Phoenix Digital

MODBUS,
MODBUS/TCP,
and MODBUS & ETHERNET
OPTICAL COMMUNICATION MODULES

INSTALLATION
and
USERS MANUAL

PHOENIX DIGITAL CORPORATION
7650 E. EVANS RD. BLDG. A, SCOTTSDALE, AZ 85260
Phone: (480) 483-7393
Fax: (480) 483-7391
E-Mail: phxdigital@aol.com
Internet: www.phoenixdigitalcorp.com

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PHOENIX DIGITAL CORPORATION

MODBUS, MODBUS/TCP, and MODBUS & ETHERNET OPTICAL COMMUNICATION MODULES

Users Manual

Notes: 1. This manual provides user information describing the operation and functionality of the following Modbus, Modbus/TCP, and Modbus & Ethernet fiber optic modules:

OCX-MOD-xx-R (Standalone, DIN-Rail or Panelmount);
OCX-ETF-xx-R (Standalone, DIN-Rail or Panelmount);
OCX-EMOD-xx-R (Standalone, DIN-Rail or Panelmount).

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2. All OCX modules (with the "-D" diagnostic option) are rated for use in Class I, Division 2 Groups A, B, C, and D hazardous locaitons. The following information is provided for hazardous location approval for OCX module applications:

"All wiring must be in accordance with Class I, Division 2 wiring methods Articles 501-4 (b), as appropriate of the National Electrical Code, NFPA 70 and in accordance with the authority having jurisdiction."

"WARNING - Explosion Hazard - Do not disconnect while circuit is live unless area is known to be non-hazardous."

"WARNING - Explosion Hazard - Substitution of components may impair suitability for Class I, Division 2."

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

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MODBUS, MODBUS/TCP, and MODBUS & ETHERNET OPTICAL COMMUNICATION MODULES USERS MANUAL

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CHAPTER 1

DESCRIPTION AND SPECIFICATION

1.1 INTRODUCTION

Phoenix Digital's family of Modbus, Modbus/TCP, and Modbus & Ethernet fiber optic modules provide the most advanced, comprehensive, state-of-the-art fiber optic communication capabilities on the market today. Phoenix Digital's Modbus, Modbus/TCP, and Modbus & Ethernet fiber optic modules are available as Standalone, DIN-Rail or Panelmount modules with integral 120/220 VAC, 24 VDC, or 125 VDC power supplies (single or redundant). These fiber optic modules translate hardwire networks into optical networks, transparent to the communication protocol and configurable for distribution by the user in ring, bus, star, tree, or point-to-point network installations. Fiber optic network options include features not found in even the most expensive communication network installations; on-line diagnostic monitoring with high speed self-healing communication recovery around points of failure (Fault Tolerant), interactive diagnostics to locate and trap fault conditions (accessible by the user program), and wavelength selection for matching fiber media characteristics to enable communication over extended distances. Phoenix Digital makes all of this possible through application of its patented self-healing communication switch and advanced optical technologies.

The following table provides correspondence between Phoenix Digital fiber optic module Model Numbers and Modbus, Modbus/TCP, and Modbus & Ethernet network compatibility. The user should check the Model Number label located on the side of the fiber optic module cover to verify network interface compatibility.

FIBER OPTIC MODULE MODEL #	NETWORK COMPATIBILITY
OCX-MOD-(1)-(2)-(3)-(4)-(5)-(6)-(7)-(8)-(9)-(10)-(11)	Modbus Communications
OCX-ETF-(1)-(2)-(3)-(4)-(5)-(6)-(7)-(8)	Modbus/TCP Communications
OCX-EMOD-(1)-(2)-(3)-(4)-(5)-(6)-(7)-(8)-(9)-(10)-(11)	Modbus & Ethernet Communications
OCX-CBL-MOD-(12)	Modbus RS-232/485 Interconnect Cable Adapter (9 female male pin, micro D sub. connector to 9 female pin, standard D sub. connector)
OCM-CBL-A1-10	10/100 Base-T Modbus/TCP, Ethernet, or Modbus Bridge Port Intereconnect Cable (RJ45 to RJ45; 10 foot/3 meter length)

(1)	"85"	= 850 nanometer wavelength selection (Multimode only)
	"13"	= 1300 nanometer wavelength selection (Multimode or Single Mode)
	"15"	= 1550 nanometer wavelength selection (Single Mode only)
(2)	"R"	= Standalone DIN-Rail or Panelmount Enclosure
(3)	"D"	= Interactive Diagnostics
	blank	= No Diagnostics
(4)	"ST"	= ST Fiber Optic Connector Style
	"SC"	= SC Fiber Optic Connector Style
	"LC"	= LC Fiber Optic Connector Style (Not available for the 850 nm wavelength.)
	"MT"	= MTRJ Fiber Optic Connector Style (Not available for the 850 nm and 1550 nm wavelengths.)
(5)	"24V"	= 24 VDC Operation
	"ACV"	= 120/220 VAC, 50/60 Hz Operation
	"125V"	= 125 VDC Operation
	"R24V"	= Redundant 24 VDC Operation
	"RACV"	= Redundant 120/220 VAC, 50/60 Hz Operation
	"R125V"	= Redundant 125 VDC Operation
(6)	"SM"	= Single Mode Fiber Compatibility (Available with the 1300 nm or 1550 nm wavelengths only.)
	blank	= Multimode Fiber Compatibility
(7)	"xA1"	= Integral 10/100 Base-T Modbus TCP or Ethernet Transceiver, required for OCX-ETF-R or OCX-EMOD modules, where "x" specifies the number of 10/100 Base-T Modbus/TCP or Ethernet ports (1, 2, 3, 4, 5, or 6).
(8)	"EXT"	= Extended Capacity option, required for networks with 10 or more OCX-ETF-R or OCX-EMOD modules connected together on a Modbus/TCP or Ethernet network, in a ring or bus network configuration.
(9)	"485"	= RS-485 Modbus Interface for OCX-MOD and OCX-EMOD modules.
	blank	= RS-232 Modbus Interface for OCX-MOD and OCX-EMOD modules.
(10)	"FD"	= Full Duplex Modbus Communication for OCX-MOD and OCX-EMOD modules.
	blank	= Half Duplex Modbus Communication for OCX-MOD and OCX-EMOD modules.
(11)	"MAS"	= Modbus Multi-Master Multiplexing for OCX-MOD and OCX-EMOD modules.
(12)	"10"	= 10 foot/3 meter length
	blank	= 1.5 feet/.5 meter length

PRODUCT MODEL NUMBER DEFINITION

TABLE 1

A summary of selected fiber optic module features is given below:

- Provides On-the-Fly, Modbus Multi-Master Multiplexing for RS-232/RS-485 Modbus Networks.
- Provides Transparent Network Management and Switched Operation for up to 6 independent, Modbus/TCP and/or Ethernet 10/100 Base-T communication ports on each module.
- Fault Tolerant Communication: Provides On-line, Interactive Diagnostic Monitoring and Ultra-Fast, High Speed, Self-Healing Communication Recovery for Control Networks.
- Priority Queuing System (PQS) Manages Overall Communication Bandwidth and Network Latency, to Insure Priority Access and even Faster Thruput for Critical Control Nodes on the Network.
- Interactive Diagnostics: Locates Fault Conditions Throughout the Network.
- Selectable Wavelengths: 850 nanometer (multimode), 1300 nanometer (multimode and single mode), and 1550 nanometer (single mode).
- Extended Capacity Option: Supports an Unlimited Number of Fiber Optic Modules on a Single Multidrop Bus or Ring Network Configuration.
- Single or Redundant Power Supply Operation, All Voltages.
- Easy to see, visual indication of Communication Diagnostic Status.

1.2 PRODUCT DESCRIPTION

1.2.1 FAULT TOLERANT, SELF-HEALING COMMUNICATION

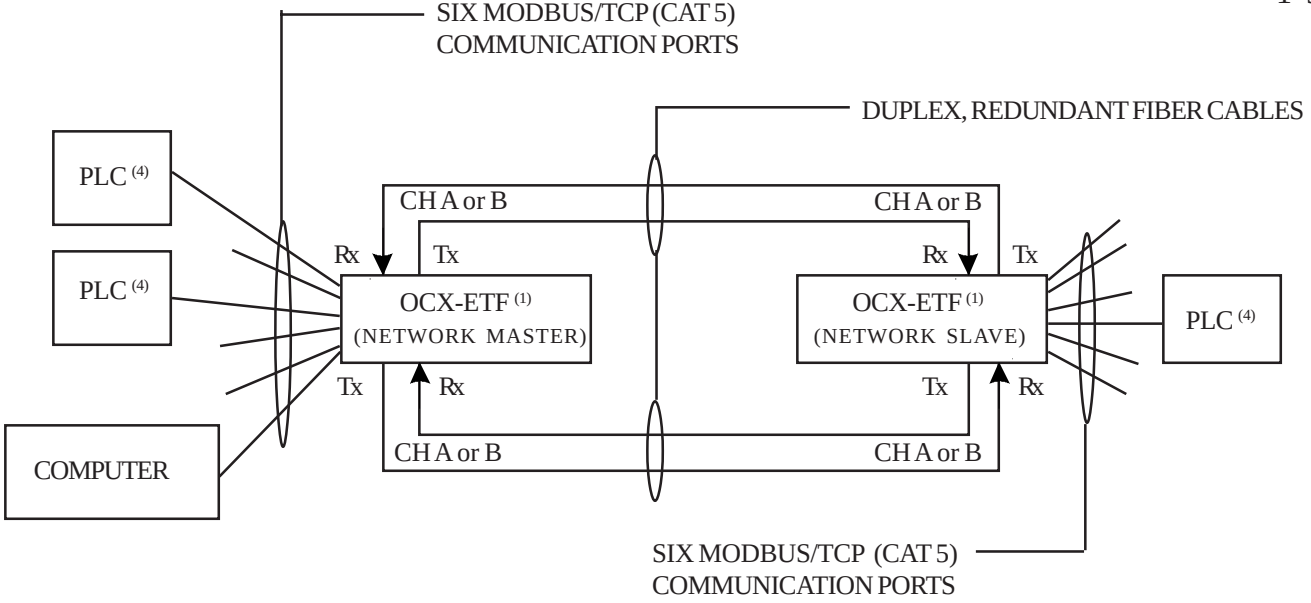
Phoenix Digital's Fault Tolerant, Self-Healing Communication technology provides diagnostic monitoring of the communication signal waveforms at each node on the network, and ultra-high speed detection, isolation, and correction of points of communication failure anywhere on the network grid. Phoenix Digital's fiber optic modules will self-heal around communication failures in ring, bus, star, tree, or point-to-point network configurations, and automatically reconfigure the overall fiber optic communication network to maintain communication continuity throughout the network. In the event of a network failure in a fault tolerant network configuration, Phoenix Digital's fiber optic modules

will insure fiber optic Network Reconfiguration in less than 2.0 milliseconds. Figure 1 illustrates Examples of Typical Fault Tolerant, Fiber Optic Module Network Configurations using Phoenix Digital's fiber optic communication modules.

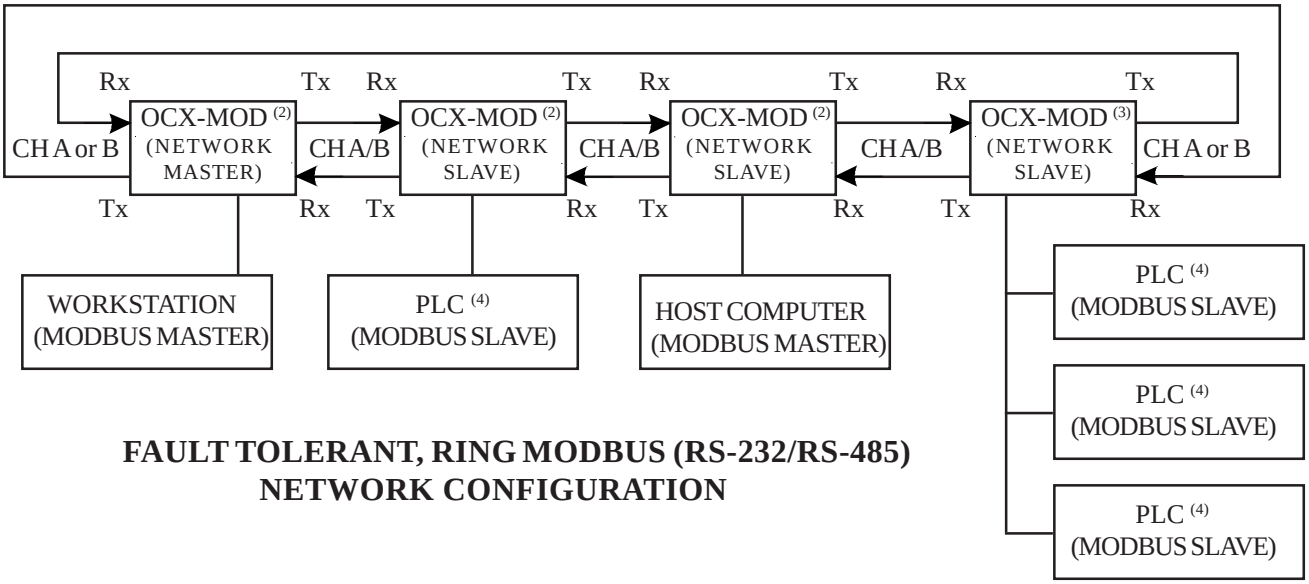
The ultra-high speed, self-healing communication technology on each Phonix Digital fiber optic module will automatically redirect network traffic around points of failure. In a failed condition, the fiber optic communication network will self-heal around a fault by reconfiguring the network, and redirecting data communications around the point of failure to find the shortest path from the source location to the intended destination.

In fault tolerant ring network configurations, one fiber module on the fiber optic ring network must be switch configured to be a Network Master module, and all other modules must be switch configured to be Network Slave modules. (This is Fiber Optic Network Master/Slave configuration, and is NOT Modbus Master/Slave configuration. Fiber Optic Network Master/Slave module configuration is totally independent of where Modbus Master/Slave devices are located on the network.) The fiber optic Network Master module may be located anywhere on the fiber optic network. In the event of a failure of any fiber optic Network Slave module, or failure of the Network Master module itself, the remaining fiber optic modules will self-heal around the module failure, maintaining network communication by redirecting data communications around the point of failure. (Configuring more than one fiber optic Network Master module on a ring network will result in network failures. See Table 10 for fiber optic module Master/Slave Switch Designations. See Configuration Instructions in Chapter 2, Section 2.6 for more detailed information.)

Figure 2 illustrates a typical redundant, fault tolerant, fiber optic ring network configuration. In this example one fiber optic module is configured to be the Network Master module, and the other fiber optic modules are configured as Network Slave Modules. The fiber optic modules may either be interconnected Channel A Tx/Rx to Channel A Rx/Tx, then Ch B Tx/Rx to Ch B Rx/Tx, etc., around the ring; or Ch A Tx/Rx to Ch B Rx/Tx, then Ch A Tx/Rx to Ch B Rx/Tx, etc., around the ring. There is no special restriction limiting how the fiber channels may be connected together, as long as the transmit/receive connections from one channel are connected to a complementary set of connections on another channel. Diagnostic monitoring circuitry at each module (Network Master and Slave) will continuously monitor the integrity of the communication carriers present at the receive data inputs of each communication module. This high speed combinational diagnostic monitoring circuitry will monitor and detect communication failures in carrier symmetry, jitter, amplitude, and babble. In the event a fault condition is diagnosed on the network (Figure 2: Between Nodes 2 and 3) the fiber modules detecting the failure (Nodes 2 and 3) will immediately redirect communication around the point of failure. Essentially, the network dynamically reconfigures to form a new communication path from node 2 to node 3, away from the point of failure (the long way around the ring network), thus insuring communication network continuity and fault isolaton. In additon to providing network fault tolerance, Phoenix Digital's fiber optic modules enable maintenance personnel to locate fault conditons (remote status monitoring), add/delete nodes, and splice/terminate/replace media on-line, without disrupting network communications.



FAULT TOLERANT, POINT-TO-POINT MODBUS/TCP NETWORK CONFIGURATION



**FAULT TOLERANT, RING MODBUS (RS-232/RS-485)
NETWORK CONFIGURATION**

(1) OCX-ETF = Optical Communication Module
MODEL# OCX-ETF-13-R-D-ST-ACV-6A1

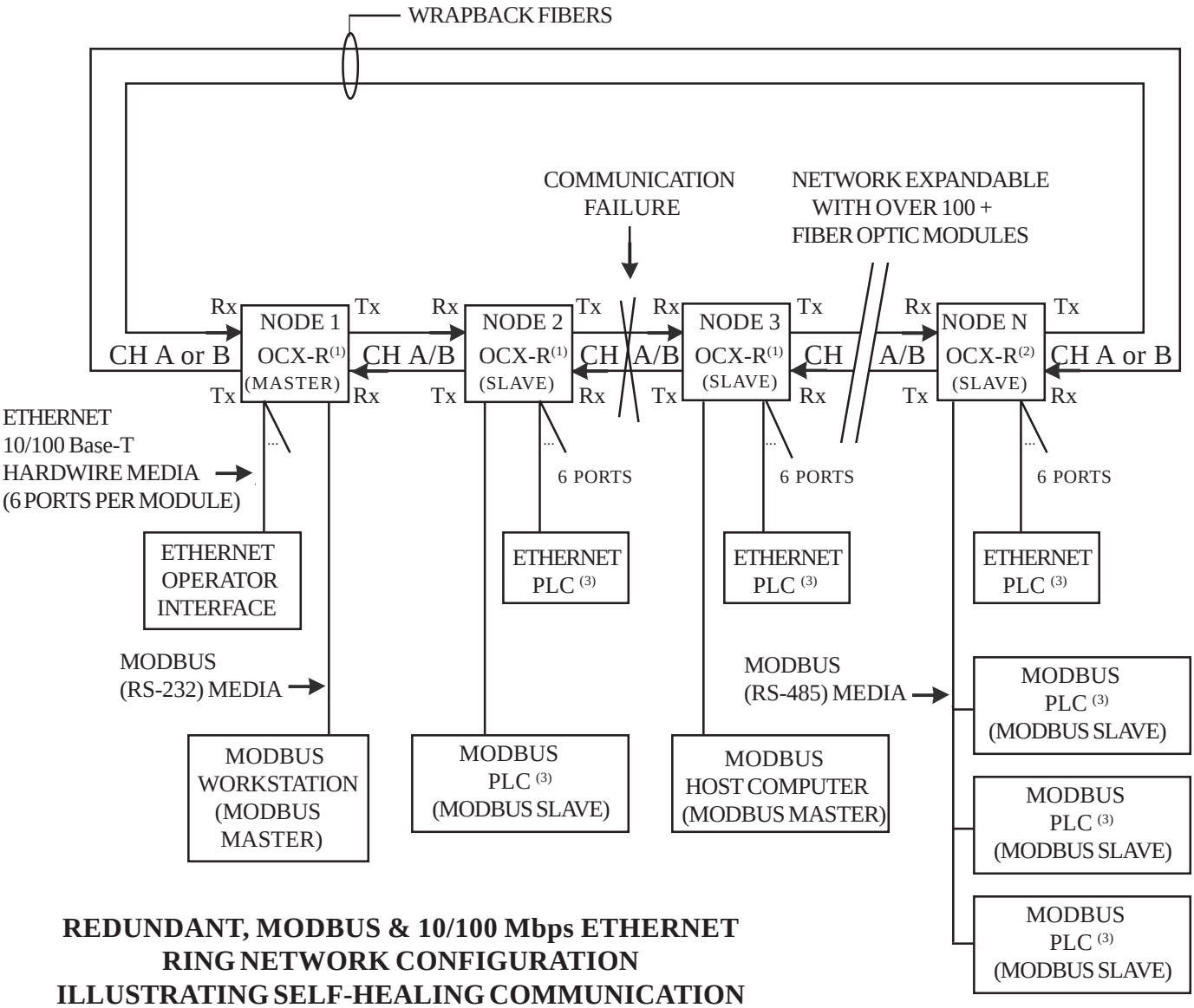
(2) OCX-MOD = Optical Communication Module
MODEL# OCX-MOD-13-R-D-ST-ACV-MAS

(3) OCX-MOD = Optical Communication Module
MODEL# OCX-MOD-13-R-D-ST-ACV-485-MAS

(4) PLC = Programmable Logic Controller

**EXAMPLES OF TYPICAL FAULT TOLERANT
FIBER OPTIC MODBUS/TCP and MODBUS NETWORK CONFIGURATIONS**

FIGURE 1



REDUNDANT, MODBUS & 10/100 Mbps ETHERNET RING NETWORK CONFIGURATION ILLUSTRATING SELF-HEALING COMMUNICATION

FIGURE 2

(1) OCX-R = Optical Communication Module
Model# OCX-EMOD-13-R-D-ST-ACV-6A1-MAS

(2) OCX-R = Optical Communication Module
Model# OCX-EMOD-13-R-D-ST-ACV-6A1-485-MAS

(3) PLC = Programmable Logic Controller

Figure 3 illustrates a typical, non-redundant, fiber optic bus network configuration. In this example, all of the fiber optic modules should be configured as Network Slaves. The fiber optic modules may be interconnected Channel A Tx/Rx to Channel A Rx/Tx, then Ch B Tx/Rx to Ch B Rx/Tx, etc., throughout the bus; or Ch A Tx/Rx to Ch B Rx/Tx, then Ch A Tx/Rx to Ch B Rx/Tx, etc., throughout the bus. The outside ports on the two end fiber modules should remain unconnected to any other devices. Since the red ERR error indicator on the front of the fiber optic module will remain on whenever there is no connection and/or valid carrier signal at the corresponding fiber optic receive input, the error indicators corresponding to the receive data inputs on the outside ports of the two end fiber modules on the bus will remain continuously on. However, this is not an indication of a network error, because in this configuration these network inputs will remain open and unconnected.

In redundant, point-to-point fiber optic network configurations, in which two fiber optic modules are interconnected with fiber cables on two, redundant channels (see top of Figure 1), one of the fiber modules must be configured as a Network Master. For non-redundant, point-to-point fiber optic network configuration, in which only one channel is used to connect from one module to the other, both modules may be configured as Network Slaves.

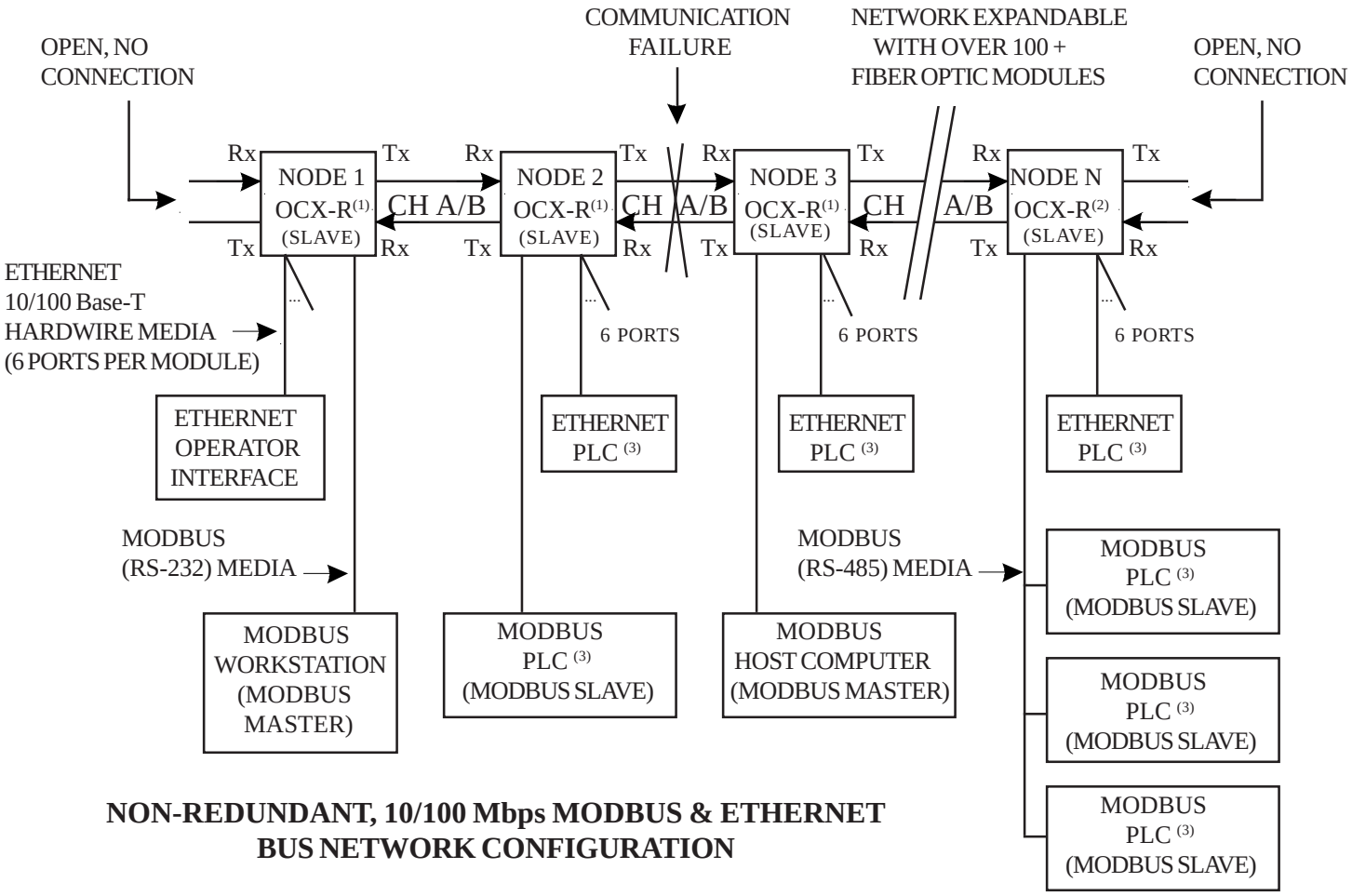
In all redundant fiber optic network configurations, communication continuity will be unconditionally maintained by the fiber optic modules in the event of either node or media failure. When the source of the network failure is corrected, the fiber modules will automatically restore the communication network to its' original traffic patterns. See Figure 4 for a typical network installation in a redundant, fiber optic ring configuration.

1.2.2 WAVELENGTH SELECTION

Phoenix Digital's fiber optic modules provide four options for wavelength selection. The economical 850 nanometer multimode wavelength may be selected for data communication networks with less than 8,000 feet (2,500 meters) between communication nodes. The higher performance 1300 nanometer multimode wavelength may be selected for longer distance applications, extending communication distances between nodes to over 4 miles (6.4 kilometers). For maximum distance, the ultra-high performance 1300 and 1550 nanometer single mode wavelengths may be selected, extending communication distances to over 60 miles (96 kilometers) between communication nodes!

1.3 PRODUCT SPECIFICATIONS

Fiber Optic Module Mounting Dimensions and Connector Designations are provided in Figures 5 and 6.



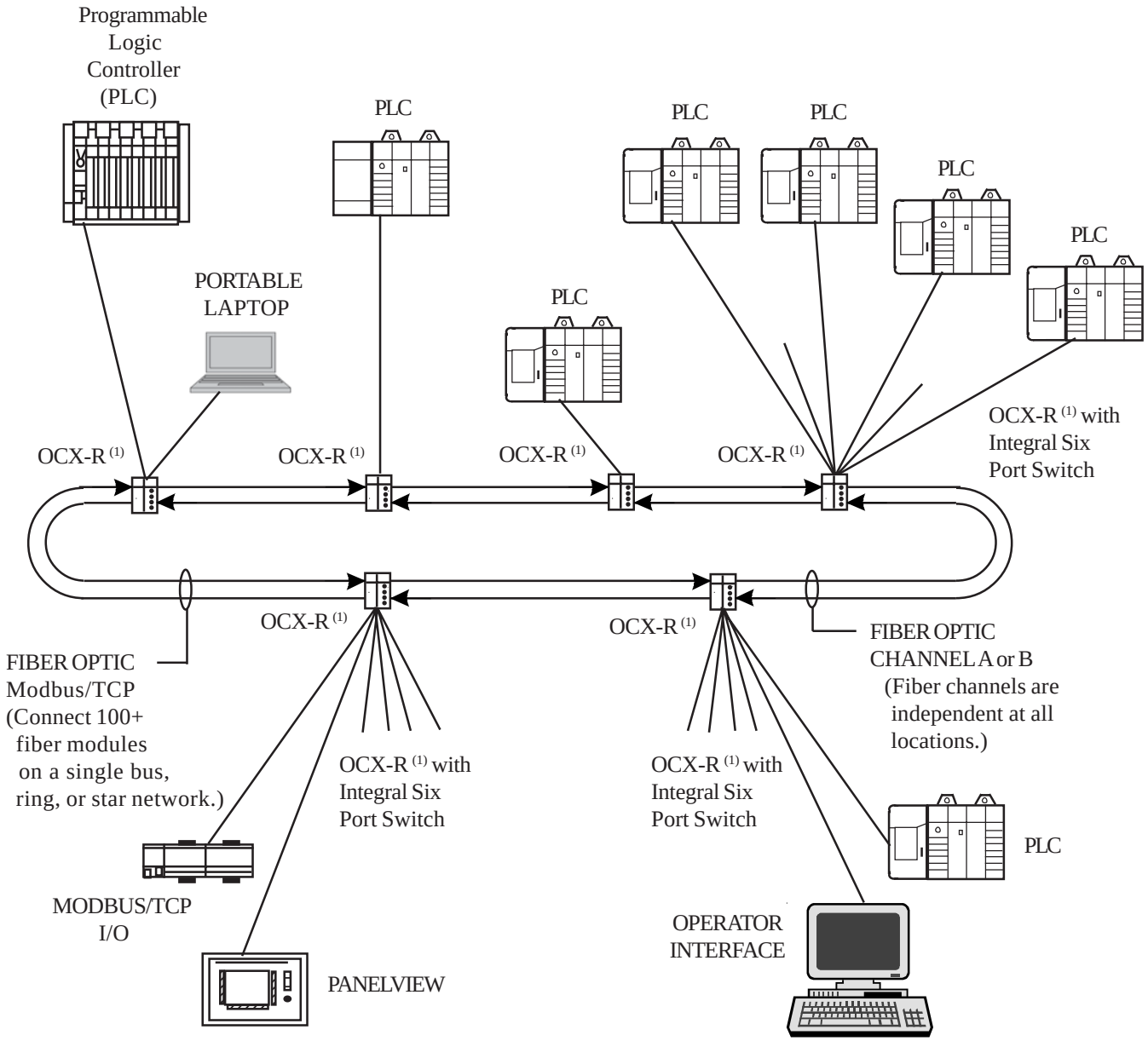
NON-REDUNDANT, 10/100 Mbps MODBUS & ETHERNET BUS NETWORK CONFIGURATION

FIGURE 3

(1) OCX-R = Optical Communication Module
Model # OCX-EMOD-13-R-D-ST-ACV-6A1-MAS

(2) OCX-R = Optical Communication Module
Model # OCX-EMOD-13-R-D-ST-ACV-6A1-485-MAS

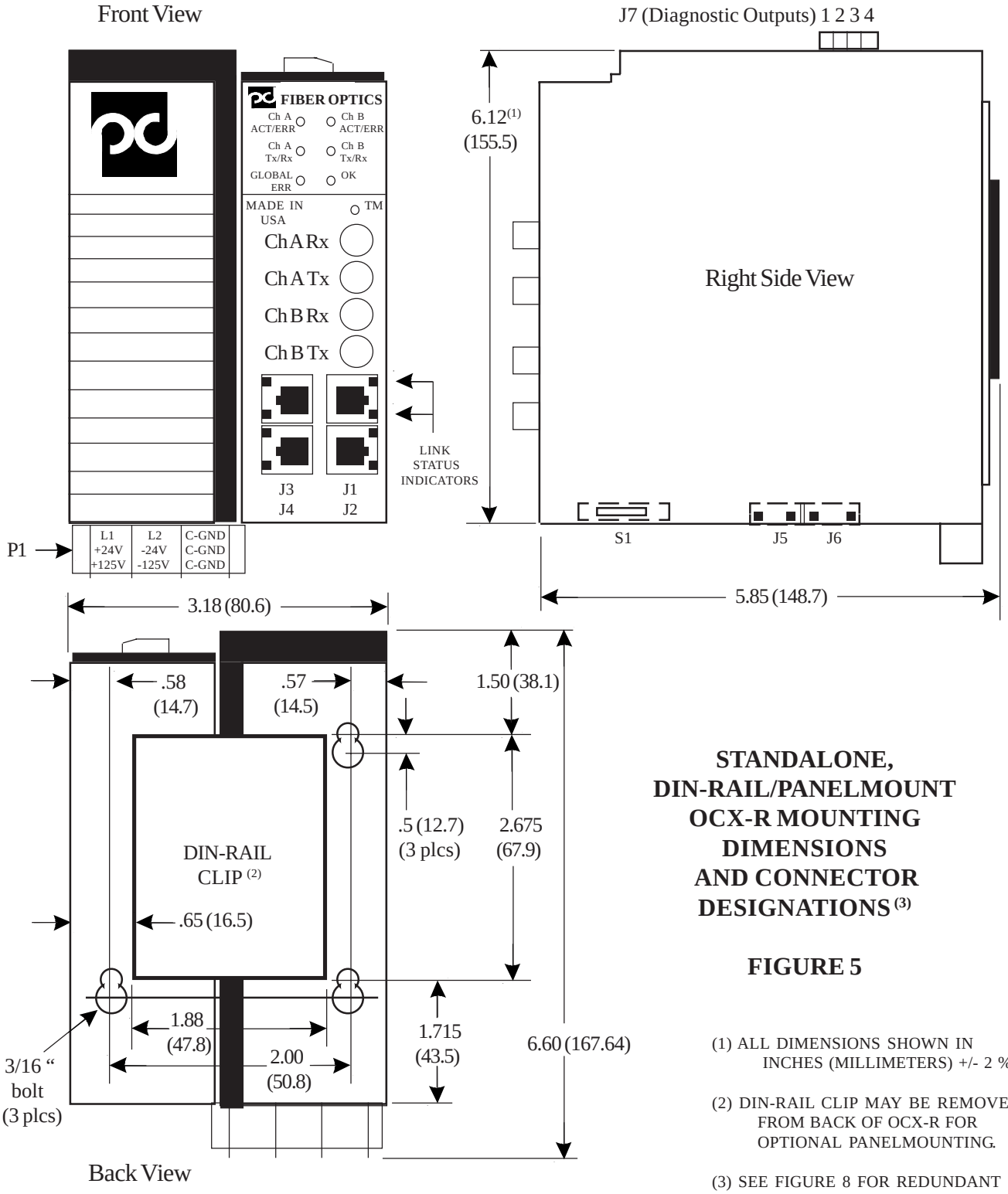
(3) PLC = Programmable Logic Controller



(1) OPTICAL COMMUNICATION MODULE
MODEL # OCX-ETF-13-R-D-ST-ACV-6A1

TYPICAL MODBUS/TCP NETWORK INSTALLATION IN A REDUNDANT, FIBER OPTIC RING CONFIGURATION

FIGURE 4



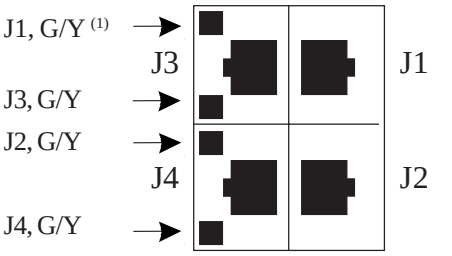
STANDALONE, DIN-RAIL/PANELMOUNT OCX-R MOUNTING DIMENSIONS AND CONNECTOR DESIGNATIONS (3)

FIGURE 5

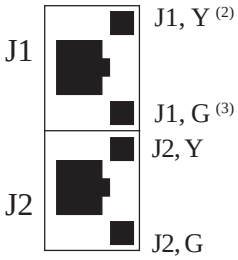
(1) ALL DIMENSIONS SHOWN IN INCHES (MILLIMETERS) +/- 2 %

(2) DIN-RAIL CLIP MAY BE REMOVED FROM BACK OF OCX-R FOR OPTIONAL PANELMOUNTING.

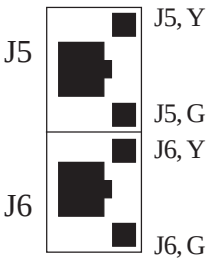
(3) SEE FIGURE 8 FOR REDUNDANT POWER SUPPLY MOUNTING DIMENSIONS AND CONNECTOR DESIGNATIONS.



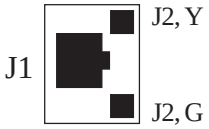
Quad Connector used on the OCX-ETF-R and OCX-EMOD-R when the modules are ordered with four, five, or six ports.



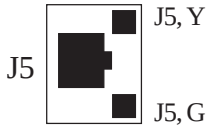
Dual Connector used on the OCX-ETF-R and OCX-EMOD-R when the modules are ordered with two or three ports.



Dual Connector used on the OCX-ETF-R and OCX-EMOD-R when the modules are ordered with six ports.



Single Connector used on the OCX-ETF-R and OCX-EMOD-R when the modules are ordered with one port.



Single Connector used on the OCX-ETF-R and OCX-EMOD-R when the modules are ordered with three or five ports.

(1) Dual Color Link Status Indicator (Quad Connector Only):
Solid Green (Link Established), Flashes Green (Transmit Data), Flashes Yellow (Receive Data), OFF (No Link).

(2) Single Color Link Status Indicator (Single and Dual Connectors Only):
Solid Yellow (Receive Data), OFF (All other states and conditions).

(3) Single Color Link Status Indicator (Single and Dual Connectors Only):
Solid Green (Link Established), Flashes Green (Transmit or Receive Data), OFF (No Link).

J1, J2, J3, J4, J5, J6 CONNECTOR DESIGNATIONS AND LINK STATUS INDICATORS

FIGURE 6

1.3.1 DEVICE INTERFACE SPECIFICATIONS

1.3.1.1 MODBUS/TCP and ETHERNET PORT SPECIFICATIONS (OCX-ETF-R and OCX-EMOD-R)

The 10/100 Base-T OCX-ETF-R Modbus/TCP and OCX-EMOD-R Ethernet device interface port connections are provided on the front and bottom of the fiber optic modules (RJ45 connectors designated as J1, J2, J3, J4, J5, and J6 - see Figures 5 and 6, and Table 3). The number of these ports populated on the module varies as a function of the number specified in the ordering information and model number ("xA1"). These port connections are provided in sequential order beginning with J1, except in the case when a module is ordered with three 10/100 Base-T ports. In this case, these ports will be provided as J1, J2, and J5.

The RJ45 connectors on the front and/or bottom of the fiber optic modules provide independent, switched 10/100 Base-T Modbus/TCP and Ethernet ports. Each of these ports also provides Auto-Negotiation, to automatically determine and conform to the speed and duplex mode of whatever device it is connected to. The ports will independently Auto-Negotiate these operating parameters each time a new device is connected, and/or on initial power-up.

Each RJ45 connector port also provides Auto MDI/MDIX Crossover. This feature allows each individual port to determine whether or not it needs to interchange cable sense between complementary pairs of signals in the cable, so that an external crossover cable will not be required if the signals in the cable are not compatible with the connector. If a port on the fiber optic module is connected to a device that cannot automatically correct for crossover, the fiber module will make the necessary adjustment prior to Auto-Negotiation. The following table provides pin mapping for the MDI/MDIX pin functions:

Physical Pin	MDIX		MDI	
	100BASE-TX	10BASE-T	100BASE-TX	10BASE-T
TXP/TXN	Transmit	Receive	Receive	Transmit
RXP/RXN	Receive	Transmit	Transmit	Receive

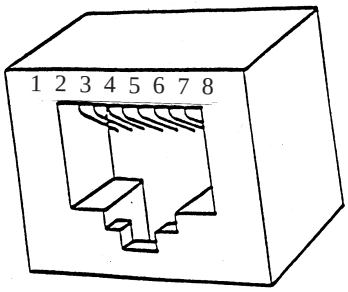
MDI/MDIX PIN FUNCTIONS

TABLE 2

In addition to all of the above, the OCX-ETF-R and OCX-EMOD-R fiber optic modules provide a CAT-5 Cable Tester, built into the RJ45 connector of each 10/100 Base-T communication port (included with the "-D" diagnostic option only). This feature utilizes Time Domain Reflectometry (TDR)

10/100 Base-T Pin Number (1)	Connector Signal Name (RJ45 Interface... Orientation)
1	RD+ (Output)
2	RD- (Output)
3	TD+ (Input)
4	NC (2)
5	NC (2)
6	TD- (Input)
7	NC (2)
8	NC (2)

(1) The J1 thru J6 connectors are 8 pin RJ45 Receptacles. RJ45 Receptacle pin orientation (front view) is given in the figure below...



(2) "NC" = No Connection. All undesignated pin numbers should remain unconnected to any electrical signals.

10/100 BASE-T MODBUS/TCP, ETHERNET, and MODBUS NETWORK BRIDGE PORT CONNECTORS (J1, J2, J3, J4, J5, J6)

TABLE 3

to determine the quality of cables, connectors, and terminators. Some of the possible problems that can be diagnosed by the fiber optic module include opens, shorts, cable impedance mismatches, bad connectors, termination mismatches, and bad magnetics. The cable tester feature is enabled whenever the fiber module is not in Trap Mode, and the TM (Test Mode/Trap Mode) pushbutton on the front of the module is depressed. When this button is depressed all Modbus/TCP, Modbus (RS-232/485), and/or Ethernet devices which are connected to the fiber module will lose their respective links, and the fiber optic module will sequentially perform TDR testing on all RJ45 device interface ports, one at a time. (The TDR test will last two to four seconds on each port.) If no problems are detected on the connected ports, the port indicators on the corresponding RJ45 connectors will flash green with a one second frequency (approximate). If one or more of the above problems are detected on one or more of the connected ports, the corresponding port indicator(s) will flash yellow with a one second frequency. (Port indicators for off-line ports, not connected to any devices, will also flash yellow.) When the TDR test is complete, the fiber optic module will automatically re-enable link communications. (Note that while the Network Master module is performing the TDR cable test, network fault management will be disabled, until the Master module cable test is complete. Also, the cable test feature is not applicable to OCX-MOD Modbus-Only modules (RS-232/485), and this pushbutton should not be pressed on these modules, except during Trap Mode operation.)

1.3.1.2 MODBUS (RS-232/RS-485) COMMUNICATION PORT SPECIFICATIONS (OCX-MOD-R, OCX-EMOD-R)

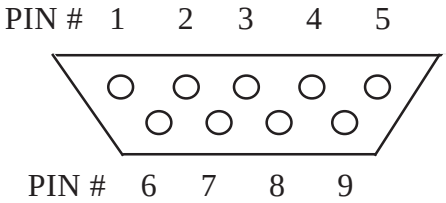
The OCX-MOD-R and OCX-EMOD-R Modbus RS-232 and RS-485 device interface port connections are provided on the bottom/front of the fiber optic modules (9 pin, micro D subminiature connector designated as S1 - see Figure 5). This connector provides RS-232 or RS-485 Modbus communication on OCX-MOD-R and OCX-EMOD-R modules. See Tables 4 and 5 for S1 Connector Pin Definitions (Table 4 for RS-232 Pin Definitions; Table 5 for RS-485 Pin Definitions). Modbus fiber optic modules, with either RS-232 or RS-485 Modbus ports, may be interconnected on the fiber optic network in any combination, providing Modbus RS-232 to RS-485 conversion, On-the-Fly.

1.3.1.3 MODBUS BRIDGE PORT SPECIFICATIONS (OCX-MOD-R, OCX-EMOD-R)

OCX-MOD-R and OCX-EMOD-R fiber optic modules may be connected together on the same fiber optic network, in any combination of module types, and in any network configuration (ring, bus, star, etc.). The network configuration may be further expanded, to interconnect multiple network segments (rings, busses, stars, etc.), by hardwire bridging together OCX-MOD-R and/or OCX-EMOD-R fiber optic modules (one from each segment) at one central location (hub). This hardwire bridging may be accomplished in two different ways. If the OCX-MOD-R and/or OCX-EMOD-R fiber optic modules are ordered with the RS-485 option (“-485”), and the Multi-Master Multiplexing option (“-MAS”) is NOT being used on the network at-large,

S1 Connector Pin Number [1]	Modbus (RS-232) Signal Name [2] (DCE Orientation)
1	Signal Ground [3]
2	No Connection
3	TxD (Transmit Data... Input) [3]
4	RxD (Receive Data... Output) [3]
5	No Connection
6	No Connection
7	CTS (Clear to Send... Output)
8	RTS (Request to Send... Input)
9	No Connection

(1) S1 Connector is a 9 pin, micro D subminiature connector, with male pins. S1 Connector orientation:



(2) Direction provides input/output orientation to/from the OCX module.

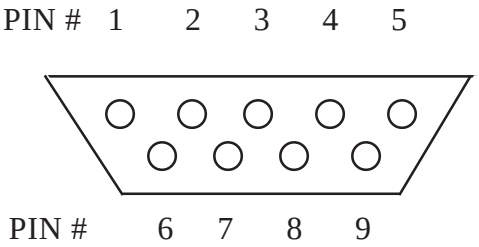
(3) OCX-MOD-R and OCX-EMOD-R fiber optic modules ordered with RS-232 communcations and the "-FD" Full Duplex communcation feature do not require RTS/CTS handshaking signals for module control. Only Transmit Data (TxD), Receive Data (RxD), and Signal Ground should be connected to the fiber optic module S1 connector, and all other connector pins shoud remain open and not connected to any external device.

OCX-MOD-R and OCX-EMOD-R S1 CONNECTOR PIN DEFINITIONS FOR RS-232 COMMUNICATIONS

TABLE 4

S1 Connector Pin Number [1]	Modbus (RS-485) Signal Name [2] (DCE Orientation)
1	Signal Ground [5]
2	Termination + [3]
3	TxD- (Transmit Data [-]... Input) [4, 5]
4	RxD- (Receive Data [-]... Output) [4, 5]
5	No Connection
6	Termination - [3]
7	RxD+ (Receive Data [+]... Output) [4, 5]
8	TxD+ (Transmit Data [+]... Input) [4, 5]
9	No Connection

(1) S1 Connector is a 9 pin, micro D subminiature connector, with male pins. S1 Connector orientation:



(2) Direction provides input/output orientation to/from the OCX module

(3) A 120 ohm termination resistor must be located on the receive data inputs on each end of the RS-485 hardwire network stub connected to the OCX module. This resistor is provided internally on OCX-MOD-R and OCX-EMOD-R fiber optic modules, and is jumper selectable. If the OCX module is located on one end of the RS-485 hardwire network stub, this resistor should be jumper selected by jumpering together S1 Connector Pin #s 2 and 6.

(4) The OCX-MOD-R and OCX-EMOD-R RS-485 Communication Interface is compatible with either 2 wire or 4 wire RS-485 communications. For 4 wire communcation, all of the devices on the hardwire network stub connected to the OCX-R module must be interconnected “TxD+” to “TxD+” and “TxD-” to “TxD-” (Transmit Data Outputs), and these lines should be connected to the OCX transmit data inputs “TxD+” and “TxD-” on S1 Pin #s 8 and 3 respectively. Similarly, all of the devices on the hardwire network stub must also be interconnected “RxD+” to “RxD+” and “RxD-” to “RxD-” (Receive Data Inputs), and these lines should be connected to the OCX receive data outputs “RxD+” and “RxD-” on S1 Pin #s 7 and 4 respectively. For 2 wire communication, OCX S1 connector “TxD-” and “RxD-” Pin #s 3 and 4 should be jumpered together, and “TxD+” and “RxD+” Pin #s 7 and 8 should also be jumpered together.

(5) OCX-MOD-R and OCX-EMOD-R fiber optic modules ordered with RS-485 communcations and the “-FD” Full Duplex communcation feature may only be used for RS-485 4 wire communications. Only Transmit Data (TxD+, TxD-), Receive Data (RxD+, RxD-), and Signal Ground should be connected to the fiber optic module S1 connector, and all other connector pins shoud remain open and not connected to any external device.

OCX-MOD-R and OCX-EMOD-R S1 CONNECTOR PIN DEFINITIONS FOR RS-485 COMMUNICATIONS

TABLE 5

the fiber modules at the hub location may be bridged together by interconnecting the hub fiber module RS-485 ports on a multidrop hardwire bus. If the hub fiber modules are ordered with RS-232 ports, or if the Multi-Master Multiplexing option ("-MAS") is being used, OCX-EMOD-R fiber optic modules with a minimum of two RJ45 communication ports must be used at the hub location (RJ45 connectors designated as J1, J2 - see Table 3 and Figures 5, 6, and 8). In this case, OCX-EMOD-R ports J1 and J2 become Modbus Bridge Ports, and are used to provide a hardwire bridge between the hub fiber modules, bridging together the independent network segments. (These same ports can also be used for 10/100 Mbps Ethernet communication.) Modbus Bridge Port functionality is described in more detail in the Configuration Instructions in Chapter 2, Section 2.6.

1.3.2 OPTICAL NETWORK INTERFACE SPECIFICATIONS

The Optical Network Interface is designated as ChA Rx, Ch A Tx, Ch B Rx, and Ch B Tx on the fiber optic module faceplate (see Figure 5). Phoenix Digital fiber optic modules are compatible with ST, SC, LC, or MTRJ fiber optic connectors... as an ordering option (mating connector which is terminated to the fiber media). Detailed specifications describing optical network transmit and receive capabilities at the 850 nm multimode, 1300 nm multimode, 1300 nm single mode, and 1550 nm single mode wavelengths are provided below:

1.3.2.1 OPTICAL TRANSMITTER BANDWIDTH (ALL WAVELENGTHS)

Maximum Optical Bandwidth = 62.5 MHz

1.3.2.2 OPTICAL TRANSMITTER (850 nm MULTIMODE) :

Parameter	Test Condition	SYM.	MIN.	TYP.	MAX.	UNITS
Fiber Coupled Power	50/125 micron, Graded, 0.20NA	Poc	65/-12.0			microwatts/dBm
	62.5/125 micron, Graded, 0.28NA		160/-9.0			microwatts/dBm
Peak Wavelength		λ_P	830	850	870	nm
Spectral Width		λ_W		1.0	4.0	nm

850 nm MULTIMODE FIBER OPTIC TRANSMITTER SPECIFICATIONS

TABLE 6

OPTICAL TRANSMITTER (1300 nm MULTIMODE)

Parameter	Test Condition	SYM	MIN.	TYP.	MAX.	UNITS
Fiber Coupled Power	50/125 micron Graded, 0.20NA	Poc	5.75 /-22.5	9/-20.3	40/-14.0	microwatts/dBm
	62.5/125 micron Graded, 0.28NA		13/-19.0	28/-15.7	40/-14.0	microwatts/dBm
Wavelength		λ_P	1270	1308	1380	nm
Spectral Width		λ_W		147		nm

1300 nm MULTIMODE FIBER OPTIC TRANSMITTER SPECIFICATIONS

TABLE 7

OPTICAL TRANSMITTER (1300 nm SINGLE MODE)

Parameter	Test Condition	SYM.	MIN.	TYP.	MAX.	UNITS
Fiber Coupled Power	9/125 micron	Poc	320/-5.0			microwatts/dBm
Wavelength		λ_P	1261	1310	1360	nm
Spectral Width		λ_W		7.7		nm

1300 nm SINGLE MODE FIBER OPTIC TRANSMITTER SPECIFICATIONS

TABLE 8

OPTICAL TRANSMITTER (1550 nm SINGLE MODE)

Parameter	Test Condition	SYM.	MIN.	TYP.	MAX.	UNITS
Fiber Coupled Power	9/125 micron	Poc	250/-6.0			microwatts/dBm
Wavelength		λ_P	1500	1550	1600	nm
Spectral Width		λ_W		3.0		nm

1550 nm SINGLE MODE FIBER OPTIC TRANSMITTER SPECIFICATIONS

TABLE 9

1.3.2.3 OPTICAL RECEIVER (850 nm MULTIMODE, 1300 nm MULTIMODE, and 1300/1550 nm SINGLE MODE)

Receiver Sensitivity: .65 microwatts/-32dbm

1.3.3 INTERACTIVE DIAGNOSTICS

Phoenix Digital's fiber optic modules provide advanced, interactive, system-level diagnostics. (Fiber modules must be ordered with the "-D" Option for Interactive Diagnostics.) These diagnostics may be accessed via Discrete Contact Outputs to validate network integrity and assist in trouble-shooting network problems...

- Detect and Locate Fault Conditions Throughout the Network
- Verify Fault Managment and Overall Network Integrity
- Simulate Network Fault Conditions
- Trap-and-Hold Intermittent Failure Conditions

These advanced interactive diagnostics provide the user with a powerful set of tools, greatly simplifying network start-up and on-line maintenance of fiber optic communication networks.

Activation and control of fiber optic module Diagnostics is provided through Diagnostic/Configuration Select Switch Settings. Diagnostic/Configuration Select Switch Settings are provided in Tables 10 and 11. Diagnostic monitoring is provided using reed relay contact outputs. These outputs are accessible on the J7 connector. Specifications and detailed pin-out for the J7 connector are provided in Table 12. Further explanation of fiber optic module diagnostic functions is provided in Sections 1.3.3.1-1.3.3.3.

SWITCH [1]	POSITION [1]	FUNCTION [2]	FACTORY CONFIGURATION (DEFAULT)
Switch Bank "A" [3]	1	Modbus Master/Slave Orientation (OFF = Slave; ON = Master)	OFF
	2	Unused [4]	OFF
	3	Modbus Data Parity, Stop Bit Selection [5]	OFF
	4	Modbus Data Parity, Stop Bit Selection [5]	OFF
Switch Bank "B" [6]	1	Network Master Fiber Module	OFF
	2	Trap Mode Select	OFF
	3	Force Optical Channel A Error	OFF
	4	Force Optical Channel B Error	OFF

(1) See Figure 7 for designated switch locations

(2) ON = Assert (Active, Switch Closed); OFF = Inactive (Switch Open), See Chapter 2, Section 2.6 for Configuration Instructions.

(3) Switch Bank "A" provides configuration switches for Modbus (RS-232/RS-485) communications only, on OCX-MOD-R and OCX-EMOD-R fiber optic modules.

(4) All unused switch positions must remain set in the Factory Default Configuration.

(5) Modbus Data Parity Settings:

Switch Bank "A" SW 3	Switch Bank "A" SW 4	Parity	Stop Bits
OFF	OFF	NONE	2
OFF	ON	ODD	1
ON	OFF	EVEN	1
ON	ON	INVALID	INVALID

(6) Switch Bank "B" provides configuration and diagnostic control switches for all OCX-R fiber optic module types.

DIAGNOSTIC/CONFIGURATION SELECT SWITCH BANK DESIGNATIONS FOR SWITCH BANKS A AND B

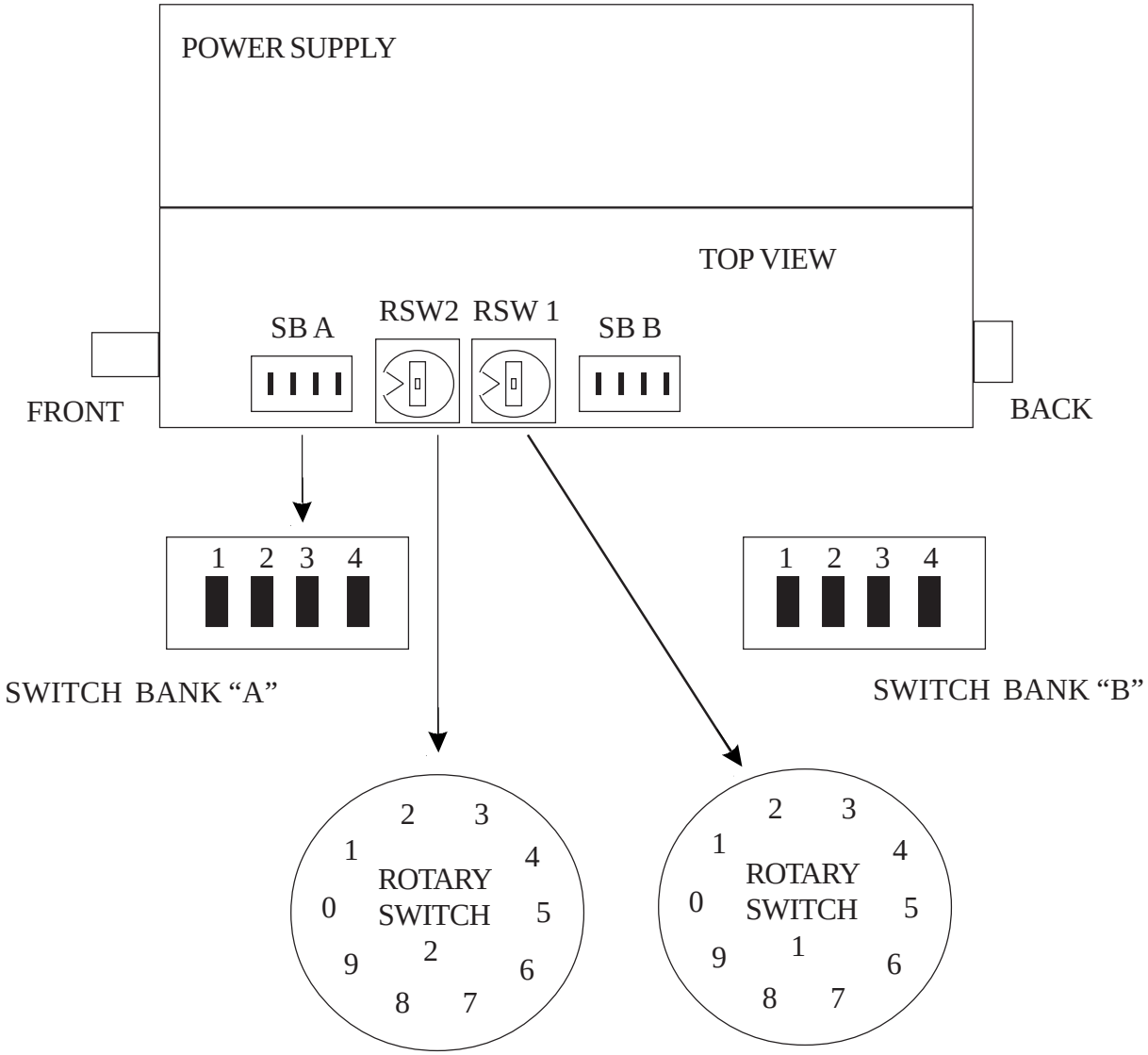
TABLE 10

SWITCH [1]	POSITION [1]	FUNCTION [2]	FACTORY CONFIGURATION (DEFAULT)
Rotary Switch	0	Level 1, Standard Priority, All Ports	**ON**
RSW1 [3]	1	Level 2, Elevated Priority, All Ports	OFF
	2	Level 3, High Priority, All Ports	OFF
	3	Ports J1, J3, J5 Level 2 Priority, Ports J2, J4, J6 Level 1 Priority	OFF
	4	Ports J1, J3, J5 Level 3 Priority, Ports J2, J4, J6 Level 1 Priority	OFF
	5	Ports J1, J3, J5 Level 3 Priority, Ports J2, J4, J6 Level 2 Priority	OFF
	6	Ports J1, J3, J5 Level 4, Management Priority Ports J2, J4, J6 Level 1 Priority	OFF
	7	Ports J1, J3, J5 Level 4, Management Priority Ports J2, J4, J6 Level 3 Priority	OFF
	8	Local Interface Disable	OFF
	9	Unused [4]	OFF
Rotary Switch	0	Modbus Baud Rate = 1,200 baud, ASCII Format	OFF
RSW2 [5]	1	Modbus Baud Rate = 2,400 baud, ASCII Format	OFF
	2	Modbus Baud Rate = 4,800 baud, ASCII Format	OFF
	3	Modbus Baud Rate = 9,600 baud, ASCII Format	OFF
	4	Modbus Baud Rate = 19.2 Kbaud, ASCII Format	**ON**
	5	Modbus Baud Rate = 1,200 baud, RTU Format	OFF
	6	Modbus Baud Rate = 2,400 baud, RTU Format	OFF
	7	Modbus Baud Rate = 4,800 baud, RTU Format	OFF
	8	Modbus Baud Rate = 9,600 baud, RTU Format	OFF
	9	Modbus Baud Rate = 19.2 Kbaud, RTU Format	OFF

(1) See Figure 7 for designated switch locations
(2) ON = Assert (Active, Switch Closed); OFF = Inactive (Switch Open),
See Chapter 2, Section 2.6 for Configuration Instructions.
(3) Rotary Switch “RSW1” provides configuration switches for Modbus/TCP and Ethernet communications, on OCX-ETF-R and OCX-EMOD-R fiber optic modules. Rotary Switch “RSW1” is also included on OCX-MOD-R fiber optic modules with the “MAS” option, and should always be set to Position “0” for this module.
(4) All unused switch positions must remain set in the Factory Default Configuration.
(5) Rotary Switch “RSW2” provides Baud Rate and ASCII/RTU Format selection for Modbus (RS-232/RS-485) communications only, on OCX-MOD-R and OCX-EMOD-R fiber optic modules.

DIAGNOSTIC/CONFIGURATION SELECT ROTARY SWITCH DESIGNATIONS FOR ROTARY SWITCHES RSW1 AND RSW2

TABLE 11



OCX-R DIAGNOSTIC AND CONFIGURATION SWITCH DESIGNATIONS

FIGURE 7

J7 CONNECTOR PIN # (1)	DIAGNOSTIC OUTPUTS (2)
1, 2	Channel A Error (ERR)
3, 4	Channel B ERR

(1) Each diagnostic output is provided as a normally open 1 FORM A contact on the designated pair of J7 pin numbers. When a diagnostic function is asserted (i.e. error) the corresponding contact will close.

(2) Diagnostic Relay Contact Electrical Specifications:

Arrangement	:	1 FORM A
Initial isolation resistance, max.	:	1,000 Meg Ohm
Rating (resistive)		
Max. switching voltage	:	350 VAC, 350 VDC
Max. continuous load current	:	.1 A
Max power dissipation	:	800 mW
Max. On resistance	:	35 ohms
Max. Off state leakage	:	1 microamp
Isolation voltage	:	1,500 VAC

DIAGNOSTIC OUTPUT
ELECTRICAL SPECIFICATIONS AND PIN DEFINITIONS

TABLE 12

1.3.3.1 DETECT AND LOCATE NETWORK FAILURES

Fault conditions are reported by each fiber optic module on relay contact outputs on J7 connector pin #s 1, 2 and 3, 4... for fiber optic Channels A and B respectively. If a fiber optic module detects a communication failure on the fiber optic receive data inputs on either Channel A or B (due to either a media failure or failure of an adjacent fiber module) it will assert the corresonding contact output, and disable the corresponding fiber optic channel transmit data output (resulting in an identical failure on the complementary receive data input of the fiber optic module, adjacent on the network). These contact outputs may be used to locate the precise location where the failure is occurring.

1.3.3.2 TRAP-AND-HOLD, AND LOCATE INTERMITTENT NETWORK FAILURES

When a fiber optic communication failure occurs it normally causes the network to remain in a failed condition until the source of the failure is identified and corrected (solid failure). Contact outputs on each fiber optic module (J7 Pin #s 1, 2 and 3, 4) enable network maintenance personnel to quickly locate this type of failure. However, occasionally an intermittent communication failure may occur, causing the network to briefly fail and then automatically recover. This type of failure can be very difficult to locate because it does not remain in the failed condition long enough for maintenance personnel to locate the source of the problem.

In the factory default configuration, all Phoenix Digital fiber optic modules provide automatic recovery from communication failures. In Auto-Recovery Mode, Phoenix Digitals' fiber modules automatically detect, isolate, and correct communication failures by switching the network around points of failure, and then automatically restore the network to its original configuration when the source of the failure(s) is corrected. However, as an alternative to Auto-Recovery Mode, Phoenix Digitals' fiber optic modules may also be configured to Trap-and-Hold the location of the failure, by configuring the fiber optic modules to operate in Trap Mode. Trap Mode Operation may be switch selected by setting the Network Master Module Switch Bank "B", Switch 2 ON. Selecting Trap Mode on the Network Master module will automatically put the entire network into Trap Mode, and no other fiber module switch or software configuration is required.

In non-redundant fiber optic networks configured for Auto-Recovery, such as open bus or single channel point-to-point network configurations, selection of a fiber optic Network Master module is optional, and not required for network operation. However, in the case of Trap Mode

operation, a single fiber optic module must always be configured as a Network Master module, and this module must also have the Trap Module switch selected. Please also note that when a Network Master module is selected in non-redundant, open bus or single channel point-to-point network configurations, the Global Error indicator will indicate an Error condition on all modules on the network. This indicator should be ignored for purposes of Trap Mode testing. See Figures 5 and 7, and Table 10 for more information.

In Trap Mode, Phoenix Digital's fiber optic modules will continue to automatically detect, isolate, and correct communication failures, just as in Auto-Recovery mode. But when the source of the failures is corrected the Trap Mode fiber modules will NOT automatically restore the network to its original configuration. Instead, the network will remain trapped in the failed condition until the source of the failures is corrected AND the fiber optic modules are reset. Thus, intermittent failures will be continuously trapped by the fiber modules (latched), providing maintenance personnel with the necessary time to locate and correct the source of the network failures.

When Trap Mode is selected the fiber optic modules must be initialized for network communications in the following manner:

1. Install and interconnect all fiber modules on the network with fiber optic cable, in the appropriate network configuration. (Note that if the fiber modules on the network are not properly interconnected with fiber optic cable, they will assume that any improper connection is an intermittent failure and trap the failure accordingly.)

2. Apply power to all of the fiber optic modules on the network. (At this point fiber optic modules configured for Trap Mode operation may indicate a failed condition on both channels... Ch A ERR, Ch B ERR).

3. Reset the Trap Mode fiber optic modules by depressing the TM (Test Mode/ Trap Mode) Pushbutton on the front of any fiber optic module on the network. This will switch the fiber modules into an active, on-line, error free mode of operation, until such time as an intermittent communication failure occurs and the fiber modules trap the failure. (See Figure 5 for the fiber module TM Pushbutton front panel designations.)

4. Trap Mode fiber optic modules may be subsequently reset (after trapping an intermittent failure) by depressing the TM Pushbutton on any fiber optic module on the network.

1.3.3.3 SIMULATE NETWORK FAULT CONDITIONS

After a fault tolerant fiber optic communication network becomes operational it is important to verify the network is correctly configured for fault managment. This may be done by deliberately introducing single points of failure throughout the network, and verifying communication continuity after each failure.

Fiber optic network faults may be simulated by forcing errors on the Channel A or B transmit outputs. Simulation of fiber optic channel errors may be accomplished by setting Switch Bank “B”, Switches 3 and/or 4 ON, for fiber optic channels A and B respectively. See Figure 7 and Table 10.

1.3.4 POWER SUPPLY AND GROUNDING SPECIFICATIONS

1.3.4.1 FIBER OPTIC MODULE POWER SUPPLY AND GROUNDING SPECIFICATIONS

OCX-R fiber optic modules may be operated from a 24 VDC, 120/220 VAC, or 125 VDC input power source, subject to the Power Supply Option specified in the product model number (see Ordering Information). The Auxiliary 24 VDC, 120/220 VAC, or 125 VDC power supply is attached to the side of the fiber optic module enclosure, and may be ordered as either a single or redundant power supply (see Figures 5 and 8).

1.3.4.1.1 AUXILIARY POWER SUPPLY SPECIFICATIONS

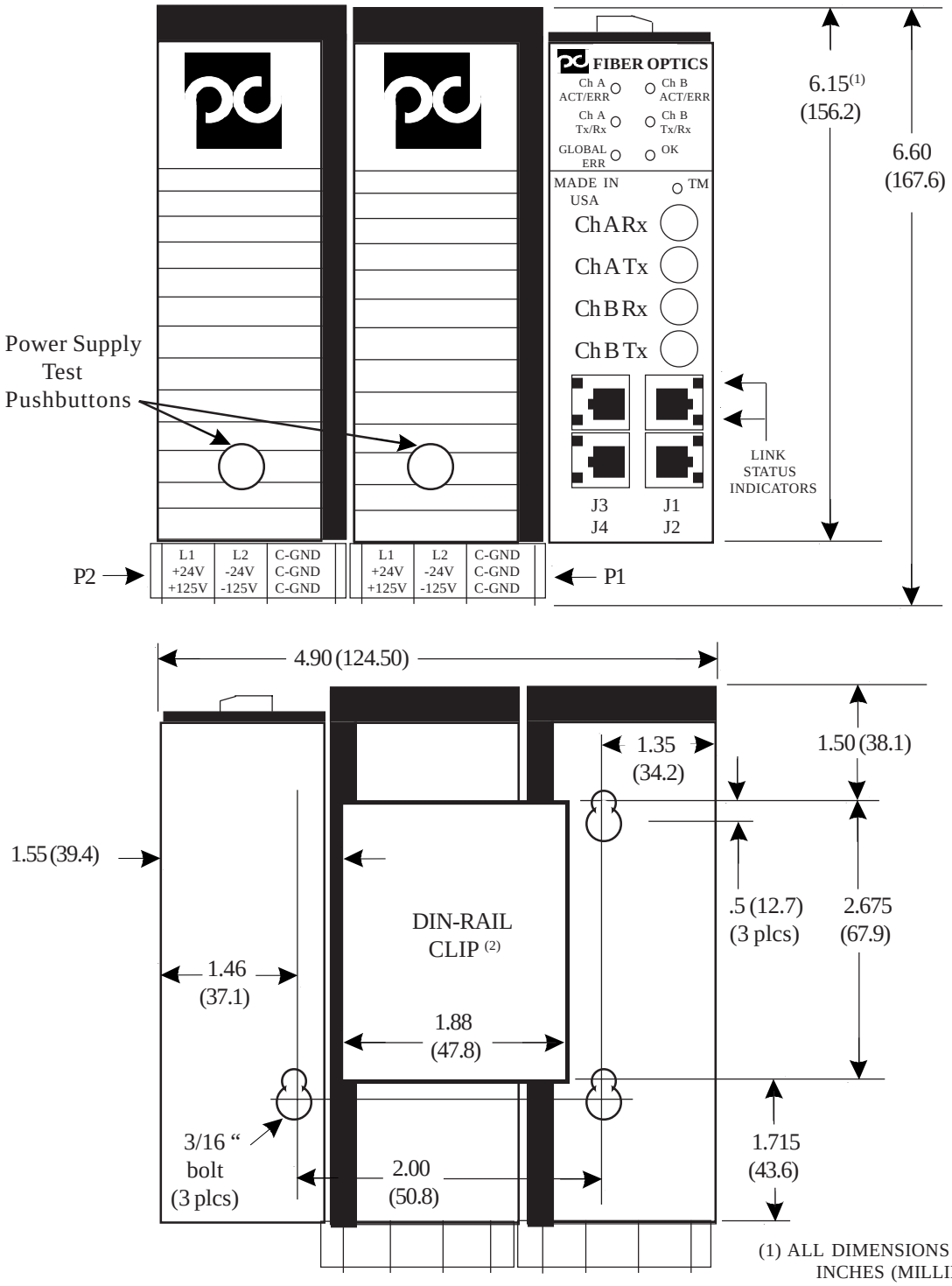
The Auxiliary Power Supply must be ordered as an option to the fiber optic module.

Table 13 provides input power pin definitions for the Auxiliary Power Supply Pl and P2 barrier strips for the 24 VDC and Redundant 24 VDC Power Supply Options (see Figures 5 and 8).

P1, P2 BARRIER STRIP PIN DESIGNATION	SIGNAL NAME (PIN DEFINITION)
+24V	+24 VDC
-24V	24 VDC Return
C-GND	Chassis Ground

24V DC INPUT BARRIER STRIP PIN DEFINITIONS

TABLE 13



Back View

OCX-R (3) WITH REDUNDANT POWER SUPPLY OPTION

FIGURE 8

(1) ALL DIMENSIONS SHOWN IN INCHES (MILLIMETERS) +/- 2 %

(2) DIN-RAIL CLIP MAY BE REMOVED FROM BACK OF OCX-R FOR OPTIONAL PANELMOUNTING.

(3) OCX-R PACKAGE SHOWN ABOVE WITH REDUNDANT POWER SUPPLY. SEE FIGURE 5 FOR OCX-R WITH SINGLE POWER SUPPLY. ALSO, SEE FIGURE 5 FOR SIDE VIEW.

24 VDC Power Supply Requirements (Specified at the +24 VDC, 24 VDC Return Input Power Connections on the fiber optic module connector):

Input Voltage Range	:	+18 VDC to +30 VDC
OCX Input Current	:	0.60 Amps
Regulation (Load and Line)	:	0.6% (min)
Fuse (1)	:	2 AMP, 250 VAC SLO BLO (0.8 inch/20 millimeter)

(1) The fuse is mounted on the internal printed circuit board of the Auxiliary Power Supply. For fuse access the user must remove the Auxiliary Power Supply from the side of the fiber optic module enclosure.

Table 14 provides input power pin definitions for the Auxiliary Power Supply Pl and P2 barrier strips for the 120/220 VAC and Redundant 120/220 VAC Power Supply Options (See Figures 5 and 8).

P1, P2 BARRIER STRIP PIN DESIGNATION	SIGNAL NAME (PIN DEFINITION)
L1	AC Power In (High Line)
L2	AC Power In (Neutral)
⏚	Chassis Ground

120/220 VAC INPUT BARRIER STRIP PIN DEFINITIONS

TABLE 14

120/220 VAC Power Supply Requirements (Specified at the L1, L2 Input Power Connections on the fiber optic module connector):

Input Voltage Range	:	85 VAC to 264 VAC
Input Frequency Range	:	47 Hz to 440 Hz
Conducted RFI (Input Line Filter)	:	FCC limit B and VDE limt A
Hold-Up Time	:	12 milliseconds
Power Consumption UL, CSA, VDE Approved	:	15 watts per OCX (approximate)
Fuse (1)	:	2 AMP, 250 VAC, SLO BLO (0.8 inch/20 Millimeter)

(1) The fuse is mounted on the internal printed circuit board of the Auxiliary Power Supply. For fuse access the user must remove the Auxiliary Power Supply from the side of the fiber optic module enclosure.

Table 15 provides input power pin definitions for the Auxiliary Power Supply Pl and P2 Barrier Strips for the 125 VDC and Redundant 125 VDC Power Supply Options (See Figure 5 and 8):

P1, P2 BARRIER STRIP PIN DEFINITIONS	SIGNAL NAME (PIN DEFINITION)
+125V	+125 VDC In
-125V	125 VDC Return
C-GND	Chassis Ground

125 VDC INPUT BARRIER STRIP PIN DEFINITIONS

TABLE 15

125 VDC Power Supply Requirements (Specified at the +125V, 125V Return Input Power Connections on the fiber optic module connector):

Input Voltage Range	:	120 VDC to 370 VDC
Power Consumption UL, CSA, VDE Approved	:	15 watts per OCX (approximate)
Fuse (1)	:	2 AMP, 250 VAC, SLO BLO (0.8 inch/20 millimeter)

(1) The fuse is mounted on the internal printed circuit board of the Auxiliary Power Supply. For fuse access the user must remove the Auxiliary Power Supply from the side of the fiber optic module enclosure.

1.3.4.2 FIBER OPTIC MODULE REDUNDANT POWER SUPPLY OPERATION

Fiber optic modules ordered with the Redundant Power Supply Option “RACV”, “R24V”, or “R125V”, include two, integral, redundant power supplies, providing dual power supply operation (See Figure 8). When both power supplies are operating correctly, they will share the load, both providing power to the fiber optic module. In the event of a failure of either power supply, the second power supply will provide 100% of the power for the fiber optic module.

Two latching Power Supply Test Pushbuttons are provided on the front of fiber optic modules with the Redundant Power Supply Option. For normal operation, with both power supplies on-line, both pushbuttons should be depressed and latched in. In this state, the pushbuttons will remain latched and will not be illuminated. To test power supply redundancy, the user should press and unlatch one power supply at a time. When the pushbutton is unlatched it will illuminate Red, indicating the corresponding power supply is off-line. This simulates a fault on that power supply. If the fiber optic module continues operating properly while one power supply is off-line, the user should first depress and latch the test pushbutton of off-line power supply to return it on-line, and then repeat the process with the second power supply. The fiber optic module should operate properly as long as at least one power supply is on-line. (Note: If both test pushbuttons are unlatched at the same time, both power supplies will be off-line, and the fiber optic module will be unpowered and non-operational.)

1.3.4.2 ELECTRICAL GROUNDING

The fiber optic module enclosure must be electrically connected to earth ground. This may be accomplished by connecting the Chassis Ground on the Auxiliary Power Supply connector to earth ground, or by attaching a ground electrode directly to the chassis. To ensure a good electrical connection between the ground lug and the module, remove paint from the chassis where the lug makes contact. Connect the ground lug to earth ground with an adequate grounding electrode.

1.3.5 MECHANICAL AND ENVIRONMENTAL SPECIFICATIONS

FIBER OPTIC MODULE DIMENSIONS :

OCX-R with Single Power Supply	:	6.60” H x 3.18” W x 5.85” D (16.8 cm H x 8.1 cm W x 14.9 cm D)
OCX-R with Redundant Power Supply	:	6.60” H x 4.90” W x 5.85” D (16.8 cm H x 12.4 cm W x 14.9 cm D)

FIBER OPTIC MODULE ENVIRONMENTAL SPECIFICATIONS :

Temperature	:	Operating 0° to 60°C Storage -40°C to 85°C
Relative Humidity	:	0 to 95% (non-condensing)

CHAPTER 2

CONFIGURATION AND INSTALLATION INSTRUCTIONS

This chapter provides preparation for use and installation instructions (including unpacking and inspection instructions), and a functional description of indicators, diagnostics and configuration instructions.

2.1 UNPACKING INSTRUCTIONS

All Phoenix Digital fiber optic modules are shipped from the factory in shock absorbing materials. Remove the fiber modules from the packing material and refer to the packing list to verify that all items are present. Save the packing materials for future storage or reshipment.

NOTE: If the shipping carton is damaged upon receipt, request that the carrier's agent be present while the unit is being unpacked and inspected.

2.2 INSPECTION PROCEDURE

Fiber optic modules should be inspected visually for damage upon removal from the shipping container.

2.3 INSTALLATION MOUNTING PROCEDURE

The fiber optic modules should be DIN-Rail mounted or panelmounted per the mounting specifications provided in Figures 5 and 8. All Phoenix Digital fiber optic modules are convection cooled, requiring no fan or forced air cooling. An unobstructed air space must be maintained above and below the fiber modules (6 inches minimum) to insure adequate convection airflow. The air at the bottom of the fiber optic module may not exceed 60 degrees celsius (140 degrees F).

2.4 DIAGNOSTIC STATUS INDICATOR DEFINITION (REFERENCE FIGURES 5 AND 8 FOR INDICATOR DESIGNATIONS)

(i) Ch A, B ACT/ERR (Ch A, B Active/Error)
- Illuminates solid green when the corresponding optical network receive input is receiving valid communications.
- Illuminates solid red when the corresponding optical network receive input fails to detect valid communications.
- Illuminates flashing green/red when the network is in Trap Mode, the module at this location had previously trapped a failure, the cause of the failure has been repaired, and the network has not yet been reset from the trapped condition.

(ii) Ch A, B Tx/Rx
- Illuminates solid green when the corresponding optical network channel is active, and no data is passing through the channel in either direction.
- Illuminates flashing green when the module is transmitting data on the corresponding fiber optic network transmit data output.
- Illuminates flashing yellow when the module is receiving data on the corresponding fiber optic network receive data input.
- Indicator is OFF when the corresponding optical network channel is inactive.

(iii) Global ERR
- Illuminates solid green when all network fiber connections are good. (Requires a redundant network configuration with a Network Master module.)
- Illuminates solid red on OCX/OLC-MOD and OCX/OLC-EMOD modules with the "-MAS" option, when a Modbus Master (Host) device is incorrectly connected to a module which is switch configured for Modbus Slave communications. (To reset this error condition the user must power cycle the fiber module, and change the Master/Slave switch configuration to the correct settings.)
- Illuminates flashing green when there is a break somewhere in the network and the modules are not in Trap Mode. (Requires a redundant network configuration with a Network Master module.)
- Illuminates flashing red when the network is in Trap Mode and there is a failure condition trapped somewhere on the network.
- Illuminates flashing green/red when the network is in Trap Mode, a failure had been previously trapped somewhere on the network, the cause of the failure has been repaired, and the network has not yet been reset from the trapped condition.
- Indicator is OFF when no Master Module is detected on the network.

(iv) OK... Illuminates solid green when the module is powered.

(v) Link Status Indicators (Indicators on Connectors J1, J1, J3, J4, J5, J6. See Figure 6 for Link Status Indicator Designations.)

Dual Color: Green/Yellow (Provided only on Quad Connectors for the J1, J2, J3, and J4 ports on OCX-ETF-R and OCX-EMOD-R Modules with four or more Modbus/TCP or Ethernet ports.)...

Solid Green = Link Established
Flashing Green = Transmit Data
Flashing Yellow = Receive Data
OFF = No Link Detected

Single Color: Green (Provided only on Single and Dual Connectors for the J1, J2, J5, and J6 ports, on OCX-ETF-R and OCX-EMOD-R Modules with one, two, three, five, or six Modbus/TCP or Ethernet ports, and on OCX-EMOD-R Modules with J1, J2 Modbus Bridge Ports.)...

Solid Green = Link Established
Flashing Green = Transmit or Receive Data
OFF = No Link Detected

Single Color: Yellow (Provided only on Single and Dual Connectors for the J1, J2, J5, and J6 ports, on OCX-ETF-R and OCX-EMOD-R Modules with one, two, three, five, or six Modbus/TCP or Ethernet ports, and on OCX-EMOD-R Modules with J1, J2 Modbus Bridge Ports.)...

Solid Yellow = Receive Data
OFF = No Receive Data

(vi) Redundant Power Supply Test Pushbuttons

- Indicator is OFF when the Power Supply Test Pushbutton is depressed and latched in, and the corresponding power supply is on-line and operating properly.
- Illuminates solid red when the Power Supply Test Pushbutton is not depressed and unlatched, and the corresponding power supply is off-line and not operational.

2.5 DIAGNOSTIC STATUS OUTPUT CONNECTIONS

ERR (Ch A, B Communication Error -

Switches ON (closed contact) when the corresponding optical network receive input fails to detect valid data or data carrier. (Since the module detecting the receive data input failure will also disable the corresponding transmit data output, this will have the affect of creating an identical error on the complementary network channel of the fiber optic module, adjacent on the network. The corresponding channel ERR contact will also Switch ON for the adjacent fiber optic module.)

2.6 CONFIGURATION INSTRUCTIONS

Each fiber optic module must be configured (switch selectable) prior to installation.

Configuration Switch locations are identified on the overview of the fiber optic modules depicted in Figure 7. Specifications detailing fiber optic module Network Configuration Switch designations are provided in Tables 10 and 11.

2.6.1 FIBER OPTIC MODULE REPEATER OPERATION

Phoenix Digital's fiber optic modules function as active fiber optic repeaters on the optical network. Each fiber module serves to both restore and resynchronize the data at each location on the network. Therefore, Phoenix Digital's fiber optic modules may be daisychained and/or cascaded together in any quantity and over virtually any distance... subject only to the fiber optic module transmit power, and the optical attenuation (loss) of the optical communication paths.

Optical attenuation may be caused by a number of different elements, including optical connectors, series optical couplers, splices and/or the fiber optic cable itself. If the actual distance between adjacent fiber optic modules on the network is greater than the maximum distance allowed due to optical attenuation, the user should consider upgrading to a more powerful version of the fiber optic module (1300 nm Multimode or 1300/1550 nm Single Mode). However, as an alternative to upgrading the fiber module optical interface, additional fiber optic modules may be inserted into the network as needed, and used as standalone fiber optic repeaters, without making any type of connection to the fiber module's communcation interface. In these cases, the fiber modules will serve as fiber network repeaters only, extending the maximum allowable distance between adjacent locations on the network.

2.6.2 FIBER OPTIC MODULE MASTER/SLAVE CONFIGURATION

One fiber optic module must be switch configured as a Network Master module on all redundant ring and redundant point-to-point network configurations. The fiber optic Network Master module may be located anywhere on the fiber optic network. This Network Master module provides data management and control throughout the fiber optic network. (In tree [combinaton ring, bus/star] network topologies each redundant fiber network segment [segment in a ring or redundant point-to-point configuration] must have one fiber module configured as a Network Master module.) All other fiber optic modules on the network must be configured as Network Slaves.

In the event of a failure of any Network Slave module, or failure of the Network Master module itself, the remaining fiber optic modules will self-heal around the module failure, maintaining network communication by redirecting data communications around the point of failure.

An example of a fiber optic module Network Master/Network Slave configuration in a ring topology network is illustrated in Figure 2. Fiber optic module Network Master/Network Slave Selection configuration switch designations are provided in Table 10. (Note that in the event of failure of the Network Master fiber optic module in a fault tolerant, ring topology network configuration, the remaining fiber optic modules will assume network management, and communication continuity will be maintained throughout the network.)

2.6.3 MODBUS (RS-232/RS-485) NETWORK CONFIGURATION (OCX-MOD-R and OCX-EMOD-R)

Each Modbus fiber optic module must be switch configured to be compatible with the serial commuication parameters of the Modbus device(s) that are connected to the module. These communcation parameters include parity, stop bits, and baud rate. Each fiber optic module must also be switch configured to be compatible the Modbus network format (ASCII vs RTU) and orientation of the device(s) that are connected to it (Modbus Master vs Modbus Slave). See Tables 10 and 11, and Figure 7 for Configuration Switch locations and designations.

Phoenix Digital's Modbus fiber optic modules will convert all Modbus serial data communication parameters, on-the-fly, network-wide. Each fiber optic module may operate at a different baud rate, with different parity and stop bits, to be compatible with the device(s) that are connected to it. Multiple Modbus devices may be connected to a single Modbus fiber optic module using RS-485 communications. The fiber optic modules at each location on the network will convert the serial communication paramters, on-the-fly, to insure compatibility for all devices at all locations. Modbus network format (ASCII vs RTU) must be the same for all devices at all locations on the network.

2.6.4 MODBUS (RS232/RS485) MULTI-MASTER MULTIPLEXING CONFIGURATION (OCX-MOD-R and OCX-EMOD-R)

Phoenix Digital's Modbus fiber optic communication modules (OCX-MOD-R and OCX-EMOD-R) ordered with the "-MAS" Multi-Master Multiplexing option enable communication between multiple Modbus Master devices and Modbus Slave devices on-the-fly, on the same Modbus network. Fiber optic modules with the "-MAS" option provide virtual Modbus Multi-Master Multiplexing, without the requirment for external Modbus Master Multiplexers. This feature enables the user to install Modbus Master devices anywhere on the fiber optic network, and the fiber optic modules will manage and multiplex Modbus Master/Slave communications. This feature is totally transparent to the Modbus network at-large, requires no special Modbus function codes or software intervention by the user, and requires no changes to either the hardware or software of the Modbus network itself. ALL fiber optic modules on a network with multiple Modbus Master devices must include the "-MAS" Modbus Multi-Multiplexing feature. See Table 10 and Figure 7 for Modbus Master/Modbus Slave Configuration Switch locations and designations.

Modbus Multi-Master Multiplexing configuration requires that each fiber optic module be switch configured for either Modbus Master or Modbus Slave communication, compatible with the device(s) that are connected to it. If a Modbus Master device is connected to the fiber optic module, then that fiber module must be switch configured to be a Modbus Master module. If one or more Modbus Slave devices are connected to a fiber optic module, then that fiber module must be switch configured to be a Modbus Slave module. Only ONE Modbus Master device may be connected to the fiber optic module at Modbus Master module locations. NO Slave devices may be connected to Modbus Master fiber optic modules. (The limitation of one Modbus Master device and NO Modbus Slave devices at each Modbus Master fiber optic module location only applies to Modbus networks with more than one Modbus Master device, utilizing the "-MAS" Modbus Multi-Master Multiplexing feature.)

Phoenix Digital's Modbus fiber optic modules are network topology independent, and may be interconnected on fiber in virtually any network configuration (ring, bus, star, etc.). Multiple fiber optic network segments may also be bridged together at a network "HUB" location, using the hardwire Modbus Bridge Ports available on OCX-EMOD fiber optic modules (with the "-MAS" feature), providing one global Modbus network distributed across multiple rings, busses, etc. (OCX-EMOD and OCX-MOD modules may be mixed together on the same fiber optic network.) Bridging of multiple fiber rings or busses on networks using the Modbus Multi-Master Multiplexing feature, requires that OCX-EMOD-R fiber optic modules with two RJ45 ports are used at the "HUB" location, even if only one Modbus Master device is present on the network. (Modbus Bridge Ports are only available on OCX-EMOD fiber optic modules with the "-MAS" feature.)

Bridging of multiple Modbus fiber rings or busses may be performed by interconnecting the OCX-EMOD fiber optic modules from each ring or bus (one per ring or bus) using the fiber optic module Modbus Bridge Ports (RJ45 connectors designated as J1, J2 - see Figures 5, 6, and 8). Bridging of two Multi-Master Modbus fiber rings or busses may be performed by interconnecting the Modbus Bridge Ports between two fiber optic modules, one from each ring or bus. In this case the Modbus Bridge Port connection is made point-to-point between the two fiber optic modules, from the Fiber Module 1, J1 connector to the Fiber Module 2, J1 connector, using Phoenix Digital Interconnect Cable Part Number OCM-CBL-A1-10. Bridging of three or more Modbus fiber rings or busses may be performed by interconnecting the Modbus Bridge Ports between three or more fiber optic modules, one from each ring or bus. In this case the Modbus Bridge Port connections are made between three or more fiber optic modules, from the Fiber Module 1, J1 connector to the Fiber Module 2, J1 connector; from the Fiber Module 2, J2 connector to the Fiber Module 3, J2 connector; from the Fiber Module 3, J1 connector to the Fiber Module 4, J1 connector; etc.; using Phoenix Digital Interconnect Cable Part Number OCM-CBL-A1-10 to connect adjacent fiber optic module Modbus Bridge Ports. The OCX-EMOD-R may also utilize the J1 and J2 communication ports for 10/100 Mbps Ethernet communcation.

2.6.5 FIBER OPTIC NETWORK PRIORITY QUEUING SYSTEM (PQS) (OCX-ETF-R and OCX-EMOD-R MODULES ONLY)

Phoenix Digital's Modbus/TCP and Ethernet fiber optic communication modules (OCX-ETF-R and OCX-EMOD-R) enable the user to adjust overall Modbus/TCP and Ethernet fiber optic network bandwidth, and optimize the performance of the fiber network to insure that higher priority and more frequent communication access is given to the most important Modbus/TCP and Ethernet devices, in the most critical locations on the network, during time periods when the network is heavily loaded with data. Network bandwidth optimization is accomplished by setting Rotary Switch 1 (described in Table 11) to one of eight Priority Settings, 0 through 7.

Rotary Switch 1, Priority Setting 0 is the factory default setting. At this setting the fiber optic module will operate at the Level 1, Standard Priority. All devices connected to this module will have equal priority and equal access to the network. If all fiber optic modules on the network are at the Level 1 Priority setting, all devices on the network will have equal priority and equal access, regardless of network loading.

Rotary Switch 1, Priority Setting 1 will set the fiber optic module to operate at the Level 2, Elevated Priority. At this setting all of the devices connected to this module will have equal priority and equal access to the fiber optic network. On networks where this is the only Level 2, Elevated Priority fiber optic module, and all of the other fiber optic modules are at the Level 1, Standard Priority, devices connected to the Level 2 module will have the highest priority on the network. During times of heavy network traffic, devices connected to the Level 2 fiber optic module will be given twice as much network access as devices connected to Level 1 fiber modules.

Rotary Switch 1, Priority Setting 2 will set the fiber optic module to operate at the Level 3, High Priority. At this setting all of the devices connected to this module will have equal priority and equal access to the fiber optic network. On networks where this is the only Level 3, High Priority fiber optic module, and all of the other fiber optic modules are either at Level 1, Standard Priority or Level 2 Elevated priority, devices connected to the Level 3 module will have the highest priority on the network. During times of heavy network traffic, devices connected to the Level 3 fiber optic module will be given twice as much network access as devices connected to Level 2 fiber modules, and four times as much network access as devices connected to Level 1 fiber optic modules.

Rotary Switch 1, Priority Settings 3, 4, and 5 enable the user to mix network priorities among devices connected to the same fiber optic module. Rotary Switch Priority Setting 3 will assign network Priority Level 2 to devices connected to the odd numbered ports (J1, J3, J5), and Priority Level 1 to devices on the even numbered ports (J2, J4, J6). Similarly, Rotary Switch Priority Setting 4 will assign network Priority Level 3 to devices connected to the odd numbered ports, and Priority Level 1 to devices on the even numbered ports. Rotary Switch Priority Setting 5 will assign network Priority Level 3 to devices connected to the odd numbered ports, and Priority Level 2 to devices on the even numbered ports. These mixed settings are recommended for applications in which the user wants to reserve the highest priority for only the most critical devices connected to the fiber optic module.

Rotary Switch, Priority Settings 6 and 7 provide the Management Priority Level, which is the very highest priority level that can be assigned to any device on the network. These settings enable the user to mix the Management Priority level with lower priority devices, connected to the same fiber optic module. During times of heavy network traffic, devices connected to fiber optic module ports assigned to the Management Priority will be given twice as much network access as devices connected to Level 3 fiber modules and/or ports, four times as much network access as devices connected to Level 2 fiber modules and/or ports, and eight times as much network access as devices connected to Level 1 fiber optic modules and/or ports. Rotary Switch Priority Setting 6 will assign the Management Priority to devices connected to the odd numbered ports on the module, and Priority Level 1 to devices on the even numbered ports. Similarly, Rotary Switch Priority Setting 7 will assign the Managment Priority to devices connected to the odd numbered ports, and Priority Level 3 to devices on the even numbered ports.

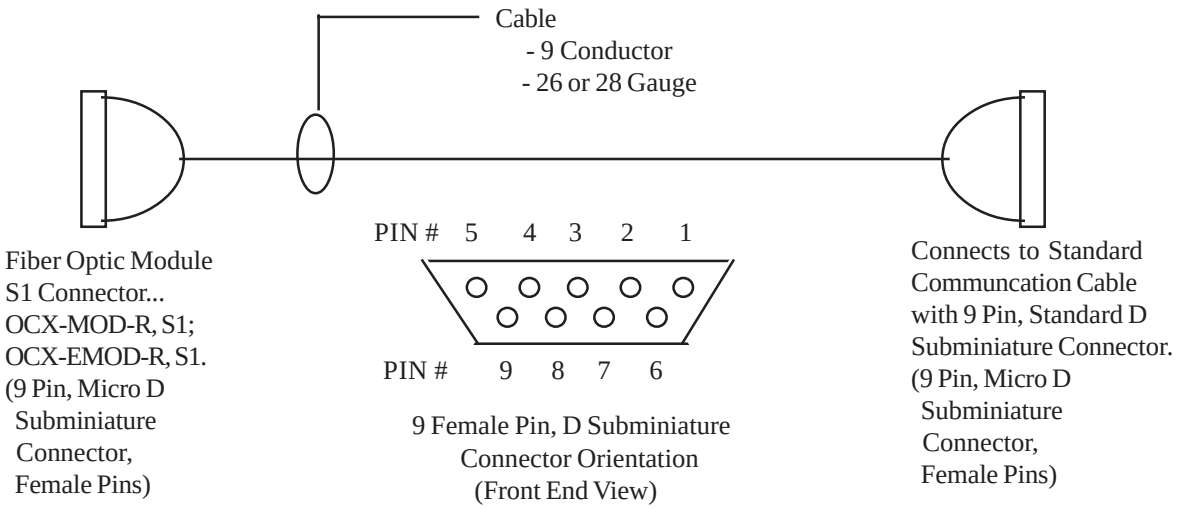
It is recommended for optimum performance, the user assign no more than one fiber optic module on the network to the Management Priority Level. This fiber module should be connected to the most time-critical devices on the network, transmitting short to medium length messages. Assignment of Management Priority to more than one fiber optic module may result in slightly longer reconfiguration times in fault tolerant network configurations.

It is important to recognize that Phoenix Digital's Priority Queuing System (PQS) prioritizes fiber optic network access between the fiber optic modules themselves, and among their respective communication ports. As such, the user should reserve higher priority communication levels for only the select few devices which would benefit from more frequent network access, and allow all other devices to communicate at lower priority levels. The more fiber optic communication modules and/or ports that are assigned to higher priorities, the less noticeable the improvement of communication thruput will be for higher priority devices. For instance, if all of the fiber optic communication modules and/or ports are set to the Level 3, High Priority, the relative communication thruput for all devices would be exactly the same as if all of the fiber optic modules were set to the Level 1, Standard Priority. Therefore, assignment of higher priorities to fiber optic modules and/or ports should only be made when and where needed, and should be judiciously applied.

It is also important for the user to recognize that Phoenix Digital's Priority Queuing System will not improve and/or enhance the performance of the individual communication devices beyond their own unique capabilities. The PQS will only have a relative affect on the preformance of devices connected to higher priority fiber optic modules and/or module ports during periods of heavy network loading. During these times, devices connected to higher priority fiber optic modules and/or ports will experience a significant improvement in network access and thruput. However, during times of moderate network loading, the relative communication thruput improvement of devices connected to higher priority fiber modules and/or ports may be less noticeable. Similarly, during periods of light network loading, the relative communication thruput improvement of devices connected to higher priority fiber modules may not be noticeable at all. During these periods of light network loading, all network devices, regardless of the priority of their fiber optic modules and/or ports, should have the same opportunity to gain access to the fiber optic network, whenever requested. Therefore, there may be little or no noticeable relative performance improvement of those devices which are connected to higher priority fiber optic modules and/or module ports. Essentially, in a lightly loaded networking environment, network performance may be optimum for all devices at all locations, and thus relative performance improvements are not necessary.

APPENDIX A

MODBUS (RS-232/RS-485) 9 PIN MICRO D SUBMINIATURE TO 9 PIN STANDARD D SUBMINIATURE CABLE ADAPTER (OCX-CBL-MOD-(10) [1])

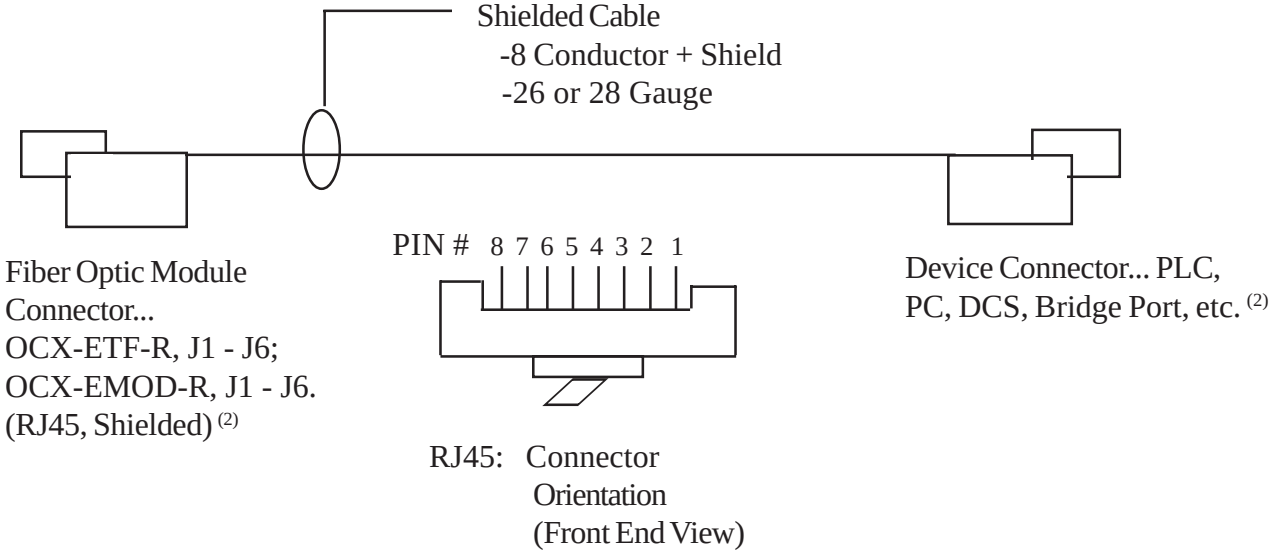


9 Pin, Micro D Subminiature Connector Pin Number	9 Pin, Standard D Subminiature Connector Pin Number	RS-232 Signal Name	RS-485 Signal Name
1	5	Signal Ground	Signal Ground
2	4	No Connection	Termination +
3	3	TxD (Input)	TxD- (Input)
4	2	RxD (Output)	RxD- (Output)
5	1	No Connection	No Connection
6	9	No Connection	Termination -
7	8	CTS (Output)	RxD+ (Output)
8	7	RTS (Input)	TxD+ (Input)
9	6	No Connection	No Connection

[1] 1.5 Foot/.5 Meter Length = No Suffix; 10 Foot/3 Meter Length = "-10" Suffix

APPENDIX B

FIBER OPTIC MODULE INTERCONNECT CABLE DRAWING FOR CONNECTION TO MODBUS/TCP, 10/100 BASE-T ETHERNET, and MODBUS NETWORK BRIDGE PORTS (OCM-CBL-A1-10 [1])



Fiber Module Connector Pin Number	Device Connector Pin Number	Signal Name
1	1	RD +
2	2	RD -
3	3	TD +
4	4	No Connection
5	5	No Connection
6	6	TD -
7	7	No Connection
8	8	No Connection

(1) 10 Foot/3 Meter Length

(2) Cable shield foil or braid should be placed under RJ45 shield housing in order to make good electrical contact.

APPENDIX C

LIST OF FIGURES IN MANUAL

APPENDIX D

LIST OF TABLES IN MANUAL