PEN

Installation and Programming Manual

This Manual describes the PEN PowerLogic Ethernet NIM with the SY/MAX 802.3 Ethernet Protocol, its uses and set up.

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Introduction

The Niobrara PEN (PowerLogic Ethernet NIM) is a network module that interfaces PowerLogic Circuit Monitors (CM) and other PNIM (and RNIM) Slave devices to an Ethernet network. The PEN mounts directly onto the back of a Series 2000 Circuit Monitor. Power for the PEN is provided by the Circuit Monitor through the CM's Input/Output Module Connector.

This manual covers the operation of the PEN-802 and PEN-802-SA models. The -802 version supports the SY/MAX 802.3 Ethernet protocol only. This is the protocol used by the Square D Model 650 and 450 PLCs, SFI-610 card, and standard Niobrara EPE5 and MEB modules. For NRD/TCP or Modbus TCP/IP support order the PEN-TCP. For PowerLogic MMS TCP/IP support order the PEN-MMS.

The PEN includes an industry standard Attachment Unit Interface (AUI) for connecting to the Ethernet network. The AUI port allows the use of any type of Medium Attachment Unit (MAU) to match the installed Ethernet. MAUs are available in a wide variety of sizes for each type of Ethernet Media. Niobrara offers small MAU transceivers for ThinWire (10Base2), Twisted Pair (10BaseT), and fiber optic.

The PEN will support up to 8 CMs (PNIM Slaves) through its RS-485 port. A short color coded pigtail with spade lugs is provided to allow easy connection to the Circuit Monitor. Each of the Slave devices must have a unique network address within the range of 1 through 8. It is recommended that the PEN should be mounted on be the CM set for Slave address 1.

Upon power-up, the PEN will attempt to communicate with CM#1. It will attempt each of the possible CM baud rates and parity combinations until communication is established. Upon establishment of communication with CM#1, the PEN will read register 6995 from the Circuit Monitor to determine its Ethernet network address. Therefore, the only configuration for the PEN is to write the proper value to register 6995 within the CM and this may be accomplished using the controls on the front panel of the CM or with a personal computer and the optical interface for the CM.

The PEN includes internal registers that may be accessed from the Ethernet including mailbox and statistics registers.

Specifications

Module Specifications

Mounting Requirements

One PowerLogic Circuit Monitor Series 2000 with the I/O expansion port free.

Current Draw on CM power supply

mA @ 5VDC nominal + MAU current drain. Power connection is through the 34 pin ribbon cable to the CM's Input/Output Module Connector.

Operating Temperature

0 to 60 degrees C operating. -40 to 80 degrees C storage.

Humidity Rating

up to 90% noncondensing

Pressure Altitude

-200 to +10,000 feet MSL

Ethernet DTE AUI Communication Port

15 pin female D-connector, optically isolated. 10Mb data rate. SY/MAX 802.3 protocol.

RS-485 Communication Port

4 inch pigtail with spade lugs for connecting to the screw terminals on a CM. Fixed PNIM protocol. Self adjusting baud rate and parity to match CM#1. Possible values are 1200, 2400, 9600, and 19200 baud and EVEN or NONE parity.

Indicator lights

4 LEDs: Yellow Serial TX, Yellow Serial RX, Green Active, Red Error, Green E-net Activity.

Physical Dimensions

IOM-4411 footprint.
Wt.:2.5 lb.
W: 6.2 in.
H: 1.5 in.
D: 9.1 in.

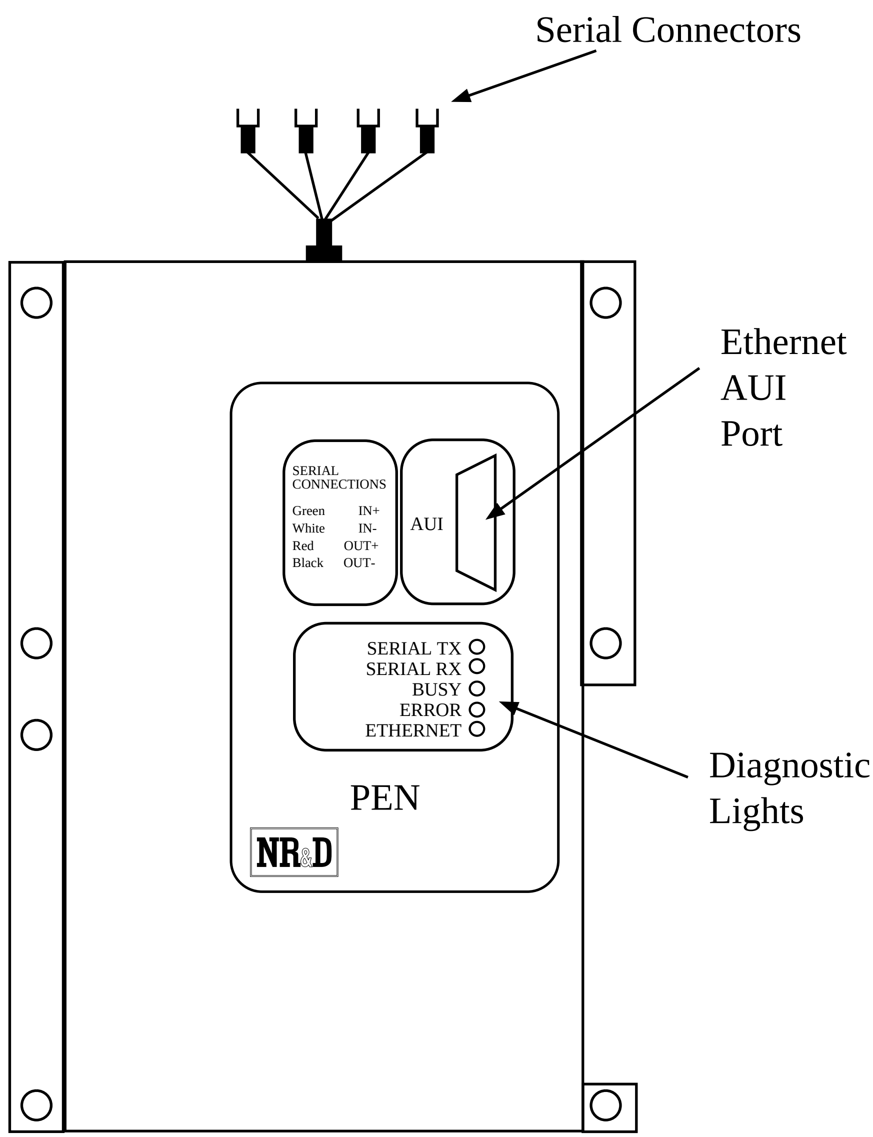

Figure 1-1 PEN Front Panel

2
Installation

Warning
Do NOT install or remove the PEN with power applied to the Circuit Monitor. Turn OFF power at the power supply. Damage to the equipment may occur if the power is on during installation.

Warning
Installing a PEN onto a live Ethernet may result in a duplicate address conflict with another Ethernet device. Configure the PEN to an address known not to exist on the network before connecting the PEN to the network.

PEN Installation

1. Remove power from the Circuit Monitor.
2. Remove the connector guard from the I/O connector on the back of the Circuit Monitor.
3. Plug the PEN's ribbon cable connector into the I/O connector on the back of the Circuit Monitor. Use care not to twist or pinch the ribbon cable as you mount the PEN onto the CM. (See Figure 2-1)
4. Guide the PEN's mounting holes onto the seven studs of the Circuit Monitor. Secure the PEN to the CM with the seven #6-23 nuts supplied with the PEN. Tighten to 6-9 lb.-in (0.68 - 1.01 N-M) of torque.

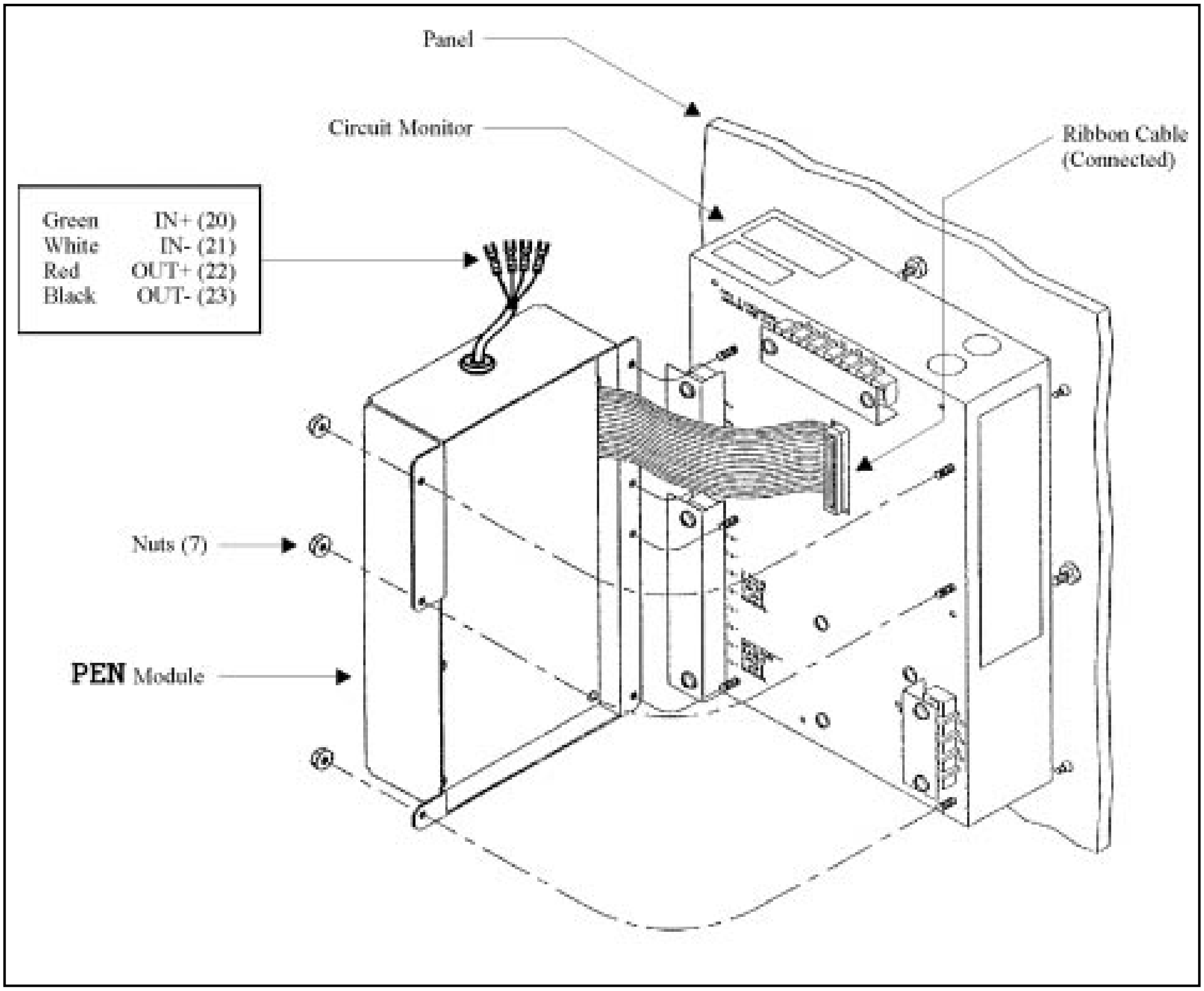

Figure 2-1 PEN Installation

Serial Communications Wiring

The PEN is the PNIM protocol master for a multidrop RS-485 communication network. Up to eight (8) PNIM slave devices may be attached to the PEN with the following restrictions:

- The network Address of each slave devices must be unique and fall within the range of 01 through 08 inclusive.
- At least one slave device must have the network Address of 01. The PEN polls slave #01 determine its setup parameters. It is recommended that the PEN be mounted on the CM with Slave Address 01.
- All slave devices must be set for the same baud rate and parity. The default values are 9600 baud and EVEN parity. The PEN will operate at 1200, 2400, 4800, 9600, and 19200 baud at EVEN and NONE parity. The PEN automatically determines the baud rate and parity for the network based upon the settings of Slave #01.
- The maximum recommended distance for the RS-485 network is 4000 ft. (1220m).

- The last unit on the multidrop network must be terminated with the PowerLogic MCT-485 terminator or equivalent. Terminate only the LAST device (furthest from the PEN). If a link has only one device, terminate that device.
- The PEN provides internal biasing of the multidrop network. NO external biasing device is required or allowed.

PEN to CM Wiring

The PEN provides a short pigtail cable with spade connectors for connection to the RS-485 port of the CM to which it is attached. Table 2-1 provides the color code for connecting to the Circuit Monitor.

Table 2-1 PEN RS-485 Wiring Code

PEN Wire	CM Connector	CM Terminal
Green	IN +	20
White	IN -	21
Red	OUT +	22
Black	OUT -	23

Daisy-Chaining PowerLogic Devices

To daisy-chain additional PowerLogic devices from the PEN, wire the RS-485 terminals from each device to the matching terminal on the next device. In other words, simply connect all of the IN+ connections together on one wire, all of the IN- connections together on another, all of the OUT+ connections together, all of the OUT- connections together and all of the shields together. See Table 2-2 for an example of connecting 4 CMs to a PEN.

Belden 8723 cable (or equivalent) is recommended for the RS-485 network wiring.

Table 2-2 Daisy-Chaining Wiring Example

PEN	CM #1	CM #2	CM #3	CM #8
Green	IN +	IN +	IN +	IN +
White	IN -	IN -	IN -	IN -
Red	OUT +	OUT +	OUT +	OUT +
Black	OUT -	OUT -	OUT -	OUT -
	Shield	Shield	Shield	Shield

NOTE: When connecting multiple devices to the PEN, make sure that each device is configured for a unique network address between 1 and 8. Also make sure that all devices are configured for the same baud rate and parity.

Shielding the RS-485 Network

It is recommended that the Shield cable of the RS-485 link be grounded at one, and only one, point on the multidrop network.

Terminating the RS-485 Network

To ensure reliable communication between the PEN and the devices on the network it is important to provide the proper termination at each end of the network. The PEN provides this termination at its end but an external terminator is needed at the other end. The PowerLogic Class 3090 Type MCT-485 Multipoint Communications Terminator provides an easy solution for connections involving Circuit Monitors. Simply slide the terminator's four spade connectors under the IN+, IN-, OUT+, and OUT- terminals on the CM's RS-485 block.

Biasing the RS-485 Network

The PEN automatically provides full biasing of the network. NO external biasing equipment is required or allowed.

Configuring the PEN

NOTICE: It is important to configure the PEN before placing the unit on the Ethernet network. If the PEN has the same Ethernet address as another SY/MAX device, both devices will drop into a duplicate address error state. This is typically noted by the red Ethernet Error light flashing quickly. No Ethernet communication is allowed to either device while in this state. The SY/MAX protocol requires each device to be manually released from this state. On Square D PLCs, this may require cycling of power on the unit. This type of situation may result in unpredictable behavior of equipment and may lead to personal and property damage and should be avoided.

The Ethernet parameters of the PEN are configured through a group of registers in CM#1. Upon power-up, the PEN attempts to communicate to CM#1 using its last known communication parameters. If it is unable to communicate with the CM, it tries all possible combinations of legal baud rates and parity. Once the PEN is able to talk to the CM#1, it reads registers 6995 to find its Ethernet Network Address. The value in this register must be set in the Circuit Monitor. This may be accomplished through the front panel in Diagnostic mode, using the OCI-2000, or by messages through the PEN to the CM.

For normal SY/MAX 802.3 Ethernet operation, only the PEN's SY/NET address is required for configuration. This value is stored in register 6995 of the CM and must be in the range of 0 through 99. It is recommended that address 0 not be used in order to avoid possible conflicts with new units being placed online.

Warning
Use caution when writing values to the Circuit Monitor. Writing an incorrect value may cause the Circuit Monitor to operate incorrectly.

Setting the Registers through the Front Panel Diagnostics

The Diagnostics mode of the Circuit Monitor allows the user to READ and WRITE registers within the CM directly from the keypad on the front panel. The following steps may be used to set the SY/MAX 802.3 address of a PEN:

1 Press the MODE button until the red LED next to [Setup] is is lit.
The Circuit Monitor displays "Config."

2 Press the down arrow SELECT METER [Value] button until "diAg" is displayed.

3 Press the PHASE [Enter] button to select the Diagnostics mode.
The Circuit Monitor displays the password prompt "P----."

4 Enter the master password.
To enter the password, use the SELECT METER [Value] buttons to increase or decrease the displayed value until it reaches the password value. Then press the PHASE [Enter] button.
The Circuit Monitor display alternates between "rEg No" (an abbreviation fro register number) and "1000" (the lowest available register number)

5 Use the SELECT METER [Value] buttons to increase or decrease the displayed register number until it reaches the desired number.
In this case: 6995.

6 Press the PHASE [Enter] button.
The Circuit Monitor reads the register, then alternately displays the register number as r.XXXX and the register contents as a decimal value.

7 To read another register, press the MODE button, then repeat steps 5 and 6 above.

8 To write to a register, continue with step 9 below.

9 Use the SELECT METER [Value] button to increase or decrease the displayed register number until it reaches the register that you would like to write.
In this case: 6995.

10 Press the PHASE [Enter] button.
Again, the CM alternately displays the register number and the present value in decimal format.

11 Use the SELECT METER [Value] buttons to increase or decrease the displayed decimal value until it reaches the value you would like to write.

12 Press the MODE button.
The Circuit Monitor displays "No".

13 To abort the register write, press the PHASE [Enter] button.

14 To write the value, press the up arrow SELECT METER [Value] button to change from "No" to "Yes." Then press the PHASE [Enter] button.
The display flashes, indicating that the value has been written, then returns to the register number.

15 To write another register, repeat steps 11-14 above.

16 To leave the Diagnostics mode, press the MODE button while the circuit monitor displays "rEg No."

Setting the Registers With the OCI-2000.

All CM-2000 units have an optical serial interface on the front panel. The PowerLogic OCI-2000 provides an interface from this optical connection to RS-232 for connection to a personal computer. When using the OCI-2000, consider the following:

- When the OCI-2000 is powered and attached to the Circuit Monitor, all RS-485 communication to that CM is interrupted. The Circuit Monitor only allows one serial connection to be active at a time and the optical port takes precedence over the RS-485 port. Therefore, devices polling the CM over the RS-485 network will not receive replies from the CM and the RS-485 network master (PEN) will return error replies of the remote device inactive (SY/MAX error 17 (11hex)).
- The baud rate and parity settings for the optical port are the same as those of the RS-485 port. Set the personal computer to match the communication parameters of the CM. The default values are 9600 baud and EVEN parity.
- The CM's network address through the optical port is fixed at 01. It doesn't matter which network address the Circuit Monitor has on the RS-485 network because the CM will only respond to the address 01 when using the optical port. Simply set the last drop in the route to 01 to access the CM.
- The OCI-2000 must have a good 9V battery installed or an external power supply connected. The 9VDC 200mA power supply for the Niobrara SC902 or SC406 (Part number TR92) smart cables may be used to power the OCI-2000.

Any software capable of performing register writes may be used to write a new value to register 6995.

Setting the Registers through the PEN.

If an Ethernet connection is already established, the Ethernet address of the PEN may be changed by routing to the CM #1 and writing a new value to register 6995. The PEN will automatically adjust its address to match the new value within 5 seconds.

Ethernet Network Connection

Warning

Installing a PEN onto a live Ethernet may result in a duplicate address conflict with another Ethernet device. Configure the PEN to an address known not to exist on the network before connecting the PEN to the network.

The PEN requires additional hardware to connect to an Ethernet network. The Ethernet interface on the PEN is an industry standard AUI port. This 15 pin D connector provides the transmit, receive, collision detect, and power connections to an external Medium Attachment Unit (MAU). MAUs are available for a wide variety of Ethernet media. Niobrara offers small MAUs for the most common connections (see Table 2-3).

Table 2-3 Niobrara MAU List

Part Number	Description
ETTW	ThinWire (BNC) transceiver for 10Base2 connections
ETTP	Twisted Pair transceiver for 10BaseT connections
ETFO	Fiber Optic transceiver

Small MAUs may be directly connected to the AUI port of the PEN. The MAU may be located up to 15 meters from the PEN with the use of an AUI cable (See page 40).

3
Operation

The PEN-802 provides support for the Square D SY/MAX 802.3 Ethernet protocol. This protocol is implemented in the Square D Model 650 and 450 series PLCs, the Square D SFI-610 personal computer card, the Niobrara standard EPE5 and MEB modules as well as other devices. The SY/MAX 802.3 protocol provides high speed communication over a standard 10Mbit Ethernet network. This protocol is not compatible with but will co-exist with other network protocols such as TCP/IP or DECnet on a network.

The SY/MAX 802.3 protocol topography allows for up to 100 devices on a network. Each device on a network must be assigned an unique network address within the range 00 through 99. Multiple networks may be bridged together to form large systems. Messages are passed from one device to another by the appropriate use of a route within the message. The route will include the network address of the starting unit, the network address of the target device, and any inter-network addresses required. The route field of a message may be up to 8 layers deep.

The PEN will have its own SY/MAX network address that it reads from CM#1. If the last drop in the route of a message on the network matches that of the PEN, then the PEN will operate on the message and return a reply. If the next to last drop in the route is that of the PEN then the PEN will try to route the message to the network of CMs attached to it. In this case, the last drop in the route must be within the range of 01 through 08 inclusive. The PEN will return an error message for routes with drop numbers outside of this range.

Simple Model 650 Example

Consider Figure 3-1. This is a simple ThinWire network with a Square D Model 650 PLC and a PEN with three CMs attached. The PEN has an external 10Base2 transceiver connected via an AUI cable. The PEN has an Ethernet address of 05 as assigned by register 6995 in CM#1. The Model 650 has an Ethernet address of 44. Each CM is uniquely addressed with values of 01, 02, and 03.

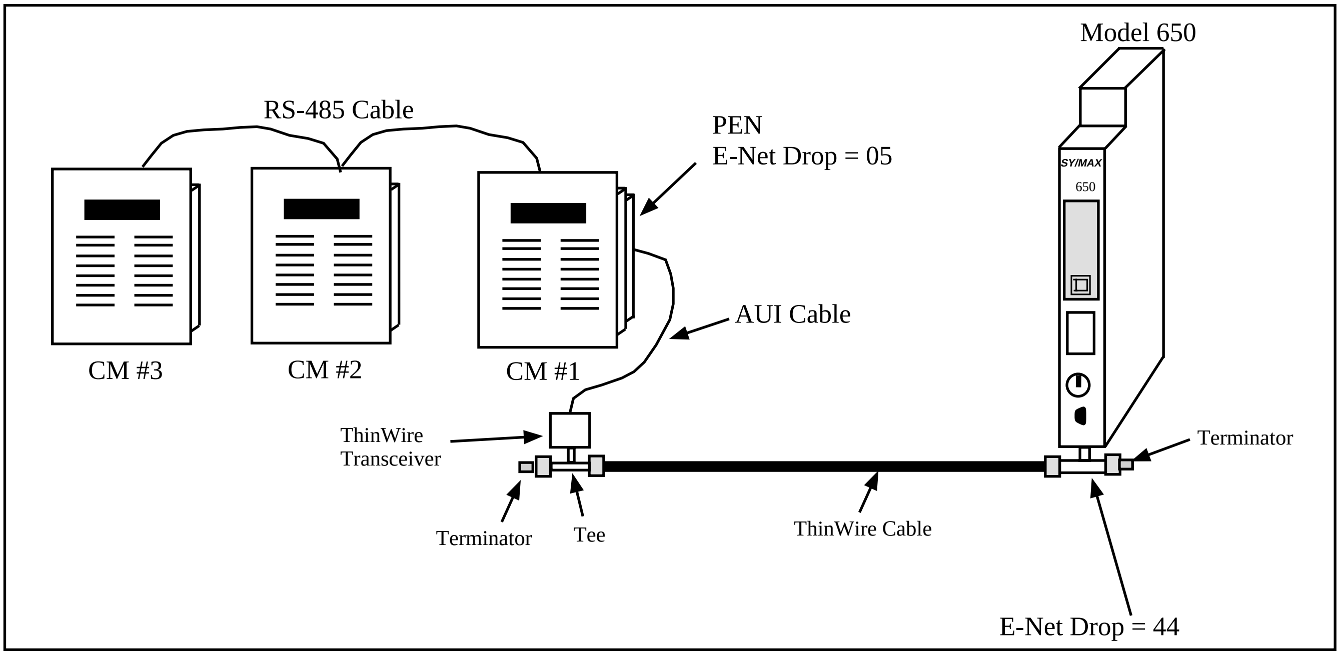

Figure 3-1 Ethernet Routing Example

Communication messages in the Model 650 could be set to target the PEN as well as each of the Circuit Monitors. Table 3-1 lists the possible routes for each destination.

Table 3-1 Example routing

Source	Target	Route
Model 650	PEN	44, 5
Model 650	CM #1	44, 5, 1
Model 650	CM #2	44, 5, 2
Model 650	CM #3	44, 5, 3

EPE5 Example

Figure 3-2 displays a simple ThinWire network with a Niobrara EPE5-D, a PEN with one CM, and a PEN with three CMs attached. Both PENs have an external 10Base2 transceiver connected via an AUI cable. The PEN with the single CM has an Ethernet address of 87 as assigned by register 6995 in CM#1. The other PEN has an Ethernet address of 23. The EPE5 has an Ethernet address of 55. Two personal computers running PowerLogic System Manager Software (SMS) are connected to ports 1 and 2 of the EPE5 using NR&D SC902 RS-232<>RS-422 converter cables. The drop numbers of ports 1 and 2 are 1 and 101 respectively. The internal SMS drop number for each computer is set to 30.

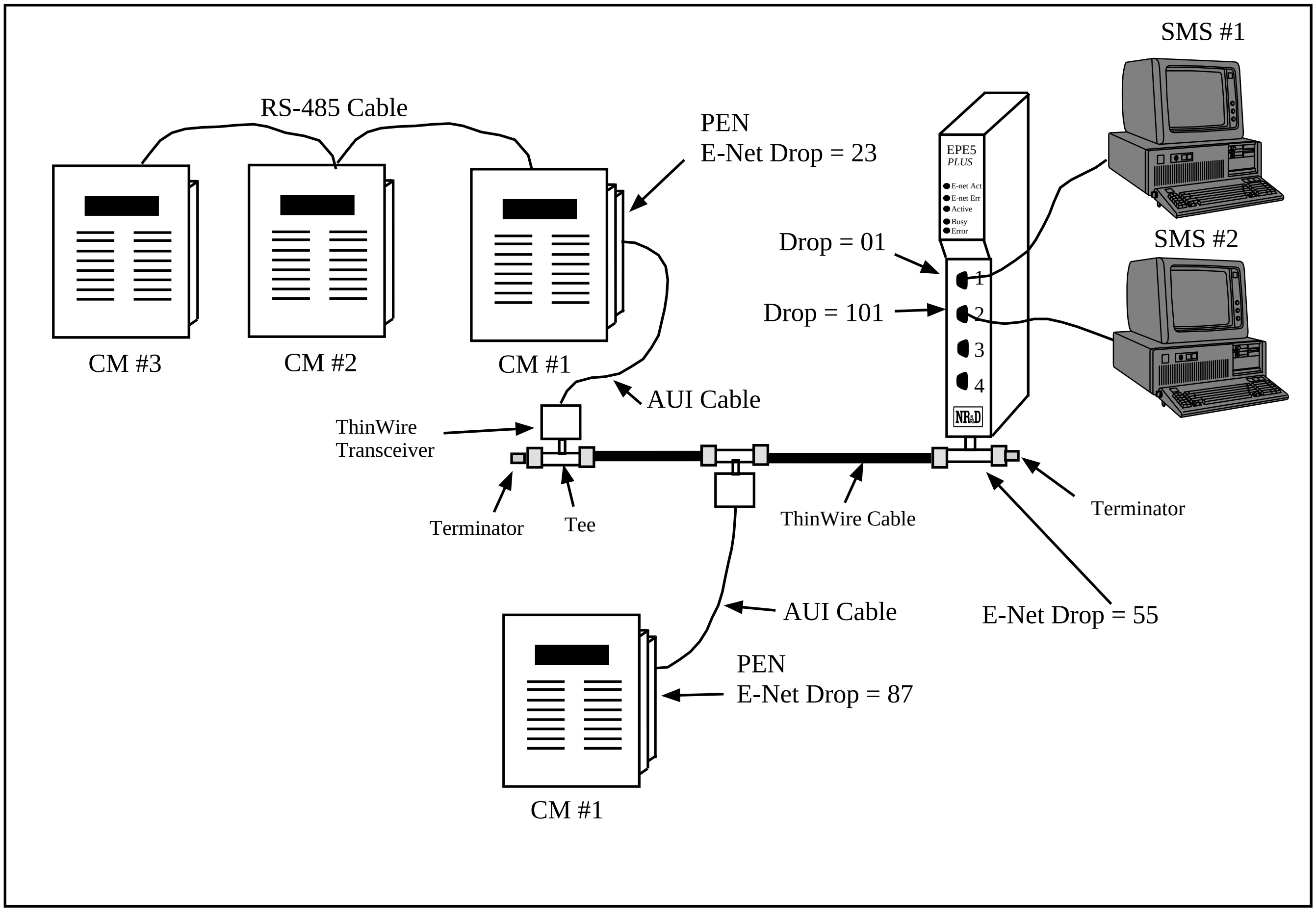

Figure 3-2 EPE5 Routing Example

Communication routes in the SMS computers would be set to access each of the Circuit Monitors. Table 3-2 lists the possible routes for each destination.

Table 3-2 EPE5 Example routing

Source	Target	Route
SMS #1	PEN 87, CM #1	30, 01, 55, 87, 01
SMS #1	PEN 23, CM #1	30, 01, 55, 23, 01
SMS #1	PEN 23, CM #2	30, 01, 55, 23, 02
SMS #1	PEN 23, CM #3	30, 01, 55, 23, 03
SMS #2	PEN 87, CM #1	30, 101, 55, 87, 01
SMS #2	PEN 23, CM #1	30, 101, 55, 23, 01
SMS #2	PEN 23, CM #2	30, 101, 55, 23, 02
SMS #2	PEN 23, CM #3	30, 101, 55, 23, 03

MEB Example

Figure 3-3 displays a simple ThinWire network with a Niobrara PEN with one CM, a PEN with three CMs, and a Niobrara MEB, a Quantum PLC attached via Modbus Plus, and a personal computer running SMS. Both PENs have an external 10Base2 transceiver connected via an AUI cable. The PEN with the single CM has an Ethernet address of 87 as assigned by register 6995 in CM#1. The other PEN has an Ethernet address of 23. The EPE5 has an Ethernet address of 55. The personal computer running PowerLogic System Manager Software (SMS) is connected to port 1 of the MEB using an NR&D SC902 RS-232<>RS-422 converter cable. The drop numbers of port 1 is 2. The internal SMS drop number for the computer is set to 30.

The MEB and Quantum PLC are connected on a Modbus Plus network (MB+). The Quantum may be programmed with the MSTR block to read data from each CM. In this example, each route to a CM was selected to use a unique data path to the E-net port of the MEB. This is not necessarily required and the actual implementation will depend upon the layout of the MB+ network and the amount of traffic through the MEB. More information on MEB routing is available in the MEB manual.

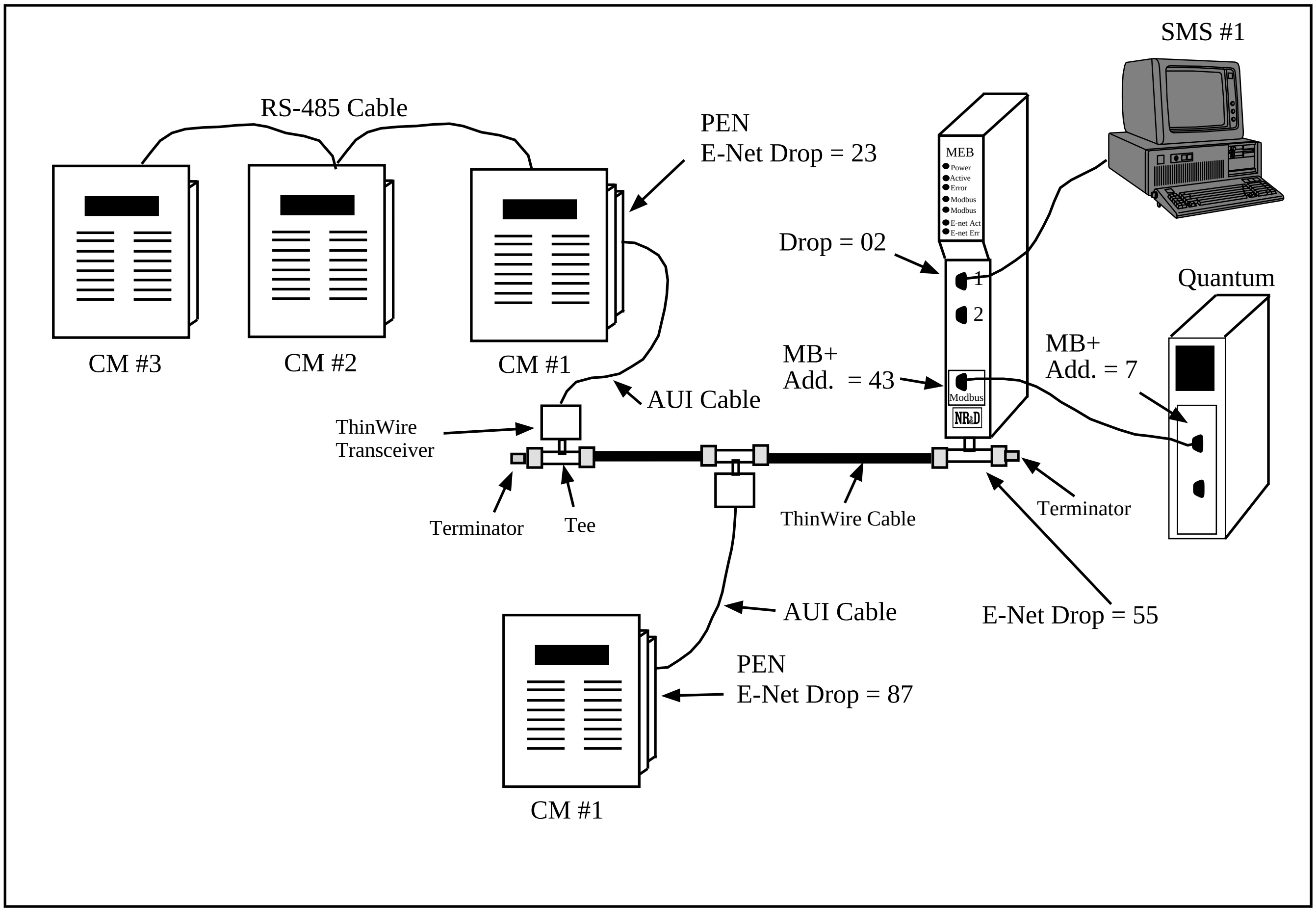

Figure 3-3   MEB Routing Example

Table 3-3 MEB Example routing

Source	Target	Route
SMS #1	PEN 87, CM #1	30, 02, 55, 87, 01
SMS #1	PEN 23, CM #1	30, 02, 55, 23, 01
SMS #1	PEN 23, CM #2	30, 02, 55, 23, 02
SMS #1	PEN 23, CM #3	30, 02, 55, 23, 03
Quantum PLC	PEN 87, CM #1	43 . 04 . 87 . 01
Quantum PLC	PEN 23, CM #1	43 . 05 . 23 . 01
Quantum PLC	PEN 23, CM #2	43 . 06 . 23 . 02
Quantum PLC	PEN 23, CM #3	43 . 07 . 23 . 03

4
Local Registers

The PEN configuration is controlled by writing to a set of registers in CM#1. The PEN also displays its configuration in registers local to the PEN itself. These registers may be read by sending SY/MAX read and write messages to the PEN itself. These messages may be generated by ladder program read and write rungs in a processor, by a SFI-610 card, or a computer program such as the MEBSW program provided with the module. In order for the module to know that a SY/MAX message is for the module itself and not to be routed to the Circuit Monitors, the route should end with the drop number of the Ethernet port. The Register Viewer located in the Utility section of the Niobrara's EPE5SW, SPE4SW, or MEBSW programs is a convenient interface to the PEN's registers.

PEN Register Overview

Table 4-1 represents an overview of the local registers present within the PEN. All registers must be read or written through the E-Net ports.

Table 4-1 Module Register Overview

Register	Function
1..2048	Mailbox registers for user applications
2049..2176	Statistics Registers (See Tables 4-2 and 4-3)
2177..2999	Reserved for future use, do not modify
3000..3302	Ethernet Addresses (See Table 4-4)
3303..7999	Reserved for future use.
8001..8162	Setup and Configuration (See Tables 4-5, 4-6, 4-7)
8176..8188	Module identification (See Table 4-9)

Mailbox Registers

The PEN contains 2048 Mailbox registers numbered 1..2048. Each of these registers may be written or read from the E-net port.

Statistics Registers

The E-net port and PNIM port both have 32 statistical registers. These registers are incremented each time the conditions presented in their description is met. These registers may be cleared by writing a zero.

Ethernet Port Statistics

The Ethernet port has its own group of statistics registers to give the user an idea of the activity on the Ethernet connection of the PEN. The group of registers is shown in Table 4-2.

Table 4-2 Ethernet Port Statistics Registers

Register	Incremented when the following occurs:
2049	SY/MAX Ethernet commands/replies received.
2050	Incoming E-Net SY/MAX packet lost because no available buffer.
2051	Retry packets received.
2052	Packets generated locally. (Auto-transfer)
2053	Packet generation failed because no available buffer.
2054	Packet transmitted successfully.
2055	Transmission failed.
2056	Transmission retry.
2057	Packet lost because of unrecognized or illegal drop or bad route.
2058	Illegal SY/MAX operation request on local registers.
2059	Priority read received and performed upon local registers.
2060	Priority write received and performed upon local registers.
2061	Non-Priority read received and performed upon local registers.
2062	Non-Priority write received and performed upon local registers.
2063	Non-SY/MAX Ethernet packet received.
2064	Ethernet packets transmitted.
2065	Ethernet packets received.
2066	Ethernet collisions.
2067	Ethernet transmit packets lost to excess collisions.
2068	Ethernet receive packets with CRC error.
2069	Ethernet receive packets with framing error.
2070	Ethernet NAK TRANS sent (Sequence error).
2071	Reserved for future use.
2072	Reserved for future use.
2073	Reserved for future use.
2074	Reserved for future use.
2075	Reserved for future use.
2076	Last route received (drops 1,2).
2077	Last route received (drops 3,4).
2078	Last route received (drops 5,6).
2079	Last route received (drops 7,8).
2080	Buffers in use. Number indicates the buffers in use by this port.

Data Port Statistics

The RS-422 port has its own group of statistics registers. These are displayed in Table 4-3.

Table 4-3 Ports 1 and 2 Statistics Registers

Port 1	Port 2	Incremented when the following occurs:
2081	2113	Receipt of a packet on the port. In SY/MAX mode, packet was valid.
2082	2114	Incoming packet rejected (SY/MAX) or lost (other) because no available buffer.
2083	2115	Invalid SY/MAX packet received and negative acknowledge sent.
2084	2116	Message generated internally. (translation, Auto-transfer)
2085	2117	Internal message generation failed because no available buffer.
2086	2118	Packet transmitted (SY/MAX packet acknowledged by recipient.)
2087	2119	Transmission failed (SY/MAX retries exhausted).
2088	2120	Transmission retry.
2089	2121	Message lost because of unrecognized or illegal drop or bad route.
2090	2122	Illegal operation request for local command or translation.
2091	2123	Priority read received and performed upon this port.
2092	2124	Priority write received and performed upon this port.
2093	2125	Non-Priority read received and performed upon this port.
2094	2126	Non-Priority write received and performed upon this port.
2095	2127	Character receive error (parity, framing, etc.)
2096	2128	Characters transmitted
2097	2129	Characters received.
2098	2130	Reserved for future use.
2099	2131	Reserved for future use.
2100	2132	Reserved for future use.
2101	2133	Reserved for future use.
2102	2134	Reserved for future use.
2103	2135	Number of queued messages.
2104	2136	Number of bytes transmitted between SY/MAX checksum and ack returned.
2105	2137	Reserved for future use.
2106	2138	Reserved for future use.
2107	2139	Reserved for future use.
2108	2140	Last route received (drops 1,2).
2109	2141	Last route received (drops 3,4).
2110	2142	Last route received (drops 5,6).
2111	2143	Last route received (drops 7,8).
2112	2144	Buffers in use. Number indicates the buffers in use by this port.

Ethernet Addresses of Known Drops Registers

The IEEE 802.3 protocol requires each physical device on the Ethernet to have a unique address. (This address the address of the Ethernet controller and is not to be confused with the SY/MAX drop number 00..99.) This address is a 6 byte number and its value is governed by the IEEE. Each company that makes Ethernet devices is assigned a block of addresses by the IEEE. All NR&D Ethernet products will have addresses with the form 00-20-BD-XX-XX-XX.

The PEN provides a listing of the physical Ethernet 802.3 address of each known active SY/MAX device on the network (See Table 4-4). These values are placed in Registers 3000..3302 with three registers allocated for each address. The Ethernet address requires six bytes of data and this data is split into two bytes per register. The following formulas will provide the registers containing the Ethernet address of each of the 100 possible devices on the SY/MAX network:

3000 + Drop * 3 = First two bytes of Ethernet Address
3001 + Drop * 3 = Middle two bytes of Ethernet Address
3002 + Drop * 3 = Last two bytes of Ethernet Address

Registers 3300..3302 give the Ethernet address of the MEB.

Table 4-4 Ethernet Physical Address Registers

Register	E-Net Address Bytes	SY/MAX Drop Numbers
3000	First	Drop 00
3001	Middle	
3002	Last	
3003	First	Drop 01
3004	Middle	
3005	Last	
3006	First	Drop 02
3007	Middle	
3008	Last	
3009	First	Drop 03
3010	Middle	
3011	Last	
...	...	...
3297	First	Drop 99
3298	Middle	
3299	Last	
3300	First	Address of this PEN
3301	Middle	
3302	Last	

Setup and Configuration Registers

Registers 8001..8130 are provided for the setup and configuration for the ports of the PEN. Each Port of the PEN uses 32 registers to control its operational parameters. The first two registers concern the entire module and are shown in Table 4-5.

Table 4-5 Module Setup Identification Registers

Register	Legal Values	Function
8001	5001(hex)	Setup identification constant.
8002		Reserved for future use. Do not modify.

Ethernet Port Control Registers

Table 4-6 Ethernet Port Control Registers

Port 0	Legal Values	Function
8003	0..99	Ethernet SY/MAX drop number.
8004		Reserved (IP sub-net mask)
8005		Reserved (IP sub-net mask)
8006		Reserved (IP address)
8007		Reserved (IP address)
8008	2	Protocol Mode (Presently 2, SY/MAX 802.3 only)
8009		Reserved for future use, do not modify
8010		Reserved for future use, do not modify
8011		Reserved for future use, do not modify
		Reserved for future use, do not modify
8012		Reserved for future use, do not modify
		Reserved for future use, do not modify
8013		Reserved for future use, do not modify
		Reserved for future use, do not modify
8014		Reserved for future use, do not modify
8015		Reserved for future use, do not modify
8016		Reserved for future use, do not modify
8017		Reserved for future use, do not modify
8018		Reserved for future use, do not modify
8019		Reserved for future use, do not modify
8020		Reserved for future use, do not modify
8021		Reserved for future use, do not modify
8022		Reserved for future use, do not modify
8023		Reserved for future use, do not modify
8024		Reserved for future use, do not modify
8025	1..32	Buffer Limit
8026		Reserved for future use, do not modify
		Reserved for future use, do not modify
8027		Reserved for future use, do not modify
		Reserved for future use, do not modify
8028		Reserved for future use, do not modify
		Reserved for future use, do not modify
8029		Reserved for future use, do not modify
8030		Reserved for future use, do not modify
8031		Reserved for future use, do not modify
8032		Reserved for future use, do not modify
8033		Reserved for future use, do not modify
8034		Reserved for future use, do not modify

Data Port Control Registers

The serial parameters of the RS-422 port is displayed in Table 4-7.

Table 4-7 Serial Port Configuration Registers

Port 1	Legal Values	Function
8035		Reserved
8036	0..14	Baud Rate
8037	1	Data Bits fixed at 8.
8038	0,2	Parity Bits, 0 = NONE, 2 = EVEN
8039	0	Stop Bits fixed at 1 stop bit.
8040	11	Protocol Mode fixed for PNIM
8041		Reserved
8042		Reserved
8043		Reserved
8044		Reserved
8045		Reserved
8046		Reserved
8047		Reserved
8048		Reserved
8049		Reserved
8050		Reserved
8051		Reserved
8052		Reserved
8053		Reserved
8054		Reserved
8055		Reserved
8056		Reserved
8057	1..16	Buffer Limit
8058		Reserved
8059		Reserved
8060		Reserved
8061		Reserved
8062		Reserved
8063		Reserved
8064		Reserved
8065		Reserved
8066		Reserved

Clear Function Register

Register 8174 is the module clear register. When a specific bit pattern is written to it, the module clears the register after performing the requested operation.

Table 4-8 Reset Bit Description

Bit Number	Description
1	Reserved
2	Reserved
3	Reserved
4	Clear all mailbox registers.
5	Load factory default setup. (does not effect mailbox)
6	Reserved, must be zero if not supported.
7	Must be zero.
8	Must be one.

NOTE: Bits 9 through 16 must be the same as bits 1 through 8 respectively.

For example, the PEN may be reset to factory default settings, clear all mailbox registers by writing the value 9F9Fhex (-24673 decimal) to register 8174. When the PEN has finished resetting, it will zero out register 8174.

Module Identification Registers

All NR&D modules contain a group of registers, 8176..8188, which may be used to determine the module type, the port being used to access the module, and certain operational parameters of the module. Table 4-9 provides an overview of these registers.

Table 4-9 Module Identification Registers

Register	Legal Values	Definition
8176	Bit 16, Bit 5	Port number (not drop number) that is being used to communicate with the module. Bit 16 is always set. Bits 5 indicates Ethernet port.
8177		Packed ASCII module identification. Space Padded.
8178		Packed ASCII module identification. Space Padded.
8179		Packed ASCII module identification. Space Padded.
8180		Packed ASCII module identification. Space Padded.
8181		Packed ASCII module identification. Space Padded.
8182		Packed ASCII module identification. Space Padded.
8183		Packed ASCII module identification. Space Padded.
8184		Packed ASCII module identification. Space Padded.
8185		Packed ASCII module identification. Space Padded.
8186		Packed ASCII module identification. Space Padded.
8187		Reserved
8188	9990 hex	Constant 9990(hex). Indicates NR&D module with name starting at Reg. 8177.

For example, if the PEN has a Firmware revision of 18OCT95, Registers 8177..8186 would have the values in Table 4-10.

Table 4-10 Module ID Example

Register	Values (hex)	Packed ASCII Values
8177	5045	PE
8178	4E20	N
8179	3138	18
8180	4F43	OC
8181	5439	T9
8182	354F	5O
8183	2020	
8184	2020	
8185	2020	
8186	2020	

5

Connector Pinouts

AUI port on PEN (DB15S with slide lock posts)

1	CI-S	Control In Shield (gnd)
2	CI-A	Collision Detect +
3	DO-A	TX+
4	DI-S	Data In Shield (gnd)
5	DI-A	RX+
6	VC	Voltage Common (gnd)
7	CO-A	Control Out+ (no connection in PEN)
8	CO-S	Control Out Shield (gnd)
9	CI-B	Collision Detect -
10	DO-B	TX-
11	DO-S	Data Out Shield (gnd)
12	DI-B	RX-
13	VP	+12VDC
14	VS	Voltage Shield (gnd)
15	CO-B	Control Out- (no connection in PEN)

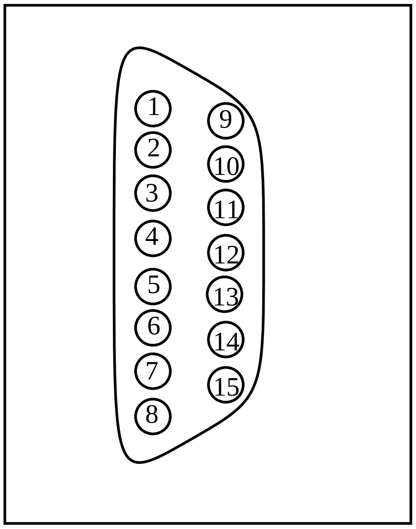

Figure 5-1 AUI Connector Pinout

RS-485 Pigtail Cable Color Code

- GREEN - transmit data (noninverted) from PEN. Connect to IN+ on the CM.
- WHITE - transmit data (inverted) from PEN. Connect to IN- on the CM.
- RED - receive data (noninverted) to PEN. Connect to OUT+ on the CM.
- BLACK - receive data (inverted) to PEN. Connect to OUT- on the CM.

6
Recommended Cabling

PNIM Network Cabling

The PEN provides a short pigtail cable with spade connectors for connection to the RS-485 port of the CM to which it is attached. Table 6-1 provides the color code for connecting to the Circuit Monitor.

Table 6-1 PEN RS-485 Wiring Code

PEN Wire	CM Connector	CM Terminal
Green	IN +	20
White	IN -	21
Red	OUT +	22
Black	OUT -	23

Daisy-Chaining PowerLogic Devices

To daisy-chain additional PowerLogic devices from the PEN, wire the RS-485 terminals from each device to the matching terminal on the next device. In other words, simply connect all of the IN+ connections together on one wire, all of the IN- connections together on another, all of the OUT+ connections together, all of the OUT- connections together and all of the shields together. See Table 6-2 for an example of connecting 4 CMs to a PEN.

Belden 8723 cable (or equivalent) is recommended for the RS-485 network wiring.

Table 6-2 Daisy-Chaining Wiring Example

PEN	CM #1	CM #2	CM #3	CM #8
Green	IN +	IN +	IN +	IN +
White	IN -	IN -	IN -	IN -
Red	OUT +	OUT +	OUT +	OUT +
Black	OUT -	OUT -	OUT -	OUT -
	Shield	Shield	Shield	Shield

NOTE: When connecting multiple devices to the PEN, make sure that each device is configured for a unique network address between 1 and 8. Also make sure that all devices are configured for the same baud rate and parity.

Shielding the RS-485 Network

It is recommended that the Shield cable of the RS-485 link be grounded at one, and only one, point on the multidrop network.

Terminating the RS-485 Network

To ensure reliable communication between the PEN and the devices on the network it is important to provide the proper termination at each end of the network. The PEN provides this termination at its end but an external terminator is needed at the other end. The PowerLogic Class 3090 Type MCT-485 Multipoint Communications Terminator provides an easy solution for connections involving Circuit Monitors. Simply slide the terminator's four spade connectors under the IN+, IN-, OUT+, and OUT- terminals on the CM's RS-485 block.

Biasing the RS-485 Network

The PEN automatically provides full biasing of the network. NO external biasing equipment is required or allowed.

AUI Wiring

Most micro transceivers such as the Niobrara ETTW, ETTP, or ETFO may be directly connected to the AUI port of the PEN. Simply connect the 15 pin MAU onto the AUI port and secure the slide lock.

An AUI cable may be used to connect a remotely located MAU to the PEN. This cable may be built from a 5 shielded pair cable with shield as shown in Table 6-3.

Table 6-3 AUI Cable Wiring

15 pin Male		15 pin Female
3	DO-A	3
10	DO-B	10
11	DO-Shield	11
5	DI-A	5
12	DI-B	12
4	DI-Shield	4
7	CO-A	7
15	CO-B	15
8	CO-Shield	8
2	CI-A	2
9	CI-B	9
1	CI-Shield	1
6	V-Com	6
13	V-Plus	13
14	V-Shield	14
Shell	Protective GND	Shell

Note: The PEN does not use the Control Out circuit so it is not strictly required but it is a good idea to include it if the AUI cable is ever to be used elsewhere.

7
Troubleshooting

Reaching NR&D Technical Support

Technical support at Niobrara may be reached by:

Voice	(800) 235-6723
Voice	(417) 624-8918
Fax	(417) 624-8920
E-mail	techsupport@niobrara.com

Troubleshooting the PEN

The first step in troubleshooting the PEN is to inspect the lights on the PEN itself.

Booting

When the PEN is first powered up, the BUSY, ETHERNET, and ERROR lights will flash on and off four times quickly with the BUSY and ETHERNET on while the ERR is off. If the PEN is displaying this sequence repeatedly, it may be due to the internal watchdog resetting the unit. Causes may include low 5V power from the CM or an internal hardware problem in the PEN itself. The unit may need to be returned to the factory for inspection and service. Call NR&D for a Return Material Authorization number (RMA) before sending the unit in.

Troubleshooting the RS-485 network

Attempting to communicate with CM#1

After booting, the PEN waits for about 5 seconds for the Circuit Monitor to finish booting before it attempts to communicate with it. The PEN first attempts with the baud rate and parity settings stored in its memory from the last time it communicated with the CM. If it is unable to talk to the CM, it adjusts its baud rate and parity to try all possible combinations used by the CM. The yellow Serial TX light will periodically flash as the PEN sends messages to slave #1. If Slave #1 is able to hear and understand the message from the PEN, it will reply and the yellow RX light will flash on the PEN.

The PEN will poll on a two second interval while it is attempting to communicate with CM#1 and hasn't yet established communication. Once communication is established the PEN will poll CM#1 to read register 6995 every five seconds if there is no Ethernet traffic routed to the RS-485 network, or every 50 seconds if it is busy.

Serial TX and RX Lights

The yellow TX light flashes as data is being transmitted from the PEN's RS-422 port. Observing the duration of the TX flashes can give a visual indication of the baud rate being used; 19200 baud flashes quickly while 2400 baud blinks slowly.

The yellow RX light flashes when the PEN is receiving data on the RS-422 port. This light will only flash when the PowerLogic RS-485 slave responds to a command from the PEN. A number of problems may prevent the slave from replying to the PEN:

- **Incorrect RS-485 Cable Connection.** Check that the PEN's RS-485 pigtail is connected to the CM with the GREEN wire to the IN+, the WHITE wire to the IN-, the RED wire to the OUT+, and the BLACK wire to the OUT-. Check all other connected devices to be sure that all of the IN+s are connected to the other IN+s, IN-s, to the other IN-s, OUT+ to OUT+, and OUT- to OUT-. There should be a terminator on only the last CM on the network. The Shield should be grounded at only one location of the RS-485 network. Initial troubleshooting may be easier if only CM#1 is connected to the PEN; then adding additional units after communication is established with CM#1.
- **Incorrect addressing of slaves.** All slave devices on the RS-485 network must be uniquely addressed. These addresses must be within the range of 1 through 8 inclusive. There must be one slave with the Address = 1. The PEN reads register 6995 in slave #1 to determine its Ethernet address. Make certain that all CMs have their own address and that one is set for 1. It is easier to troubleshoot if slave #1 is the unit with the PEN attached.
- **OCI-2000 adapter is connected to the CM.** The optical communications interface disables the RS-485 network on a Circuit Monitor while it is attached and turned on. Power down or remove the OCI-2000 unit to restore communication through the RS-485 network to the CM.
- **RS-422 driver failed on PEN.** The optically isolated RS-422 driver may be tested with a good high impedance voltmeter. Place the meter in the DC Voltage range. Place the RED probe on the Green wire (CM IN+) and the BLACK probe on the White wire (CM IN-). While the PEN is not transmitting (TX light off), there should be approximately +4.1 VDC across these wires. When the PEN is transmitting, the voltage will oscillate through +-4VDC. It may be difficult to see the deflection at the higher baud rates and an oscilloscope is suggested for advanced troubleshooting. The minimum voltage obtained during a full 1200 baud to 19200 baud sweep will be around -1.6 VDC. If the voltage is fixed at around +4, 0, or -4 volts, and doesn't oscillate as the TX light blinks, then the transmitter is probably damaged and must be returned to the factory for repair.

- **RS-422 Receiver failed on CM.** The CM-2000 units have a variety of statistical registers that may be monitored from the Diagnostics monitor on the front panel of the Circuit Monitor.
  - — Register 2100 - **Number of good messages sent to this Unit**. This register will increment each time the CM receives a good message from either the RS-485 network or the Optical port on the front. If this register increments when the PEN transmits at the proper baud rate then the CM's receiver is functioning.
  - — Register 2101 - **Number of good messages sent to other units.** This register will increment each time the CM receives a good message targeted to another slave on the network. If this register increments when the PEN transmits at the proper baud rate then the CM's receiver is functioning.
  - — Register 2102 - **Number of messages with Invalid Address.** This register will increment each time a message is sent from the Master (PEN) targeted to a non-responding slave. If this register increments when the PEN transmits at the proper baud rate then the CM's receiver is functioning.
  - — Register 2103 - **Number of messages with bad checksum.** This register is incremented each time a message is sent to this CM that has a bad checksum.
  - — Register 2104 - **Number of bad messages received at this CM.** This register is incremented each time a bad message is received. This register will increment as the PEN tries different baud rates and parity combinations.
  - — Register 2105 - **Number of messages received at this CM with illegal opcode.**
  - — Register 2106 - **Number of messages received at this CM with illegal registers.**
  - — Register 2107 - **Number of messages received at this CM with illegal counts.**
  - **— Register 2108 -** Number of messages received at this CM with bad frames.
- **RS-422 receiver failed on PEN.** If the PEN is transmitting to CM1, the CM is indicating a good reception by reading register 6100 in the CM from the front panel and observing this counter incrementing, and a slight voltage deflection is observed on the OUT pairs of the CM, then the receiver in the PEN may be malfunctioning. If the RX light on the PEN flashes as the CM transmits, then the RS-422 receiver is good. If the RX light flashes when the PEN polls at the CM's baud rate but the CM continues to poll at other baud rates then either the PEN is broken or most likely, the polarity is reversed between the OUT of the CM and the PEN. Reverse the OUT- and OUT+ wires at the CM.

Ethernet Troubleshooting

Appendix A

NR&D/Online BBS and Internet Access

Niobrara Research & Development is currently offering a Bulletin Board Service for its customers. This valuable customer service tool makes it easy to bring the user up to date on software revisions, firmware changes, product support news, and more.

This BBS operates on a 24 hour a day basis and is accessible from any personal computer equipped with a Hayes compatible modem. **NR&D/Online** will support communications from 300 to 9600 baud, at 8 data bits, NO parity, and 1 stop bit. Set your communications software for the baud rate of your modem, 8 data bits, NO parity, and 1 stop bit, then dial (417) 624-2028 to connect to **NR&D/Online**.

Once connected, you will find a message center, product bulletins, downloadable files and software, plus other news from the NR&D product support team.

Access and online time for **NR&D/Online** is free! You simply pay for your phone call.

For more information about **NR&D/Online** call Tom Fahrig at (800) 235-6723. He will take your information to allow you to log on to **NR&D/Online**.

Niobrara is now on the World Wide Web! Our Internet home page is at **http://niobrara.com** so check us out.

Appendix B

Ethernet Drop Number List

The following Tables are for record keeping of the Ethernet Drop numbers for a single network. Each of the available drop numbers 00 through 99 are listed with space for a brief description of the Ethernet device and location. Below is a typical example:

Ethernet Drop Number	Device Description	Device Location
00	Square D Model 650	Building C, Builder 1, Rack 1
01	NR&D MEB	Building C, Builder 1, Rack 3
02	Square D SFI-610	Building C, Maintenance Office, Jim's PC
03	DEC VAX 3200	Building B, Computer Room
04	NR&D EPE5	Building A, Builder 12, Rack 1

These tables are for the user's convenience and the information is very helpful when new network units are brought on-line.

Table B-1 Ethernet Drop Number Reference

Ethernet Drop Number	Device Description	Device Location
00		
01		
02		
03		
04		
05		
06		
07		
08		
09		
10		
11		
12		
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Ethernet Drop Number	Device Description	Device Location
34		
35		
36		
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46		
47		
48		
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62		
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66		
Ethernet Drop Number	**Device Description**	**Device Location**

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68		
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