJ-X must have 2.52. In order to use predefined point sets (except Set 7), an MJ-X^L must have version 3.07 and a MJ-X must have 2.53. Set 7 is only available on the MJ-4 Control.

It is recommended that a Latching Relay command be used for all Binary Outputs (e.g., remote raise/lower, auto inhibit, etc.).

8.1 Using the DNP Configure program for a custom DNP point set

The DNP Configure program is used to place a custom set of user-defined DNP points on the control panel. You can obtain this program free-of-charge from your Siemens representative. After installing the program, run it and follow the steps below to set your DNP points.

1. Connect your computer's com port to the panel's Data Port with a "straight-thru" male-female DB9 cable.
2. If you already have a DNP points profile, open it and go to Step 8. To open an existing points profile, in the menu bar: click File → Open and select your file. Otherwise go to Step 3 to create a points profile.
3. Click the Class 0 button. Move between the tabs and checkmark the points you want. Click OK.
4. If Class 1, 2, or 3 polls are desired, these can now be set the same way.
5. Click the Send button. Drag and drop the points up and down in the list boxes to change their point number if desired. The top point in each box is point # 0, the point below that is point # 1, etc. Click the Cancel button after points are ordered as desired.
6. In the menu bar: click File → Save and save your file as XXXX.dnp
7. Click the Setting button.
8. Match the baud rate and parity between the computer and the panel. Choose the COM port your computer is using. Set Addressing to be Disabled (if MJ-4's "DataPortAddr" setting is OFF). Click OK.
9. Click the Send button.
10. Click the Send button on the bottom of the points list screen.
11. If successful, a window will pop up displaying "Send Communication Status: OK…" Click OK.
12. DNP Configure can be closed or you can use the same point set to configure other panels.

8.2 Selecting a predefined DNP point set

8.2.1 DNP point set for MJ-4A or MJ-4B

When the MJ-4 Communications Module with firmware version 3.10 (initial release) or higher is interfaced with a MJ-4A or MJ-4B, you will be able to choose from a number of DNP point sets, including Set 7. Sets 8 through 15 are not defined at this time.

8.2.2 DNP Point set for other Control Panels

The MJ-4 Communications Module may be used with the MJ-X^L or MJ-X control panels, but the DNP sets available may be limited. The operation and functionality of the MJ-4 Communications Module is similar to older versions of the Communications Module though either the Fiber Optic or the RS-232/485 interfaces may be used at a time. If the control panel is an MJ-X^L with firmware version 3.07 or higher (or an MJ-X with version 2.53 or

higher) and the Communications Module has firmware 3.07 or higher, you will be able to use predefined DNP point sets. Go to the <COMMUNICATIONS> menu and scroll to "DNPset." The complete list of points for each set is listed below. Two of the most popular point sets are 2.x4 set and 2.x3 set. 2.x4 is backwards compatible with versions 2.04, 2.14, 2.44, etc. Likewise, 2.x3 is backwards compatible with 2.03, 2.13, 2.43, etc. For more information about the DNP3.0 Level 2 implementation, please contact your Siemens representative.

8.2.3 2.x4

Binary Inputs

Point #	Description
0	Tap Pos Known
1	Power Flow Direction
2	Auto Inhibit Status
3	Remote Control occurring
4	Neutral (U12) Signal
5	VRC1 contacts
6	VRC2 contacts
7	Remote Switch position
8	Manual Switch position

Binary Outputs

Point #	Description
0	Tap Raise
1	Tap Lower
2	Auto Inhibit (Latch On/Off)

Analog Inputs

Point #	Description
0	R/A/M switch position
1	Power Flow Direction Indicator
2	VRC contacts status
3	Tap Position
4	Load Current
5	Load Voltage
6	KW
7	Power Factor
8	KW Fwd Dmd
9	KW Rev Dmd
10	Vld Total Harm Distortion %
11	Ild Total Harm Distortion %
12	Vs Total Harm Distortion %
13	VRC Status
14	VLC Status
15	Band Status Indicators
16	Tap Control Mode
17	Op Count Last Month
18	Op Count Last 24 hrs
19	Op Count Last 30 days
20	Op Count Month-to-Date
21	Load Voltage Inst Fwd Min
22	Load Voltage Inst Fwd Max
23	Load Voltage Inst Rev Min
24	Load Voltage Inst Rev Max
25	Tap Position Min
26	Tap Position Max

Analog Outputs

Point #	Description
0	Upper Voltage Limit

1	Lower Voltage Limit
2	Local Voltage Reduction %
3	VRC Stage1
4	VRC Stage2
5	VRC Stage3
6	Auto VRC1 %I
7	Auto VRC2 %I
8	Auto VRC set1
9	Auto VRC set2
10	Rev Bandwidth Setting
11	Rev Reactive Compensation
12	Rev Resistive Compensation
13	Rev Voltage Level
14	Rev Time Delay
15	Fwd Bandwidth Setting
16	Fwd Reactive Compensation
17	Fwd Resistive Compensation
18	Fwd Voltage Level
19	Fwd Time Delay
20	Voltage Limit Control Enable
21	Voltage Reduction Control Mode
22	Log Setup
23	Alert Status part 1
24	Alert Status part 2

8.2.4 Small 2.x3

Binary Inputs

Point #	Description
0	Tap Pos Known
1	Power Flow Direction
2	Auto Inhibit Status
3	Raise (J) Motor Signal
4	Lower (K) Motor Signal
5	Remote Control occurring
6	U2/P2 Switch Position
7	Neutral (U12) Signal
8	Operations Count (U10) Signal
9	Auto Inhibit Terminal Block Input
10	VRC1 contacts
11	VRC2 contacts
12	Remote Switch position
13	Manual Switch position
14	Auto Inhibit Out Status

Binary Outputs

Point #	Description
0	Tap Raise
1	Tap Lower
2	Auto Inhibit (Latch On/Off)

Analog Inputs

Point #	Description
0	Op Count Last Year
1	N/A
2	R/A/M switch position
3	Power Flow Direction Indicator
4	VRC contacts status

5	Band, VRC, VLC status
6	Tap Position
7	Load Current
8	Load Voltage
9	Load Voltage (primary)
10	Source Voltage
11	Source Voltage (primary)
12	KVA
13	KVAR
14	KW
15	Power Factor

Analog Outputs

Point #	Description
0	Op Count Total

8.2.5 Simple

Binary Inputs

Point #	Description
0	Auto Inhibit Status
1	Remote Switch position
2	Manual Switch position

Binary Outputs

Point #	Description
0	Tap Raise
1	Tap Lower
2	Auto Inhibit (On/Off)

Analog Inputs

Point #	Description
0	Tap Position
1	Load Voltage
2	Load Current
3	Source Voltage

Analog Outputs

No Analog Outputs in the Simple set currently.

8.2.6 Metering

Binary Inputs

Point #	Description
0	LOW Voltage Limiting, [1=On]
1	HIGH Voltage Limiting, [1=On]
2	Automatic Operation, [1=Inhibited]
3	Power Flow Direction, [0=Fwd, 1=Rev]
4	R/A/M Switch, [0=Off/Manual, 1=Auto/Remote]
5	Voltage Reduction Input 1, [0=Open, 1=Closed]
6	Voltage Reduction Input 2, [0=Open, 1=Closed]
7	Supervisory Switch, [0=Off, 1=On (Remote)]
8	Neutral Position Status, [0=inactive, 1=active]
9	Low Battery Status, [0=inactive, 1=active]
10	Raise Limit Reached, [0=inactive, 1=active]
11	Lower Limit Reached, [0=inactive, 1=active]

Binary Outputs

Point #	Description
0	Control Raise (1=raise)
1	Control Lower (1=lower)
2	Remote Auto/Manual (1=block)
3	Fwd Voltage Level (+/-.1V) (0=dec, 1=inc)
4	Bandwidth Voltage (+/-.1V) (0=dec, 1=inc)
5	Fwd Time Delay (+/- 5s) (0=dec, 1=inc)
6	Fwd Reactive Comp (+/- 1V) (0=dec, 1=inc)
7	Local Voltage Reduct (1=Active)
8	Remote Volt Reduct (1=Active)
9	Local Volt Reduct % (+/-.5V) (0=dec, 1=inc)
10	Remote Volt Red. % (+/-.5V) (0=dec, 1=inc)
11	Fwd Resistive Comp (+/- 1V) (0=dec, 1=inc)
12	Reset Demands & min/max (AI 20-26)
13	Reset Energies (AI 27-28)

Analog Inputs

Point #	Description
0	Operations Counter (100's)
1	Operations Counter (10's and 1's)
2	kVA Load
3	kW Load
4	Hardware Status (0=All Good)
5	Primary Load Current in Amps
6	Secondary Load Voltage
7	Primary Load Voltage
8	Primary Source Voltage
9	kVAR Load
10	Power Factor
11	Compensated Voltage (Sec.)
12	% Voltage Reduction in Effect
13	Tap Position
14	Voltage Reduction Status
15	Voltage Limit Status
16	Tap Control Mode Status
17	R/A/M switch position
18	Load Voltage Harmonics %
19	Load Current Harmonics %
20	Fwd Voltage Level Setting
21	Fwd Bandwidth Setting
22	Fwd Time Delay Setting
23	Fwd Reactive Compensation
24	Local Voltage Reduction %
25	Remote Voltage Reduction %
26	Fwd Resistive Compensation
27	Load Current Demand (fwd. max.)
28	KVAR Load Demand (fwd. min.)
29	KVAR Load Demand (fwd. max.)
30	KW Load Demand (fwd. max.)
31	Load Voltage Inst. Fwd. Min
32	Load Voltage Inst. Fwd. Max
33	Load Current Inst. Fwd. Max
34	KWHR Forward (0-999)
35	MWHR Forward (0-999)

Analog Outputs

Point #	Description
0	Fwd Voltage Level
1	Fwd Bandwidth
2	Fwd Time Delay
3	Fwd Reactive Compensation
4	Local Voltage Reduction %
5	VRC Stage2
6	Fwd Resistive Compensation

8.2.7 Active

Binary Inputs

Point #	Description
0	Tap Pos Known
1	Power Flow Direction
2	Auto Inhibit Status
3	Neutral (U12) Signal
4	Remote Switch position
5	Manual Switch position

Binary Outputs

Point #	Description
0	Tap Raise
1	Tap Lower
2	Auto Inhibit (Latch On/Off)
3	Active Auto Inhibit

Analog Inputs

Point #	Description
0	Tap Position
1	Load Current
2	Load Voltage
3	KVAR
4	KW
5	Power Factor
6	Band Status Indicators
7	Tap Control Mode
8	Op Count Elapsed
9	CM firmware version

Analog Outputs

Point #	Description
0	Fwd Bandwidth
1	Fwd Voltage Level
2	Fwd Time Delay
3	Fwd Resistive Compensation
4	Fwd Reactive Compensation
5	Active Bandwidth
6	Active Voltage Level
7	Active Time Delay
8	Active Resistive Compensation
9	Active Reactive Compensation
10	Active Timer (mins)

8.2.8 Set 7

Binary Inputs

Point #	Description
0	Auto Inhibit Status
1	Remote Switch position
2	Manual Switch position
3	Neutral (U12) Signal
4	Power Flow Direction

Binary Outputs

Point #	Description
0	Tap Raise
1	Tap Lower
2	Auto Inhibit (On/Off)

Analog Inputs

Point #	Description
0	Tap Position
1	Load Voltage
2	Load Current
3	Source Voltage
4	kW Load
5	kVA Load
6	kVAR Load
7	Op Count Last Month
8	Op Count Month-to-Date
9	Maintain Records of Contacts
10	Tap Changer Type
11	Balance Winding
12	Range of Regulation
13	Lower Led Solid/Blink
14	U2-P2 Terminal Out
15	Fixed RL On time
16	Log Min Max
17	PT Calc Enable

Analog Outputs

Point #	Description
0	Fwd Voltage Level
1	Fwd Bandwidth
2	Fwd Time Delay
3	Clear Contact Statuses and Op Counters
4	Read Overall Status of Contacts

8.2.9 2.x3

Binary Inputs

Point #	Scale Factor	Description
0	SF = 1	Tap Pos Known
1	SF = 1	Power Flow Direction
2	SF = 1	Auto Inhibit Status
3	SF = 1	Raise (J) Motor Signal
4	SF = 1	Lower (K) Motor Signal
5	SF = 1	Remote Control occurring
6	SF = 1	U2/P2 Switch Position
7	SF = 1	Neutral (U12) Signal
8	SF = 1	Operations Count (U10) Signal
9	SF = 1	Auto Inhibit Terminal Block Input

10	SF = 1	VRC1 contacts
11	SF = 1	VRC2 contacts
12	SF = 1	Remote Switch position
13	SF = 1	Manual Switch position
14	SF = 1	Auto Inhibit Out Status

Binary Outputs

Point #	Scale Factor	Description
0	SF = 1	Tap Raise
1	SF = 1	Tap Lower
2	SF = 1	Auto Inhibit (Latch On/Off)

Analog Inputs

Point #	Scale Factor	Description
0		Op Count Last Year
1		N/A
2	SF = 1	R/A/M switch position
3		Power Flow Direction Indicator
4	SF = 1	VRC contacts status
5	SF = 1	Band, VRC, VLC status
6	SF = 1	Tap Position
7	SF = 1	Load Current
8	SF= 10	Load Voltage
9	SF= 0.1	Load Voltage (primary)
10	SF= 10	Source Voltage
11	SF= 0.1	Source Voltage (primary)
12	SF = 1	KVA
13	SF = 1	KVAR
14	SF = 1	KW
15	SF= 100	Power Factor
16	SF = 10	P2 Ratio
17	variable	Ld Current Dmd (Fwd Present)
18	SF = 1	kVA Dmd (Fwd Present)
19	SF = 1	kVAR Dmd (Fwd Present)
20	SF = 1	kW Dmd (Fwd Present)
21	SF= 10	Load Volts Dmd (Fwd Present)
22	SF= 10	CompVolts Dmd (Fwd Present)
23	variable	Load I Dmd (Rev Present) (Amps)
24	SF = 1	kVA Load Dmd (Rev Present)
25	SF = 1	kVAR Load Dmd (Rev Present)
26	SF = 1	kW Load Dmd (Rev Present)
27	SF= 10	Load Volts Dmd (Rev Present) (Volts)
28	SF= 10	Comp Volts Dmd (Rev Present)
29	SF= 10	Max % Boost or Min % Buck (%)
30	SF= 10	Max % Buck or Min % Boost (%)
31	SF= 10	Motor Voltage
32	SF= 10	Vsrc Fwd Dmd
33	SF= 10	Vsrc Rev Dmd
34	SF= 10	Vload dc offset
35	SF= 10	Vload fundamental, RMS
36	SF= 10	Vload 2nd harmonic, RMS
37	SF= 10	Vload 3rd harmonic, RMS
38	SF= 10	Vload 4th harmonic, RMS
39	SF= 10	Vload 5th harmonic, RMS
40	SF= 10	Vload 6th harmonic, RMS
41	SF= 10	Vload 7th harmonic, RMS
42	SF= 10	Vload 8th harmonic, RMS
43	SF= 10	Vload 9th harmonic, RMS
44	SF= 10	Vload 10th harmonic, RMS

45	SF= 10	Vload 11th harmonic, RMS
46	SF= 10	Vload 12th harmonic, RMS
47	SF= 10	Vload 13th harmonic, RMS
48	SF= 10	Vload 14th harmonic, RMS
49	SF= 10	Vload 15th harmonic, RMS
50	SF= 10	Vload 16th harmonic, RMS
51	SF= 10	Vload 17th harmonic, RMS
52	SF= 10	Vload 18th harmonic, RMS
53	SF= 10	Vload 19th harmonic, RMS
54	SF= 10	Vload 20th harmonic, RMS
55	SF= 10	Vload 21st harmonic, RMS
56	SF= 10	Vload 22nd harmonic, RMS
57	SF= 10	Vload 23rd harmonic, RMS
58	SF= 10	Vload 24th harmonic, RMS
59	SF= 10	Vload 25th harmonic, RMS
60	SF= 10	Vload 26th harmonic, RMS
61	SF= 10	Vload 27th harmonic, RMS
62	SF= 10	Vload 28th harmonic, RMS
63	SF= 10	Vload 29th harmonic, RMS
64	SF= 10	Vload 30th harmonic, RMS
65	SF= 10	Vload 31st harmonic, RMS
66	SF= 10	Iload dc offset
67	SF= 10	Iload fundamental, RMS
68	SF= 10	Iload 2nd harmonic, RMS
69	SF= 10	Iload 3rd harmonic, RMS
70	SF= 10	Iload 4th harmonic, RMS
71	SF= 10	Iload 5th harmonic, RMS
72	SF= 10	Iload 6th harmonic, RMS
73	SF= 10	Iload 7th harmonic, RMS
74	SF= 10	Iload 8th harmonic, RMS
75	SF= 10	Iload 9th harmonic, RMS
76	SF= 10	Iload 10th harmonic, RMS
77	SF= 10	Iload 11th harmonic, RMS
78	SF= 10	Iload 12th harmonic, RMS
79	SF= 10	Iload 13th harmonic, RMS
80	SF= 10	Iload 14th harmonic, RMS
81	SF= 10	Iload 15th harmonic, RMS
82	SF= 10	Iload 16th harmonic, RMS
83	SF= 10	Iload 17th harmonic, RMS
84	SF= 10	Iload 18th harmonic, RMS
85	SF= 10	Iload 19th harmonic, RMS
86	SF= 10	Iload 20th harmonic, RMS
87	SF= 10	Iload 21st harmonic, RMS
88	SF= 10	Iload 22nd harmonic, RMS
89	SF= 10	Iload 23rd harmonic, RMS
90	SF= 10	Iload 24th harmonic, RMS
91	SF= 10	Iload 25th harmonic, RMS
92	SF= 10	Iload 26th harmonic, RMS
93	SF= 10	Iload 27th harmonic, RMS
94	SF= 10	Iload 28th harmonic, RMS
95	SF= 10	Iload 29th harmonic, RMS
96	SF= 10	Iload 30th harmonic, RMS
97	SF= 10	Iload 31st harmonic, RMS
98	SF= 10	Vsource dc offset
99	SF= 10	Vsource fundamental, RMS
100	SF= 10	Vsource 2nd harmonic, RMS
101	SF= 10	Vsource 3rd harmonic, RMS
102	SF= 10	Vsource 4th harmonic, RMS
103	SF= 10	Vsource 5th harmonic, RMS

104	SF= 10	Vsource 6th harmonic, RMS
105	SF= 10	Vsource 7th harmonic, RMS
106	SF= 10	Vsource 8th harmonic, RMS
107	SF= 10	Vsource 9th harmonic, RMS
108	SF= 10	Vsource 10th harmonic, RMS
109	SF= 10	Vsource 11th harmonic, RMS
110	SF= 10	Vsource 12th harmonic, RMS
111	SF= 10	Vsource 13th harmonic, RMS
112	SF= 10	Vsource 14th harmonic, RMS
113	SF= 10	Vsource 15th harmonic, RMS
114	SF= 10	Vsource 16th harmonic, RMS
115	SF= 10	Vsource 17th harmonic, RMS
116	SF= 10	Vsource 18th harmonic, RMS
117	SF= 10	Vsource 19th harmonic, RMS
118	SF= 10	Vsource 20th harmonic, RMS
119	SF= 10	Vsource 21st harmonic, RMS
120	SF= 10	Vsource 22nd harmonic, RMS
121	SF= 10	Vsource 23rd harmonic, RMS
122	SF= 10	Vsource 24th harmonic, RMS
123	SF= 10	Vsource 25th harmonic, RMS
124	SF= 10	Vsource 26th harmonic, RMS
125	SF= 10	Vsource 27th harmonic, RMS
126	SF= 10	Vsource 28th harmonic, RMS
127	SF= 10	Vsource 29th harmonic, RMS
128	SF= 10	Vsource 30th harmonic, RMS
129	SF= 10	Vsource 31st harmonic, RMS
130	SF = 1	MJ-X Main Proc. SW Version
131	SF = 1	Number of Resets
132	SF=10	Compensated Voltage (Secondary)
133	SF=10	Line Frequency
134	SF=10	Percent Regulation
135	SF=10	% Voltage Reduction in Effect
136	SF = 1	Number of Interval Logs Stored
137	SF=1000	Vld Total Harm. Distortion (%)
138	SF = 10	Vload Harmonics RMS value
139	SF=1000	Iload Total Harm. Distortion (%)
140	SF = 10	Iload Harmonics RMS value
141	SF=1000	Vsrc Total Harm. Distortion (%)
142	SF = 10	Vsource Harmonics RMS value
143	SF = 1	VRC Status
144	SF = 1	VLC Status
145	SF = 1	Auto Tap Command Status
146	SF = 1	Band Status
147	SF = 1	Tap Control Mode Status
148	SF = 1	R/A/M switch position
149	SF = 1	Alert Status
150	SF = 1	Time period for Interval Log (minutes)
151	SF = 1	Number of Event Logs Stored
152	SF = 1	MJX Reset Status Register
153		Diagnostics Results Register 1
154		Diagnostics Results Register 2
155	SF = 1	Previous Month Ops Count
156	SF = 1	MP Board Hardware version
157	SF = 1	Power Board HW version
158	SF = 1	MP HC16 Mask version
159	SF = 1	Elapsed Operations Count
160	SF = 1	Year-To-Date Ops Count
161	SF = 1	KWHR Forward
162	SF = 1	KVARHR fwd lead

163	SF = 1	KVARHR fwd lag
164	SF = 1	KWHR Reverse
165	SF = 1	KVARHR rev lead
166	SF = 1	KVARHR rev lag
167	SF = 1	Operations Count for last 24 hours
168	SF = 1	Operations Count for last 30 days
169	SF = 1	Month-To-Date Operations Count
170	SF = 100	PF at Min. kVA Dmd (Fwd)
171	SF = 100	PF at Max. kVA Dmd (Fwd)
172	SF = 100	PF at Min. kVA Dmd (Rev)
173	SF = 100	PF at Max. kVA Dmd (Rev)
174	variable	Load Current Dmd (Fwd Min) (Amps)
175	variable	Load Current Dmd (Fwd Max) (Amps)
176	SF =1	kVA Load Dmd (Fwd Min)
177	SF =1	kVA Load Dmd (Fwd Max)
178	SF =1	kVAR Load Dmd (Fwd Min)
179	SF =1	kVAR Load Dmd (Fwd Max)
180	SF =1	kW Load Dmd (Fwd Min)
181	SF =1	kW Load Dmd (Fwd Max)
182	SF = 10	Load Voltage Dmd (Fwd Min)
183	SF = 10	Load Voltage Dmd (Fwd Max)
184	SF = 10	Comp Voltage Dmd (Fwd Min) (Volts)
185	SF = 10	Comp Voltage Dmd (Fwd Max) (Volts)
186	variable	Load Current Dmd (Rev Min) (Amps)
187	variable	Load Current Dmd (Rev Max) (Amps)
188	SF = 1	kVA Load Dmd (Rev Min)
189	SF = 1	kVA Load Dmd (Rev Max)
190	SF = 1	kVAR Load Dmd (Rev Min)
191	SF = 1	kVAR Load Dmd (Rev Max)
192	SF = 1	kW Load Dmd (Rev Min)
193	SF = 1	kW Load Dmd (Rev Max)
194	SF = 10	Load Voltage Dmd (Rev Min) (Volts)
195	SF = 10	Load Voltage Dmd (Rev Max) (Volts)
196	SF = 10	Comp. Voltage Dmd (Rev Min) (Volts)
197	SF = 10	Comp. Voltage Dmd (Rev Max) (Volts)
198	SF = 10	Vsrc Dmd (Fwd Min)
199	SF = 10	Vsrc Dmd (Fwd Max)
200	SF = 10	Vsrc Dmd (Rev Min)
201	SF = 10	Vsrc Dmd (Rev Max)
202	SF = 10	Load Voltage Inst. Fwd Min
203	SF = 10	Load Voltage Inst. Fwd Max
204	SF = 10	Load Voltage Inst. Rev Min
205	SF = 10	Load Voltage Inst. Rev Max
206	SF = 10	Source Voltage Inst. Fwd
207	SF = 10	Source Voltage Inst. Fwd Max
208	SF = 10	Source Voltage Inst. Rev Min
209	SF = 10	Source Voltage Inst. Rev Max
210	SF = 10	Comp Volts Inst. Fwd Min
211	SF = 10	Comp Volts Inst. Fwd Max
212	SF = 10	Comp Volts Inst. Rev Min
213	SF = 10	Comp Volts Inst. Rev Max
214	variable	Load Current Inst. Fwd Min (Amps)
215	variable	Load Current Inst. Fwd Max (Amps)
216	variable	Load Current Inst. Rev Min (Amps)
217	variable	Load Current Inst. Rev Max (Amps)
218	SF = 100	PF Inst. Fwd Min
219	SF = 100	PF Inst. Fwd Max
220	SF = 1	KVA Inst. Fwd Min
221	SF = 1	KVA Inst. Fwd Max

222	SF = 1	KVA Inst. Rev Min
223	SF = 1	KVA Inst. Rev Max
224	SF = 1	KW Inst. Fwd Min
225	SF = 1	KW Inst. Fwd Max
226	SF = 1	KW Inst. Rev Min
227	SF = 1	KW Inst. Rev Max
228	SF = 1	KVAR Inst. Fwd Min
229	SF = 1	KVAR Inst. Fwd Max
230	SF = 1	KVAR Inst. Rev Min
231	SF = 1	KVAR Inst. Rev Max
232	SF = 10	Frequency Inst. Fwd Min (Hz)
233	SF = 10	Frequency Inst. Fwd Max (Hz)
234	SF = 1	Tap position Inst. Fwd Min
235	SF = 1	Tap position Inst. Fwd Max
236	SF =1	CM self test result
237	SF = 1	Vref a/d value
238	SF = 1	Raise Limit Reached status
239	SF =1	Lower Limit Reached status
240	SF = 1	CM Response (to Init) Status
241	SF = 1	CM Software Revision
242	SF = 1	CM Hardware Revision
243	SF = 1	CM microprocessor Mask rev.
244	SF = 1	CM I/O Board Type
245	SF = 1	CM Options (to be defined)
246	SF = 1	CM I/O Board Revision
247	SF = 1	CM QSPI MP to CM Errors
248	SF = 1	CM QSPI no. of Failed Writes
249	SF = 1	CM QSPI no. of Xfer Cycles
250	SF = 1	CM DNP no. of requests for not supported items
251	SF = 1	CM RAM Error High Address
252	SF = 1	CM RAM Error Low Address

Analog Outputs

Point #	**Scale Factor**	**Description**
0	SF = 1	Total Operations Count
1	SF = 1	Level 1 PW characters
2	SF = 1	Cfg. PW characters
3	SF = 1	Reg. PW characters
4	SF = 1	Meter PW characters
5	SF = 1	Dmd PW characters
6	SF = 1	Alert PW characters
7	SF = 1	Ops PW characters
8	SF = 1	LogSet PW characters
9	SF = 1	Event/Interval PW characters
10	SF = 1	Harm PW characters
11	SF = 1	Comm PW characters
12	SF = 1	Diag. PW characters
13	SF = 1	Syskey PW characters
14	SF = 1	Raise/Lower Operation
15	variable	CT Primary Ratio (Amps)
16	SF = 1	System Line Voltage (Volts)
17	SF = 10	High Voltage Limit (Volts)
18	SF = 10	Low Voltage Limit (Volts)
19	SF = 10	Local Voltage Reduction (%)
20	SF = 10	VRC Remote Setting #1 (%)
21	SF = 10	VRC Remote Setting #2 (%)
22	SF = 10	VRC Remote Setting #3 (%)
23	SF = 1	Auto VRC #1 %Current (%)
24	SF = 1	Auto VRC #2 %Current (%)

25	SF = 10	Auto VRC #1 % Setting (%)
26	SF = 10	Auto VRC #2 % Setting (%)
27	SF = 1	P2 primary (from P2 PT ratio) (Volts)
28	SF = 1	P2 secondary (Volts)
29	SF = 1000	CT secondary (Amps)
30	SF = 1	Current Shift (in º, relative to voltage)
31	SF = 1	U2 primary (Volts)
32	SF = 1	U2 secondary (from U2 PT ratio) (Volts) (Range: 100-150)
33	SF = 1	PT Threshold (Volts)
34	SF = 1	Date Format
35	SF = 1	Demand Subperiods
36	SF = 10	MJ3A remote mode %VRC
37	SF = 1	Min/Max Time-out(sec)
38	SF = 1	Screen Timeout(minutes)
39	SF = 1	Harm. Show as: RMS/%T/fund.
40		N/A
41		N/A
42	SF = 10	Dmd Time Interval (minutes)
43	SF = 10	Bandwidth (Reverse) (Volts)
44	SF = 10	Line Comp. React. (Rev) (Volts)
45	SF = 10	Line Comp. Resist. (Rev) (Volts)
46	SF = 1	Reverse Sensing Method
47	SF = 10	Set Voltage (Reverse) (Volts)
48		Time Delay (Reverse) (seconds)
49	SF = 1	Reverse Threshold Value (%)
50	SF = 10	Bandwidth (Forward) (Volts)
51	SF = 10	Line Comp. React. (Fwd) (Volts)
52	SF = 10	Line Comp. Resist. (Fwd) (Volts)
53	SF = 1	Control Operating Modes
54	SF = 10	Set Voltage (Forward) (Volts)
55	SF = 1	Time Delay (Forward)(seconds)
56	SF = 1	Control Communications Address
57	SF = 1	Comm Port Baud Rate
58	SF = 1	Comm Port Handshake Mode
59	SF = 1	Communications Port Re-Synch Time Characters (no. characters)
60	SF = 1	Communications Port-Transmit Enable Delay (msec)
61	SF = 1	Regulator Type
62	SF = 1	Utility Winding Polarity
63	SF = 1	Meter Display Volts
64	SF = 1	Demand Type
65	SF = 1	VRC Remote
66	SF = 1	Basis Voltage
67	SF = 1	Harm: Odd Only/Odd & Even
68	SF = 1	Regulator Configuration
69	SF = 1	Voltage Limiting Mode
70	SF = 1	Voltage Reduction Mode
71	SF = 1	Event/Interval Log Setup Status
72	SF = 1	Password Enables, Bit mapped
73	SF = 1	Alert Status word 1 (encoded)
74	SF = 1	Alert Status word 2 (encoded)
75	SF = 1	Memo1 - chars 1-2
76	SF = 1	Memo1 - chars 3-4
77	SF = 1	Memo1 - chars 5-6
78	SF = 1	Memo1 - chars 7-8
79	SF = 1	Memo1 - chars 9-10
80	SF = 1	Memo2 - chars 1-2
81	SF = 1	Memo2 - chars 3-4
82	SF = 1	Memo2 - chars 5-6
83	SF = 1	Memo2 - chars 7-8

84	SF = 1	Memo2 - chars 9-10
85	SF = 1	"NN" Raise/Lower Value
86	SF = 1	Regulator Id (Range: 0 - 32766)
87	SF = 1	Tap Changer Mechanism
88	SF = 1	Max. Load Current % (Range: 0-350)
89	SF = 1	Full Load Current (50-7200) (A)
90	SF = 1	CM Pre-tx delay for DNP
91	SF = 1	CM Post-tx delay for DNP
92	SF = 1	CM transmit delay for DNP
93	SF = 1	CM number of retries (DNP)
94	SF = 1	CM protocol
95	SF = 1	CM parity
96	SF = 1	CM self test request
97	SF = 1	Raise Limit % (0=10%, 1=8.75%, 2=7.5%, 3=6.25%, 4=5%)
98	SF = 1	Lower Limit % (0=10%, 1=8.75%, 2=7.5%, 3=6.25%, 4=5%)
99	SF = 1	Data Port Baud

9 Communications Module Firmware Versions

9.1 MJ-4 Communications Module firmware version

Version 3.10 : Supports all DNP points including Set 7, supports AMD Flash memory.

9.2 MJ-XL Communications Module firmware versions

The principle firmware version released for the MJ-4 Communications Module is the 3.10, an abbreviated list of the principle firmware versions that have were released for use on the MJ-X^L communications module follows. For questions regarding firmware versions not included in this list, please contact your Siemens representative.

Version 2.13: Contains “full set” of 370 DNP3.0 points (see 2.x3 points list in Section 8.2.9).

Version 2.14: Contains “limited set” of 64 DNP3.0 points (see 2.x4 points list in Section 8.2.3).

Version 3.01: Level 2 implementation of DNP3.0, no DNP points by default; must use the DNP Configure program to load the desired DNP points onto the control panel. Supports unsolicited responses.

Version 3.07: Level 2 implementation of DNP3.0, can use DNP Configure program to load user-defined DNP points or choose to use one of the predefined DNP point sets (if used in conjunction with MJXL version 3.07 or higher).

Version 3.0701: Added short delay after CM initialization so all values are online before polling can start

Version 3.0702: Added full support for Trip/Close operations on Binary Outputs. If using a Trip/Close operation for a tap raise or lower, the TRIP command should be used to activate. Also, a *Trip* to the Tap Raise point will *raise* the tap one position; a *Close* to the Tap Raise point will *lower* the tap one position.

Version 3.0703: Added support for alternate AMD flash memory. Removed support for ATMEL Flash memory.

10 Specifications

This section contains the MJ-4 Communications Module specifications. Contained in this section are the parameters for both the fiber optic and RS-232/485 interfaces. The data provided in the fiber optic section was obtained using 62.5/125 μm cable. Typical, maximum, and minimum lengths are given for normal and long range cable lengths. Except for the maximum and minimum parameters, the numbers provided are for room temperature. The maximum and minimum lengths are for temperature extremes.

10.1 Physical Dimensions

Height	8.4 inches (21.34 cm)
Width	2.89 inches (7.34 cm)
Depth	2.84 inches (7.21 cm)

10.2 Fiber Optic Link Interface Specifications

Transmitter	**Jumper J12 In**	**Jumper J12 Out**
Maximum Output Power	-13.0 dBm (Long Range)	-16.0 dBm (Normal Range)
Typical Output Power	-16.0 dBm (Long Range)	-19.0 dBm (Normal Range)
Minimum Output Power	-20.0 dBm (Long Range)	-23.0 dBm (Normal Range)
Numerical Aperture	0.49	
Optical Port Diameter	290 μm	
Receiver		
Peak Input Power Logic Level Low	-24.0 dBm Min to -9.2 dBm Max	
Peak Input Power Logic Level High	-40.0 dBm Max	
System		
Wavelength	820 nanometers (nominal)	
Connector Type	ST	
Fiber Type	Glass 62.5/125 μm, 5dB/m	
Data Rate	5 Mbaud (design)	19.2 Kbaud (tested)
Maximum Optical Power Budget	11 dBm (Long Range)	8 dBm (Normal Range)
Typical Optical Power Budget	8 dBm (Long Range)	5 dBm (Normal Range)
Minimum Optical Power Budget	4 dBm (Long Range)	1 dBm (Normal Range)
Link Lengths		
Maximum Link Length	2.2 km (Long Range)	1.6 km (Normal Range)
Typical Link Length	1.6 km (Long Range)	0.6 km (Normal Range)
Minimum Link Length	0.8 km (Long Range)	0.2 km (Normal Range)
Operating Temperature Range	-40ºC to +85ºC (excluding cable)	

10.3 RS-232/RS-485 Interface Specifications

Parameter	**RS-232**	**RS-485**
Data Rate (maximum)	19200 baud	19200 baud
Distance (maximum)	50 ft	4000 ft
Nodes (maximum)	72	32
Isolation	500 VAC, 1 minute	500 VAC, 1 minute

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