

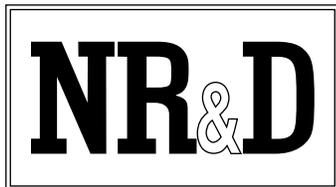
# **PEN-TCP/PEN-T**

## **Installation and Programming Manual**

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This Manual describes the PEN POWERLOGIC Ethernet NIM with the SY/MAX 802.3 and Modbus/TCP (TCP/IP) Ethernet Protocols, its uses and set up. This Manual also describes the PENSX and SETPEN softwares.

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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) and Modbus RTU 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. The Stand Alone model is powered by an included 120VAC transformer.

This manual covers the operation of the PEN-TCP, PEN-TCP-SA, PEN-T, and PEN-T-SA models. These models support the Modbus/TCP and SY/MAX 802.3 Ethernet protocols. The Modbus/TCP Ethernet protocol is the new "standard" Industrial Ethernet Protocol with wide support by Schneider Electric (Modicon and Square D POWERLOGIC) as well as most HMI companies. POWERLOGIC's System Manager Software (SMS3000, SMS1500, etc.) now offers direct support for Modbus/TCP Ethernet to allow direct communication to PEN-TCP units and their attached slaves. SY/MAX 802.3 is Square D's old Ethernet protocol used by the SY/MAX PLCs.

The PEN-TCP and PEN-TCP-SA include 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-T and PEN-T-SA include a standard RJ45 10BaseT Ethernet port.

The PEN will support up to 32 slaves (PNIM Slaves and/or Modbus RTU Slaves) through its RS-485 port. The PEN automatically determines the appropriate protocol to use with each slave and thus the serial network may be any mixture of PNIM and Modbus RTU devices. A short color coded pigtail with spade lugs is provided to allow easy connection to the Circuit Monitor. The Stand Alone PEN-TCP-SA version includes a standard 9 pin SY/MAX pinout connector for the RS-485 connection. The PEN-T-SA includes a removable 5 pin screw terminal for the RS-485 port. Each of the Slave devices must have a unique network address within the range of 1 through 32.

The PEN-T and PEN-T-SA have hardware on their RS-485 ports that directly support 2-wire RS-485 networking as well as standard 4-wire RS-485. Simply jumper the IN+ to the OUT+ and the IN- to the OUT- and the PEN-T automatically detects the 2-wire configuration and tri-states its transmitter. The PEN-TCP and PEN-TCP-SA do not directly support 2-wire RS-485 an an adapter such as the SM285 must be used.

Upon its initial power-up or whenever the PEN's memory has been cleared, the PEN will not have an IP address. The PEN automatically attempts to connect to a BOOTP or DHCP server via the Ethernet port and at the same time the PEN will attempt to communicate with Slave 1 on its RS-485 port. If a

BOOTP or DHCP server responds with an IP address then the PEN will configure itself for that IP address and select Modbus/TCP for its Ethernet Protocol. Meanwhile, the PEN will attempt each of the possible CM baud rates and parity combinations until communication with Slave #1 is established. Upon establishment of communication with CM#1, and if the PEN has not yet received an IP address from a BOOTP/DHCP server then the PEN will read registers 6995 through 6999 from the Slave #1 to determine which Ethernet protocol to use: SY/MAX 802.3 or MODBUS/TCP. So, if a BOOTP or DHCP server is not used then the only configuration for the PEN is to write the proper value(s) to register(s) 6995, 6996, 6997, 6998, and 6999 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 personal computer applications PENSU, PENSU32, and SETPEN are provided to assist in configuring the PEN-TCP-SA in applications where a BOOTP/DHCP Server is not accessible and registers 6995-6999 are not available in the slave #1 such as a POWERLOGIC POWERMETER, or POWERLINK unit.

After the PEN has its Ethernet configuration it will attempt to communicate with slaves 1 through 32 to determine which slaves are present and which protocol to use with each slave (Modbus or PNIM). If any slaves are later added to the network, the PEN will automatically add these new devices.

Modbus/TCP and RTU serial support means the PEN-TCP may be used to bridge Modbus RTU Slaves to Ethernet. Schneider Automation PLCs may be directly accessed via Modbus/TCP from Modsoft or Concept for programming.

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

## **PEN-TCP 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 or MODBUS/TCP protocol. BOOTP and DHCP support provided for automatic IP configuration.

### **RS-485 Communication Port**

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

### **Indicator lights**

4 LEDs: Yellow Serial TX, Yellow Serial RX, 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.

## **PEN-TCP-SA Specifications**

### **Operating Temperature**

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

### **Power Supply**

110VAC wall mount transformer.

### **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 or MODBUS/TCP protocol. BOOTP and DHCP support provided for automatic IP configuration.

### **RS-485 Communication Port**

9 Pin SY/MAX pinout RS-485 connector with slide lock posts. Self adjusting PNIM and/or Modbus RTU protocol. Self adjusting baud rate and parity to match the network. 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.

## **PEN-T 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 10BaseT Communication Port**

RJ45 standard twisted pair 10BaseT port. BOOTP and DHCP support for automatic IP configuration.

**RS-485 Communication Port**

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

**Indicator lights**

5 LEDs: Yellow Serial TX, Yellow Serial RX, Red Error, Green E-net Activity, Green Ethernet Link.

**Physical Dimensions**

IOM-4411 footprint.

Wt.:2.5 lb.

W: 6.2 in.

H: 1.5 in.

D: 9.1 in.

**PEN-T-SA Specifications****Operating Temperature**

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

**Power Supply**

3 terminal removable screw connector. 90-276VAC 50/60Hz or 90-220VDC.

**Humidity Rating**

up to 90% noncondensing

**Pressure Altitude**

-200 to +10,000 feet MSL

**RS-485 Communication Port**

5 Pin removable screw terminal RS-485 connector. Self adjusting PNIM and/or Modbus RTU protocol. Self adjusting baud rate and parity to match the network. Possible values are 1200, 2400, 9600, and 19200 baud and EVEN or NONE parity.

**Indicator lights**

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

**Physical Dimensions**

IOM-4411 footprint.

Wt.:2.5 lb.

W: 6.2 in.

H: 1.5 in.

D: 9.1 in.

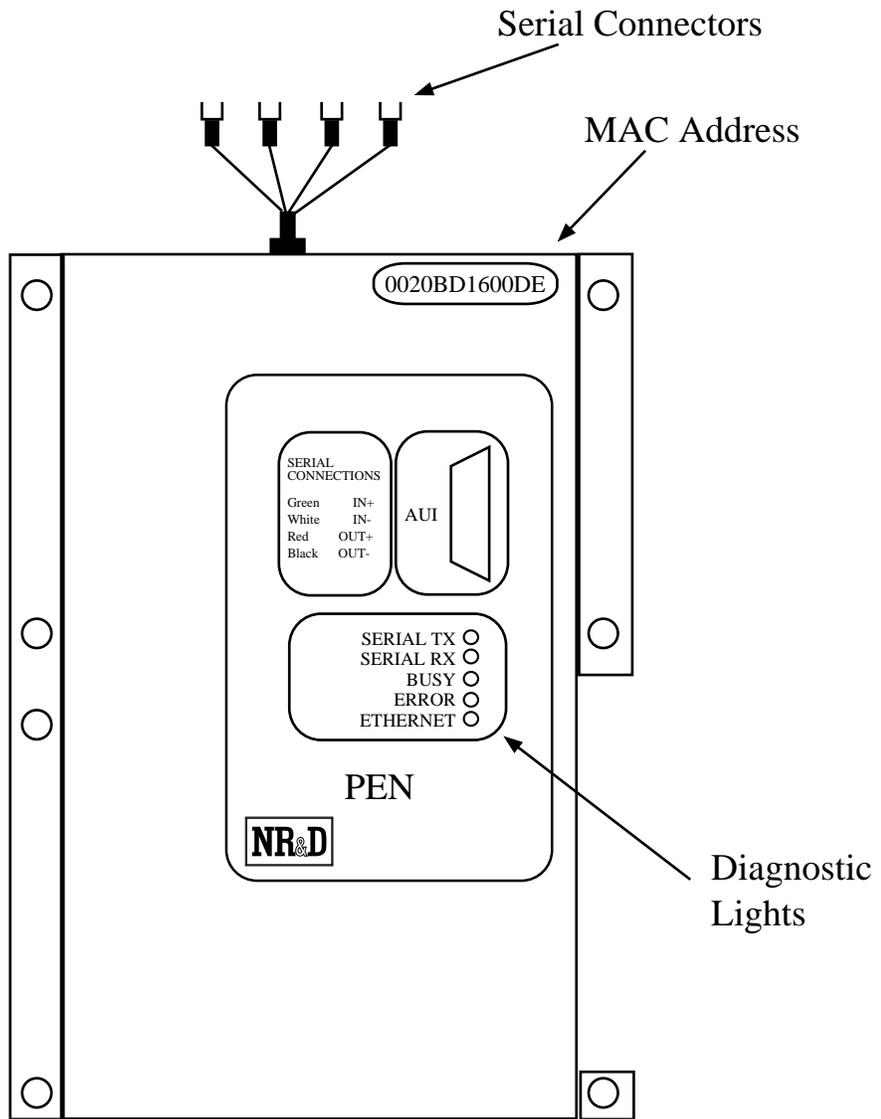


Figure 1-1 PEN-TCP Front Panel

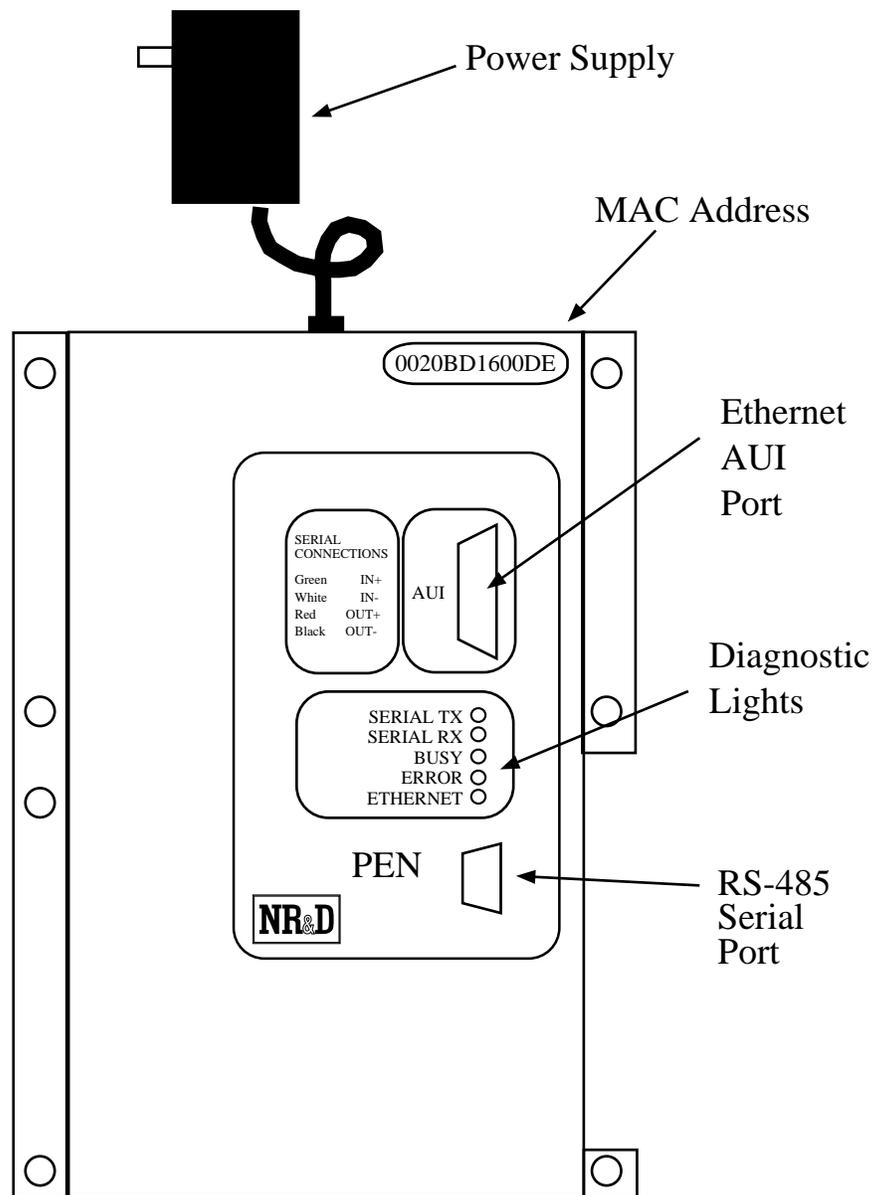


Figure 1-2 PEN-TCP-SA Front Panel

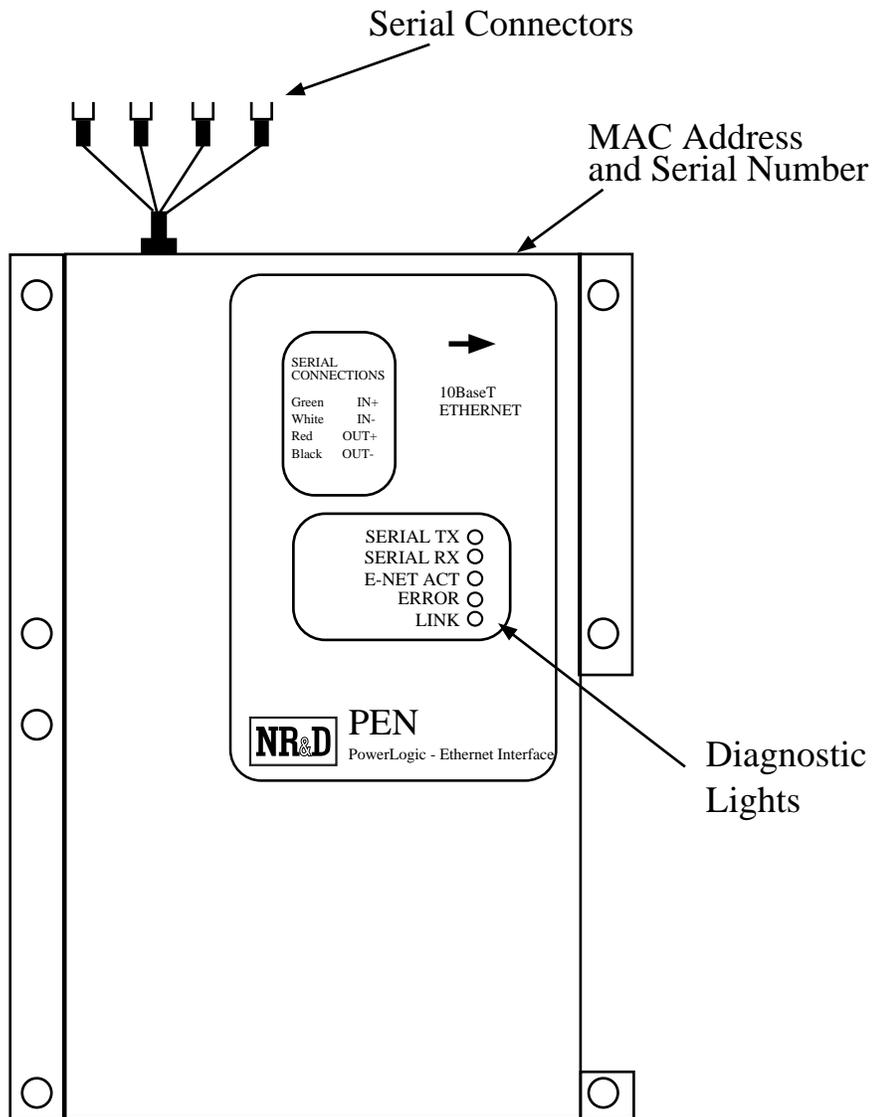


Figure 1-3 PEN-T Front Panel

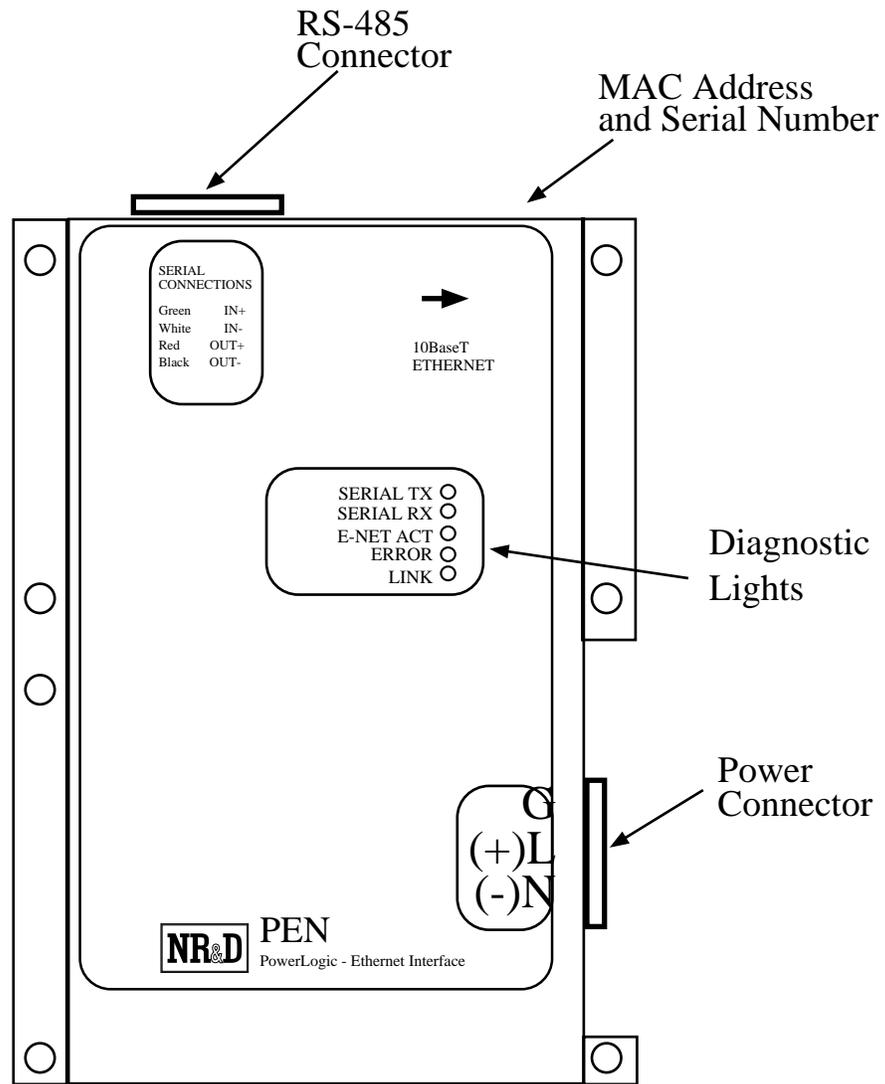


Figure 1-4 PEN-T-SA Front Panel

**Warning**

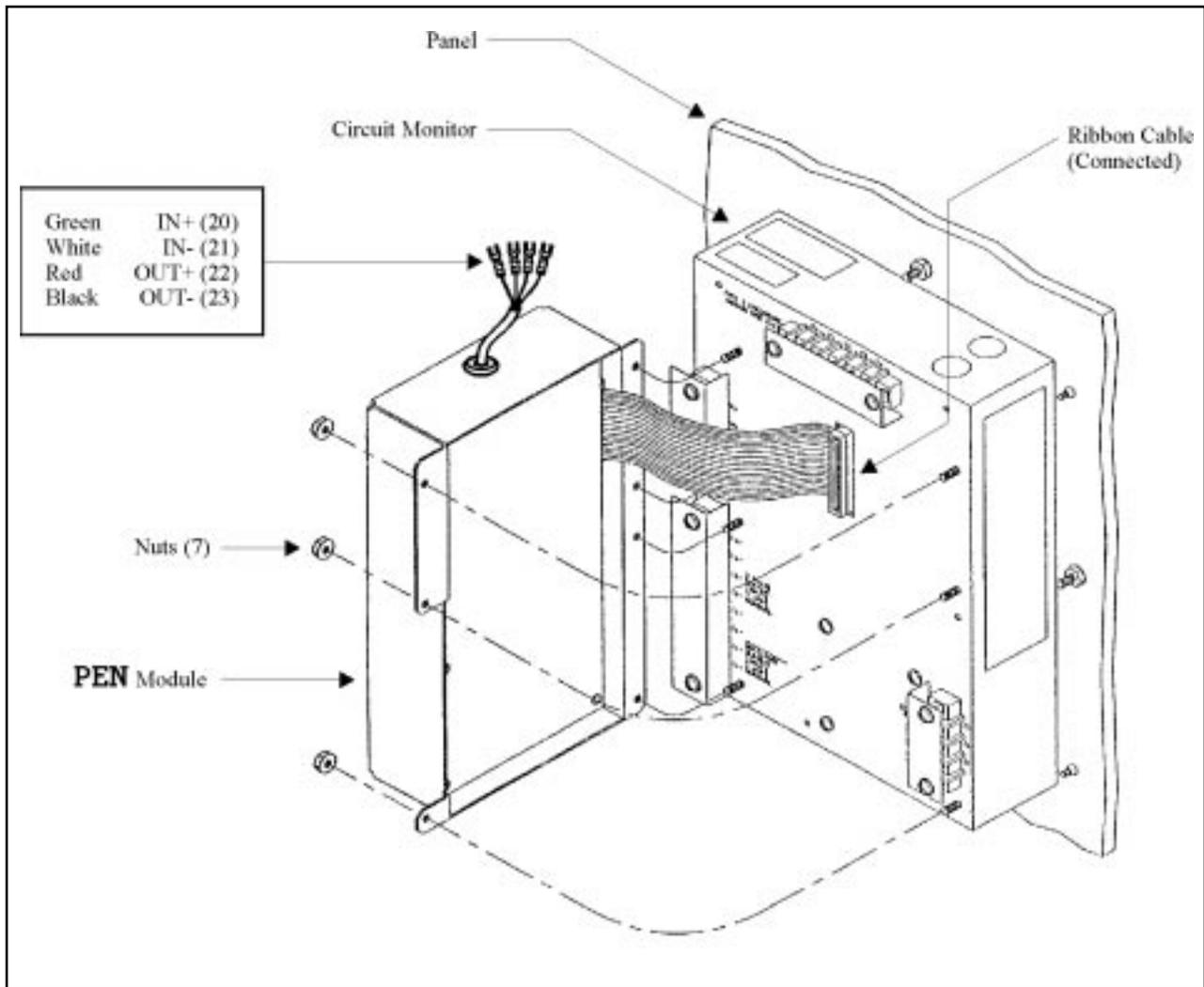
Do NOT install or remove the PEN with power applied to the Circuit Monitor. Turn OFF power at the power supply. Damage to the equipment may occur if the power is on during installation.

**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 on a CM2000**

- 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**

## Stand Alone Mounting

- 1 Select a suitable location for mounting the PEN-TCP-SA.
- 2 Use the PEN-TCP-SA as a template for determining mounting screws.
- 3 Attach the PEN-TCP-SA to frame using self tapping screws (customer provided).

## Serial Communications Wiring

The PEN is the PNIM (and/or MODBUS) protocol master for a multidrop RS-485 communication network. Up to eight (8) PNIM (and/or MODBUS) 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 32 inclusive.
- If BOOTP or DHCP is not used to configure the IP parameters then one slave device must have the network Address of 01. The PEN will poll slave #01 determine its Ethernet network 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 the first slave it is able to communicate with.

- The maximum recommended distance for the RS-485 network is 4000 ft. (1220m).
- The last unit on the multidrop network should 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. A POWERLOGIC MCA-485 must not be used.

## 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-TCP RS-485 Wiring Code**

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

## Stand-Alone 9 Pin Wiring

The PEN-TCP-SA uses a 9 pin sub-d connector for its RS-485 connection. A standard POWERLOGIC CAB-107 cable may be used to connect the first CM to the PEN. The wiring is shown in Table 2-2.

**Table 2-2 PEN-TCP-SA RS-485 Wiring Code**

PEN pin	CM Connector	CM Terminal
2	IN +	20
1	IN -	21
4	OUT +	22
3	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 2-3 for an example of connecting 4 CMs to a PEN.

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

**Table 2-3 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 inclusive. 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.

## PENSW Installation

- 1 The PENSW software is included on a 3.5" 1.2M MS-DOS diskette along with all NR&D PLC related software. For ease of installation, use the INSTALL program on the floppy. Select the PENSW file for installation and allow the INSTALL program to perform the decompression.
- 2 To manually install PENSW, run the PKUNZIP program with the following parameters:  

```
A:>PKUNZIP -d PENSW.ZIP C:\PEN\*.*
```

This will run PKUNZIP from the floppy, create the directory PEN on the c drive, expand all files from PENSW.ZIP into the \PEN\ directory.
- 3 To start the PENSW after installation, perform the following:  

```
> C:
> CD \ PEN
> PENSW
```

The screen should look like Figure 2-2.

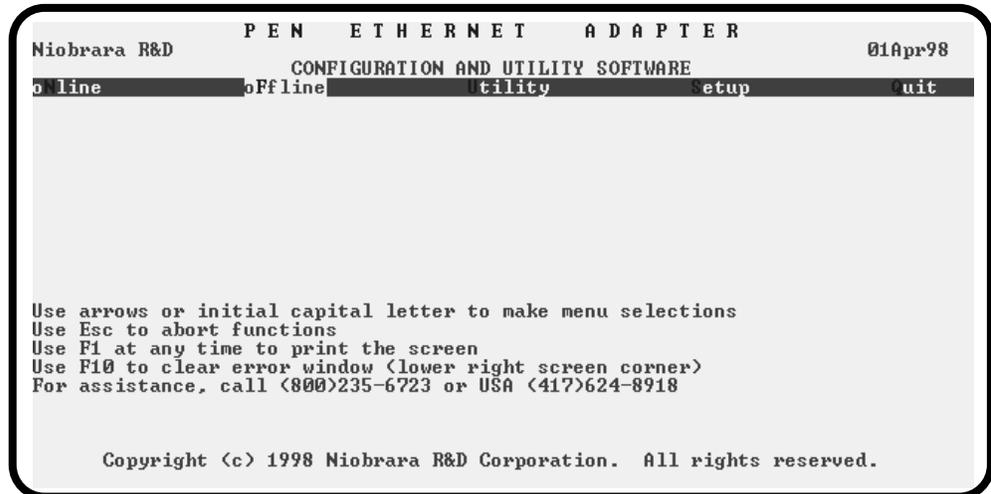


Figure 2-2 PENSX Startup Screen

- 4 Press S for Setup. A sub-menu will appear which allows the selection of the Sy/Max or PNIM connection or Terminal Emulator Connection configuration parameters. These setup parameters affect only the configuration of the personal computer, not the PEN.
- 5 Press S for Sy/Max. The screen should appear as in Figure 2-3.
- 6 Determine the type of connection from the personal computer to a RS-422 port of the PEN. For most cases this will involve a direct connection from a COM port of the computer to the PEN. If this is the case, the default settings in the SY/MAX setup will work. Make sure that the COM port selected is the one used to make the connection to the PEN.
- 7 When the configuration parameters are entered, press Enter until a window appears to prompt to save the setup to disk file. Press Y for yes.

The PENSX configuration software is now installed and ready for communication to the module. For more information about the setup parameters of PENSX see page 54.

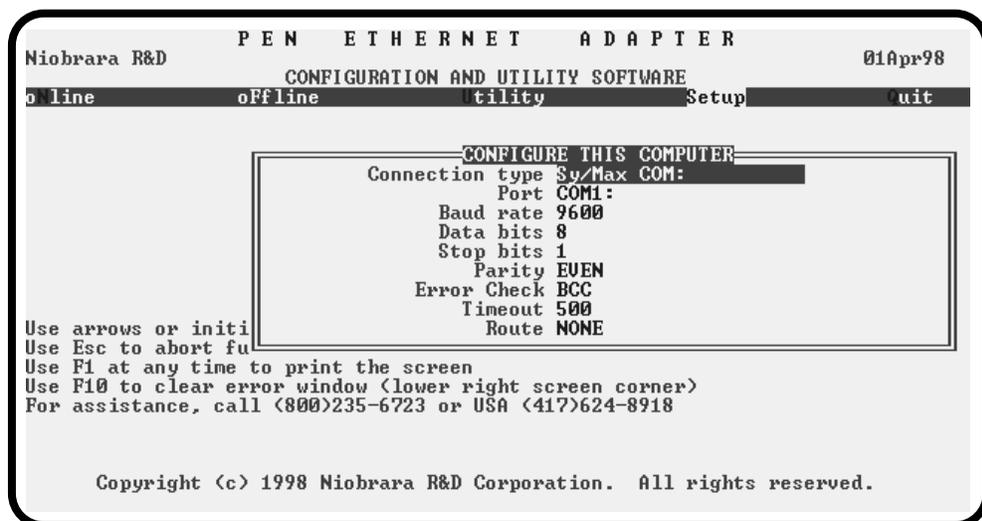


Figure 2-3 PENSX SY/MAX Configuration Screen

## 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 or the same IP address as another IP 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.

### Automatic BOOTP or DHCP Configuration

The PEN-TCP with firmware 15Nov99 or later features direct support for BOOTP and DHCP. On every power-up the PEN attempts to connect to a BOOTP and/or DHCP server on its Ethernet connection. If a server responds with an IP address then the PEN will assign itself to that address; even if it has a previously stored IP address in memory.

### Manual Configuration

The Ethernet parameters of the PEN are configured through a group of registers in Slave #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 for each of the eight possible slaves. Once the PEN is able to talk to one of the slaves then it locks the baud rate and parity for the serial network. The PEN then tries to read registers 6995 through 6999 from Slave #1 to find its Ethernet Network Address. The values in these registers must be set in the Circuit Monitor (Slave #1). This may be accomplished through the front panel in Diagnostic mode, using the OCI-2000, by messages through the PEN to the CM, or connecting a personal computer to the RS-485 port of the -SA unit and configuring the PEN with the RNIM Slave mode of PENS or SET-PEN.

### MODBUS/TCP

For MODBUS/TCP operation bit 10 of register 6995 must be set to one or register 6995 must equal zero. The IP Address for the PEN is stored in registers 6996, 6997, 6998, and 6999. For example, the PEN is to be configured for Modbus/TCP mode with an IP Address of 206.223.51.156. The following values would be loaded in Slave #1:

**Table 2-4 Modbus/TCP Configuration Example for 206.223.51.156**

CM Register	Value (decimal)	Description
6995	512 or 0	Set bit 10 for Modbus/TCP mode
6996	206	IP Address MSB in decimal
6997	223	IP Address
6998	51	IP Address
6999	156	IP Address LSB in decimal

**NOTE:** The IP Address may also be stored where the Most Significant Word of the IP address is set by register 6996 and the LSW is in register 6997. So for instance if the IP address is 206.223.51.156, you could set R[6995] = 256 dec (100 hex), R[6996] = -12577 dec (CEDF hex), and R[6997] = 13212 dec (339C hex). This is the way the PEN-TCP before REV 02Apr99 stored the IP Addresses. The PEN-TCP will accept an IP Address in this compact mode or in the expanded mode as shown in Table <Expanded NRDTCP Example>

## SY/MAX 802.3

For 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 1 through 99.

**NOTE:** Address 0 is not supported after firmware revision 02Apr99. If register 6995 has the value 0 then the PEN-TCP tries to operate in Modbus/TCP mode. This is done to provide compatibility with Square D's ECM2000.

### 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 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 for 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 need to have its RESET button pressed to trigger it to poll the new value.

### **Using the RNIM Slave in PENSW for Configuring a Stand-Alone PEN**

For applications such as Modbus or with a PNIM device that doesn't support registers 6995 through 6999, it becomes necessary to configure the Stand-Alone PEN from PENSW using the Utility, RNIM Slave. Select the Setup, RNIM Slave screen to configure the Serial port parameters for the computer and the Ethernet parameters for the PEN. Then connect the RS-485 port of the PEN-TCP-SA to the COM port of the computer with an SC902 or other RS-422<>RS-232 converter and start Utility, RNIM Slave. The PEN will eventually poll the computer with the appropriate baud rate and parity and configure itself for the appropriate parameters.

## **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 2-5).

**Table 2-5 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 76).

## Save IP Address to Flash

Once an Ethernet connection has been established, the IP address of the PEN may be saved to flash memory. This may be done with the register viewer included in PENS32. Write a HEX value of C5C5 to register 8174, and the module will automatically save its IP address to flash. Once this is done, the module will not accept a new IP address until the flash has been erased. To erase the flash, leave the module powered on and move the yellow switch to the LOAD position. Then, press the clear button. This will erase flash, and any other configured registers in the module, returning it to factory default. Move the yellow switch back to the RUN position, and load a new IP address as described above.



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## Modbus/TCP TCP/IP Operation

The Internet suite of protocols is commonly referred to as TCP/IP and includes IP, UDP, TCP, SNMP, Telnet, FTP, TFTP, SMTP, and NFS. The Internet Protocol (IP) is a network layer protocol that provides for packet delivery of all other protocols in the TCP/IP family. It does not provide for guaranteed delivery of packets, proper sequencing of the arrival of packets, or error detection. These features are provided by a higher level protocol such as TCP.

Transmission Control Protocol (TCP) is a connection-oriented means of delivering packets over IP. It provides for the error-free delivery, and proper sequencing of packets from the source to the destination. The application can simply hand a message to TCP and TCP will make sure that it arrives at the target. The PEN-TCP uses TCP/IP to send Modbus/TCP packets across the Ethernet.

The PEN-TCP also provides some support for two other protocols in the TCP/IP suite: address resolution protocol (ARP) and internet control message protocol (ICMP). ARP is used to determine the 48-bit globally unique address of the source and destination Ethernet devices. The PEN-TCP provides ICMP echo request and echo reply support. The ping utility uses these ICMP messages to determine if a particular IP node is functional.

### IP Addressing

Every node on a TCP/IP network has a unique IP address. This 32-bit value is typically represented in decimal notation where each byte of the address is displayed in decimal separated by periods. For example, a host on Niobrara's network might have the address CEDF339C (hex) is normally displayed as 206.223.51.156 in dotted-decimal notation.

A 32-bit IP address includes both the network ID and host ID for a node. The network ID specifies the network to which the node is attached. The network ID must be unique among all networks within a connected internet. On networks connected to the public Internet, this ID is provided by the InterNIC or DDN-NIC. The host ID identifies the node within its network. Each node must have a unique host ID within a network.

The Internet has been defined address classes to support different network sizes. Each network class is determined by the first byte of the IP address. Table 3-1 displays the IP classes and the total number of network and host IDs for each address class. The example is address w.x.y.z and network address 127 is reserved for loopback testing and interprocess communication on the local computer; it is not a network address. Net and Host IDs 0 and 255 are also reserved.

**Table 3-1 IP Network Classes**

Class	w values	Net ID	Host ID	Available nets	Available Hosts per net
A	1-126	w	x.y.z	126	16,777,214
B	128-191	w.x	y.z	16,384	65,534
C	192-223	w.x.y	z	2,097,151	254

## Subnet Masks

Subnet masks are 32-bit numbers that allow nodes to determine the network ID from the Host ID. Subnet masks are determined by assigning 1's to bits that belong to the network ID and 0's to the bits that belong to the host ID. The result is normally displayed in dotted decimal notation. Table 3-2 displays the default subnet masks for the three Internet classes.

**Table 3-2 Default subnet masks**

Class	Default subnet mask
A	255.0.0.0
B	255.255.0.0
C	255.255.255.0

**NOTE:** All devices on a physical network should use the same subnet mask and network ID.

Because the PEN-TCP may only act as a Server, it will only respond to messages from other devices on the network and never generate any on its own. It is therefore able to memorize the physical Ethernet addresses of other nodes on its network including all Gateways that access it. Thus the PEN will send the messages directly to the Host or Gateway that sent the Query. The Subnet Mask is consequently not needed and is effectively 0.0.0.0.

## Default Gateway

If a destination IP address is not on the local physical network (the address does not match the subnet mask), the host must send the message to a gateway IP router. This router will know where to send the message on the other network so that it will eventually reach the destination. Typically each local network will only have one (default) gateway.

Because the PEN-TCP may only act as a Server, it will only respond to messages from other devices on the network and never generate any on its own. It is therefore able to memorize the physical Ethernet addresses of other nodes on its network including all Gateways that access it. Thus the PEN does not need to be configured for a Default Gateway.

## Port Number

The TCP/IP Port number that MODBUS/TCP servers listen on for connections is always 502 decimal.

## MODBUS/TCP Protocol Mode

The MODBUS/TCP Protocol is enabled by setting the Protocol Mode of the Ethernet Port to MODBUS/TCP. (The MODBUS/TCP protocol is described in Appendix A on page 83.) Each MODBUS/TCP node on the IP network must have a unique IP address.

## Client/Server

TCP/IP implementations are of the Client/Server nature. A Server waits for connection requests from Clients; i.e. the Client is the node that initiates the connection to the Server. The Niobrara EPE5-TCP and MEB-TCP or the Modicon TSX Quantum NOE 211 can be both a Client and a Server at the same time while the PEN-TCP is only a Server. POWERLOGIC's newest versions of System Manager Soft-

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ware provide direct support for Modbus/TCP Ethernet as a Client, and thus allows direct support for the PEN-TCP.

When the PEN-TCP forms a connection as a Server and receives a command from the Client, it translates the MODBUS/TCP message into PNIM (or Modbus RTU) and routes it to the RS-485 network. The reply is in-turn translated into MODBUS/TCP and sent back to the Client.

MODBUS/TCP supports only a single "Destination Index" for downstream route information. The PEN-TCP uses the incoming Destination Index to determine the routing of the message. Only index values 1-8 are routed to the serial slaves as shown in Table 3-3.

NOTE: Index values 0 and 9 through 255 are accepted and act on the local PEN registers.

**Table 3-3 Destination Index Routing**

Destination Index Value	Target Device
0 or 9-255	PEN-TCP
1	Slave #1
2	Slave #2
3	Slave #3
4	Slave #4
5	Slave #5
6	Slave #6
7	Slave #7
8	Slave #8

## MODBUS/TCP Example

In this example a computer running SMS3000 has an IP address of 199.186.195.22, Subnet Mask of 255.255.255.0, and a Default Gateway of 199.186.195.1.

A second computer running Modsoft V2.6 has an IP address of 199.186.195.23, Subnet Mask of 255.255.255.0, and a Default Gateway of 199.186.195.1.

The PEN #1 is on the same local network with an IP address of 199.186.195.31. Two POWERLOGIC Circuit Monitors are connected to this PEN and their drop numbers are 01, and 02 respectively. A Schneider Automation TSX Momentum M1 CPU (Model 171 CCS 780 00) with a built-in RS-485 serial port is connected to the network as drop 03. The Momentum PLC communicates with Modbus RTU protocol while the CMs use PNIM; the PEN-TCP automatically chooses the appropriate protocol to use. The configuration registers in CM#1 are shown in Table 3-5.

**Table 3-4 MODBUS/TCP Example PEN #1 CM#1 Setup**

CM Register	Value (decimal)	Description
6995	0 or 512	MODBUS/TCP Mode
6996	199	IP Address
6997	186	IP Address
6998	195	IP Address
6999	31	IP Address

**Table 3-5 MODBUS/TCP Example PEN #2 CM#1 Setup**

CM Register	Value (decimal)	Description
6995	0 or 512	MODBUS/TCP Mode
6996	206	IP Address
6997	223	IP Address
6998	51	IP Address
6999	112	IP Address

A Gateway Router connects this Ethernet network to the Internet. Its IP address is 199.186.195.1. Any IP message generated on the local network that is not destined to a device on the local network will pass through this gateway. This is the address of the Default Gateway that is set in each Client.

The second Ethernet is connected to the Internet using Gateway #2. Its IP address is 206.223.51.1.

PEN-TCP-SA #2 is on this network segment and includes a POWERLOGIC Power Meter PM-620 and a Powerlink breaker panel. PEN-TCP #2 has an IP address of 206.223.51.112.

A Quantum NOE-211 is also on this network with an IP address of 206.223.51.77 with its Subnet Mask will be 255.255.255.0 and its Default Gateway is 206.223.51.1.

The Quantum uses the MSTR command to send READ and WRITE messages from the NOE module. As part of the setup for the MSTR command, the IP address of the target device is needed as well as the Destination Index.

**Table 3-6 Quantum NOE Routing Examples**

Target	Target IP	Destination Index
PEN #1	199.186.195.31	0
CM #1 on PEN #1	199.186.195.31	1
CM #2 on PEN #1	199.186.195.31	2
Momentum on PEN #1	199.186.195.31	3
PEN #2	206.223.51.112	0
PM #1 on PEN #2	206.223.51.112	1
Powerlink #2 on PEN #2	206.223.51.112	2

SMS and Modsoft will use the same Routing and Destination Index values as the Quantum in Table 3-6

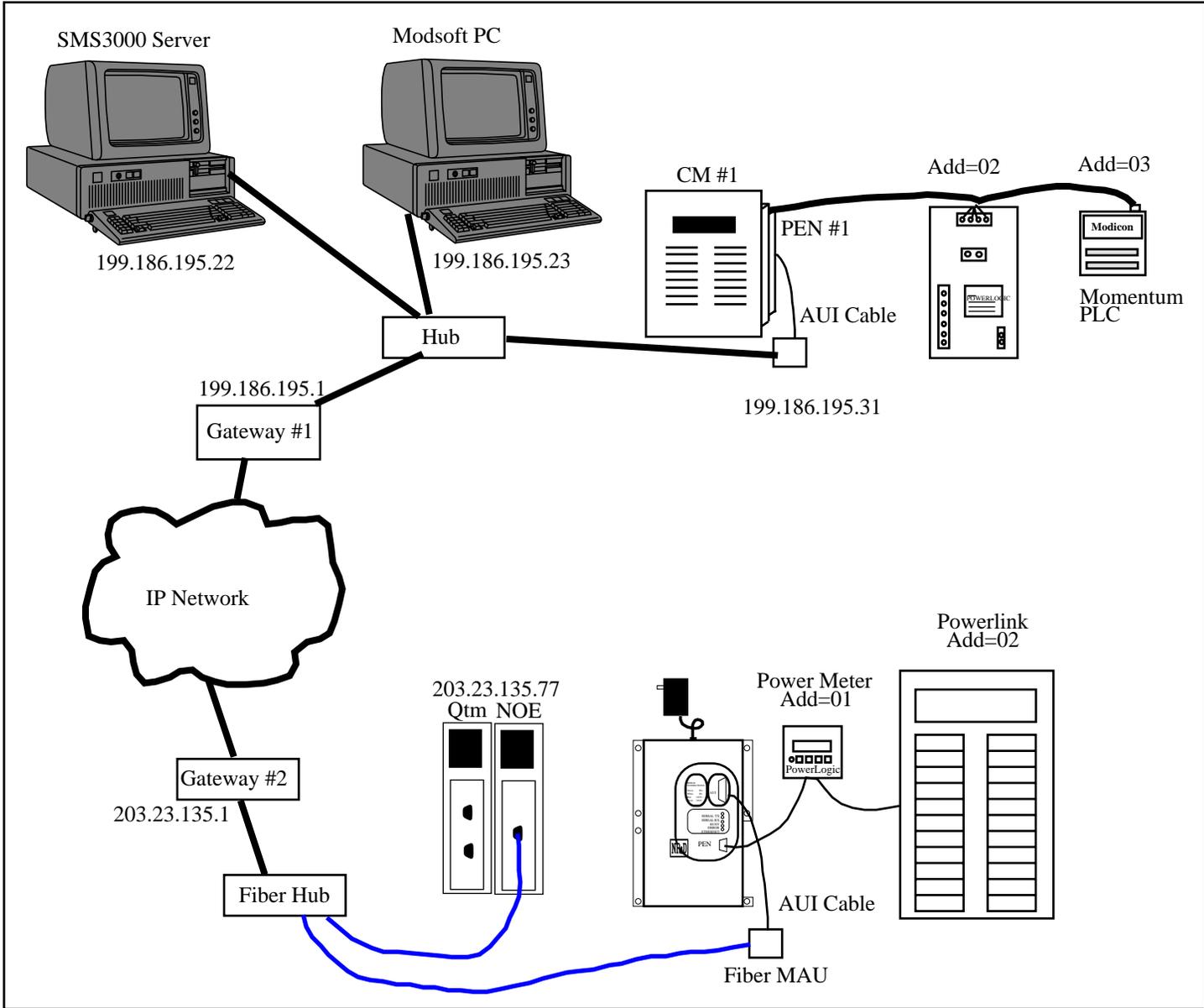


Figure 3-1 Modbus/TCP Routing Example



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## SY/MAX 802.3 Operation

The PEN-TCP 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.

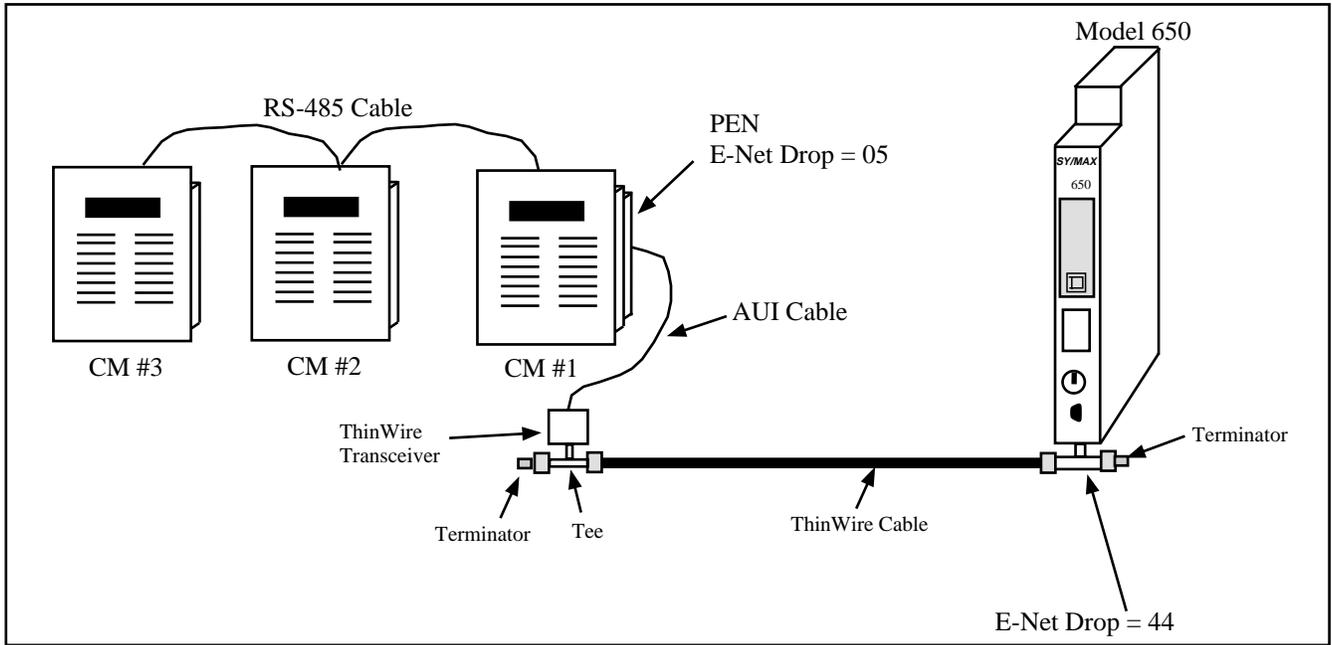
The SY/MAX 802.3 protocol topography allows for up to 100 devices on a network. Each device on a network must be assigned a unique network address within the range 00 through 99. Multiple networks may be bridged together to form large systems. Messages are passed from one device to another by the appropriate 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.

Note: The PEN-TCP cannot be set to SY/MAX address 0. Address 0 is treated as Modbus/TCP for compatibility with the Square D ECM2000.

### Simple Model 650 Example

Consider Figure 4-1. 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 4-1 Ethernet Routing Example**

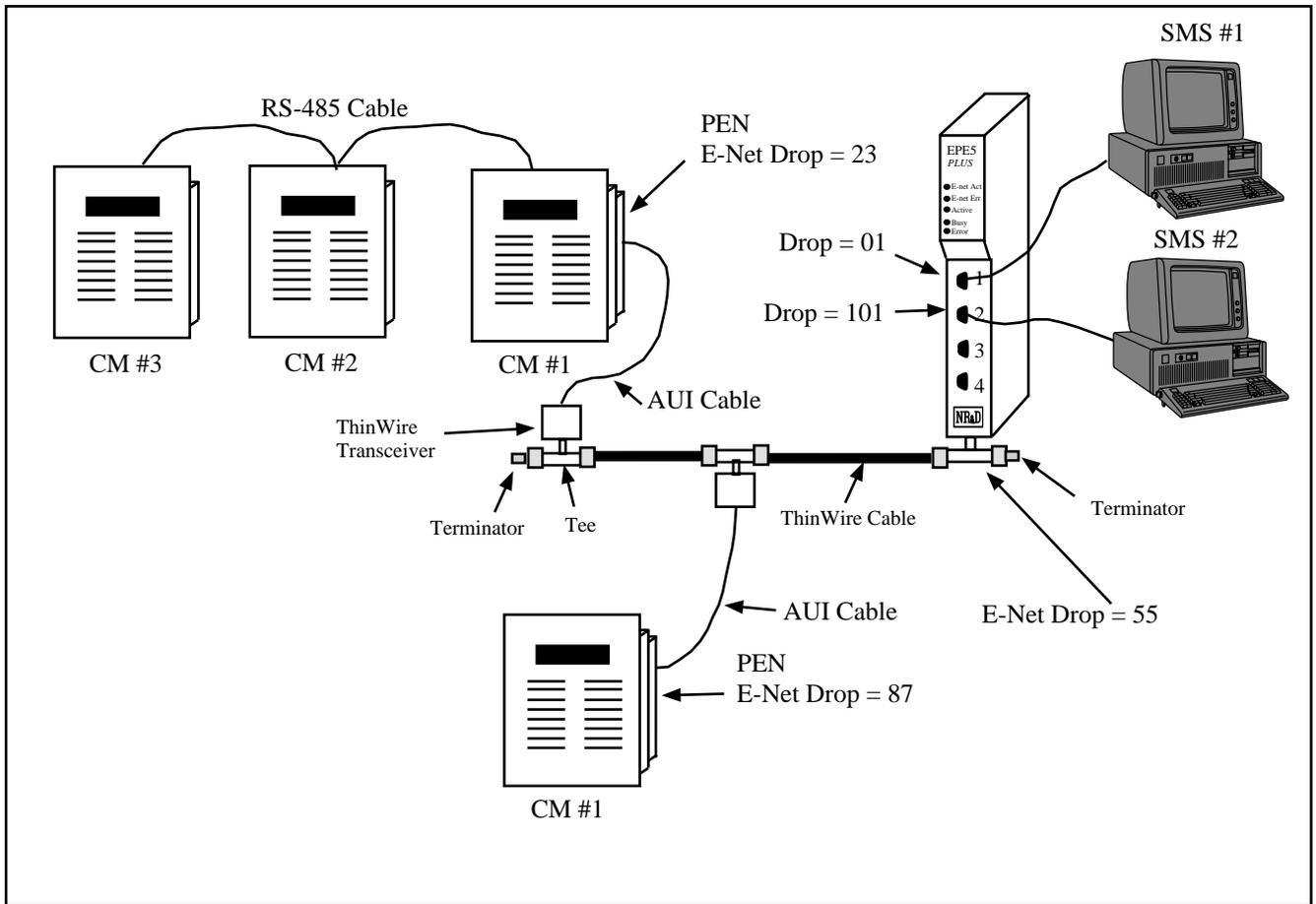
Communication messages in the Model 650 could be set to target the PEN as well as each of the Circuit Monitors. Table 4-1 lists the possible routes for each destination.

**Table 4-1 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 4-2 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 4-2 EPE5 Routing Example**

Communication routes in the SMS computers would be set to access each of the Circuit Monitors. Table 4-2 lists the possible routes for each destination.

**Table 4-2 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 4-3 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



**Table 4-3 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



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## Configuration Software PENSW

### PENSW

The PENSW software program is provided free of charge to PEN users. This software may be used to configure the operational parameters of the PEN. PENSW can be operated in either online or offline modes.

NOTE: PENSW supports all versions of the PEN including those with TCP/IP. Although they may be edited offline, the TCP/IP features will not be supported online in a non-TCP/IP PEN.

PENSW uses the SY/MAX and RNIM protocols for the configuration. Full support for the SY/LINK SFI-510 Network Interface Card and SFI-610 Ethernet Card is also provided.

In online mode, PENSW presents the user with a screen of data describing the operation all of the module's ports. The arrow keys are used select the port parameters to be modified and the space bar and + and - keys are used to change the parameters of that port. Changes made in the online mode are transferred to a connected PEN module and are effective immediately.

In offline mode, PENSW allows a copy of the configuration to be uploaded from the PEN to an image in offline memory. The offline copy can be edited without affecting the PEN in real time. The offline copy can be saved to a named disk file for later retrieval, or listed on a hard copy printer. An PEN need not be connected to perform most offline operations. The offline copy of the configuration parameters may be downloaded to an PEN module at any time.

Because the PEN has an internal nonvolatile parameter memory, the configuration parameters normally will not need to be reloaded unless a change has been made.

The startup screen of PENSW is shown in Figure 5-1 on page 40. The operational modes are selected by the highlighted menu bar on the fourth line. Selection can be made by moving the cursor to the desired option using the arrow keys and pressing **ENTER**. A short cut is provided, simply type "N" for online, "F" for offline, "U" for Utility, "S" for setup or "Q" to quit.

```

Niobrara R&D          P E N   E T H E R N E T   A D A P T E R          01Apr98
                    C O N F I G U R A T I O N   A N D   U T I L I T Y   S O F T W A R E
o n l i n e          o f f l i n e          u t i l i t y          s e t u p          u i t

Use arrows or initial capital letter to make menu selections
Use Esc to abort functions
Use F1 at any time to print the screen
Use F10 to clear error window (lower right screen corner)
For assistance, call (800)235-6723 or USA (417)624-8918

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```

**Figure 5-1 PENSX Startup Screen**

If offline mode is selected, a second menu appears as shown in Figure 5-2 on page 40. This menu presents the available functions for manipulating the offline image of the configuration parameters and for transfer of configuration data to and from the PEN module. Use the up and down arrows to move the highlight, **ENTER** to select the highlighted choice, or the initial capital letter to quickly select an option.

The online and offline parameter editing screens are nearly identical. The difference is in operation. Every time a change is made in the online mode, the modified parameter is transmitted to the PEN. In offline mode, changes are made to the parameter image in offline memory. Changes made in the online screen affect only the configuration stored in the attached PEN, not the offline copy. Likewise, changes made in offline mode have no effect on a connected PEN until they are explicitly sent to it using the "Send memory to PEN" function.

PENSX also contains several convenient utilities for general use, a SY/MAX Register Viewer, a Terminal Emulator, a Statistics Viewer, and a CTS monitor. The Register Viewer, Statistics Viewer, and CTS monitor use the same setup as the online and offline functions. The Terminal Emulator has its own setup characteristics.

```

Niobrara R&D          P E N   E T H E R N E T   A D A P T E R          01Apr98
                    C O N F I G U R A T I O N   A N D   U T I L I T Y   S O F T W A R E
o n l i n e          o f f l i n e          u t i l i t y          s e t u p          u i t

Read from disk to memory
Write from memory to disk
Edit configuration in memory
Send memory to module
Fetch memory from module
Print configuration in memory
u i t   o f f l i n e   f u n c t i o n s

Use arrows or initial capital letter to make menu selections
Use Esc to abort functions
Use F1 at any time to print the screen
Use F10 to clear error window (lower right screen corner)
For assistance, call (800)235-6723 or USA (417)624-8918

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```

**Figure 5-2 PENSX offline Menu**

## Data Entry Keys

Whenever data entry is allowed by the program, certain keys can be used to facilitate data entry. They are:

BACKSPACE	Move cursor left and remove character there
LEFT ARROW	Move cursor to the left one character
RIGHT ARROW	Move cursor to the right one character
DEL	Remove the character under the cursor
INS	Change between insert and overstrike modes of entry
HOME	Move cursor to the left edge of the field
END	Move cursor to the end of the data
Control-F	Move cursor right (Forward) one word
Control-R	Move cursor left (Reverse) one word
Control-D	Delete from the cursor to the end of the field
Control-U	Delete from cursor to the beginning of the field
Control-Y	Delete all characters in the field
ESC	Exit the field without modifying it
ENTER	Accept the contents of the field

When a field is opened for input, the cursor is positioned at the left side of the field. If data is already present in the field, typing any character other than those listed above will cause the field to be blanked allowing entry of new data without first deleting the old. If it is desired to retain the previous data for editing, make sure the first key you type is an editing key such as a left or right arrow.

Most data fields in PENS<sub>W</sub> do not allow direct entry of the parameter, instead a series of choices is presented. The following keys are used:

GRAY +	Increments options to the next available choice
GRAY -	Decrements options to the previous choice
SPACE BAR	Increments options and rolls back to first option after last

The arrow keys are used to maneuver between fields.

## Online and Offline Editing Screen

In either the online or offline mode, parameters are changed by moving the highlighted cursor to the desired field using the arrow keys and by pressing the +, -, or space bar to toggle through available parameters.

```

Niobrara R&D          P E N   E T H E R N E T   A D A P T E R          01Apr98
                        C O N F I G U R A T I O N   A N D   U T I L I T Y   S O F T W A R E   Press F2 for help.
-----
Drop                   0
-----
Protocol               NRD/TCP   PNIM
IP Address             199.186.195.88 9600
                                           EVEN
                                           8
                                           1

NRD/TCP Port           6000
TCP Backoff            100
Downstream Timeout    500
Quiet Timeout          600

```

**Figure 5-3 PENSW oNline Edit Screen**

The oNline Edit (and oFfline Edit) screen is presented as a matrix of parameters, see Figure 5-3. Each column represents one of the ports of the PEN. The lower half of the screen will change to present the available parameters for each protocol mode. The parameters are described below.

### Drop Number

This value determines the SY/MAX drop number of the PEN. When the unit is in SY/MAX 802.3 Ethernet mode, this value sets the SY/MAX Ethernet drop number. In all modes, this value sets the PNIM serial port's drop number. Valid drop numbers must fall within the range of 00 through 99. The default drop number is zero (0).

### Protocol

(Port 1) This value determines the mode of the RS-485 serial communication port. Possible values are PNIM and Modbus Gate. The default mode is PNIM.

(E-net) The standard PEN only supports the SY/MAX 802 protocol. The PEN-TCP modules support SY/MAX 802 and Modbus/TCP. The default value is Modbus/TCP.

### Baud Rate

(Port 1) Controls the baud rate of the RS-485 serial port. This value should be set to match the baud rate of the device attached to the port. The default value is 9600.

### Parity

(Port 1) Controls the parity of the serial port and should be set to match the attached device. Available choices are EVEN, and NONE. The default value is EVEN.

### Data Bits

(Port 1) Fixed at 8 data bits.

### Stop Bits

(Port 1) Fixed at 1 stop bit.

## Mode Specific Sub-menus

Certain mode values require additional parameters and other fields will appear in the middle area of the screen. These parameters are explained as follows:

### IP Address

(E-net Port only, Modbus/TCP protocol only) The IP Address is entered in dotted-decimal notation. This address should be provided by the Network Administrator of your corporate Ethernet. Each IP device on the network must have a unique IP Address. The default IP Address for the PEN is based on the MAC of the PEN and will be in the range 206.223.51.x.

### MBAP TCP Port

(E-net Port only, Modbus/TCP protocol only) The TCP Port number for Modbus TCP/IP is fixed at 502. This is the TCP Port number that the PEN-TCP Server listens on for accepting new connections.

### TCP Backoff

(E-net Port only, Modbus/TCP protocol only) The TCP Backoff is the amount of time that TCP will wait for an acknowledgment of a transmitted message. When this amount of time has passed after transmitting a message, TCP will retry the message and reset its timeout timer to twice this value. After this timer expires without an acknowledgment, the value is quadrupled, etc., until the Downstream timeout expires. This value is expressed in units of 1/100th of a second. The default value is 100 (1 sec.).

### Downstream Timeout

(E-net Port only, Modbus/TCP protocol only) The Downstream Timeout determines the amount of time that the PEN-TCP will wait for a reply from the remote device. Upon the expiration of this timer, a timeout error reply is generated to the source of the message and the TCP layer is instructed to give up on the message. This value is expressed in units of 1/100th of a second and the default value is 500 (5 sec.).

### Quiet Timeout

(E-net Port only, Modbus/TCP protocol only) The Quiet Timeout determines the amount of time that the PEN-TCP will keep a TCP connection open without receiving or transmitting a new message on the connection. This value is expressed in units of 1 second and the default value is 600 (10 minutes).

The PEN-TCP will send a keep-alive TCP message to the client after the Quiet Timeout expires. If the Client responds, then the connections is left open. If the Client doesn't respond, the PEN-TCP will retry once a second for 10 seconds and then close the connection.

### Retry timeout

(MODBUS Gate) This value expressed in units of n/100 seconds determines the delay time between retries for failed transmissions from a MODBUS mode port. The default value is 100.

# HOTKEYS

## F1 Print Screen hotkey

Pressing the F1 key at any time will allow for printing of the screen to a printer or text file. Pressing the F1 key will produce a window similar to Figure 5-4.

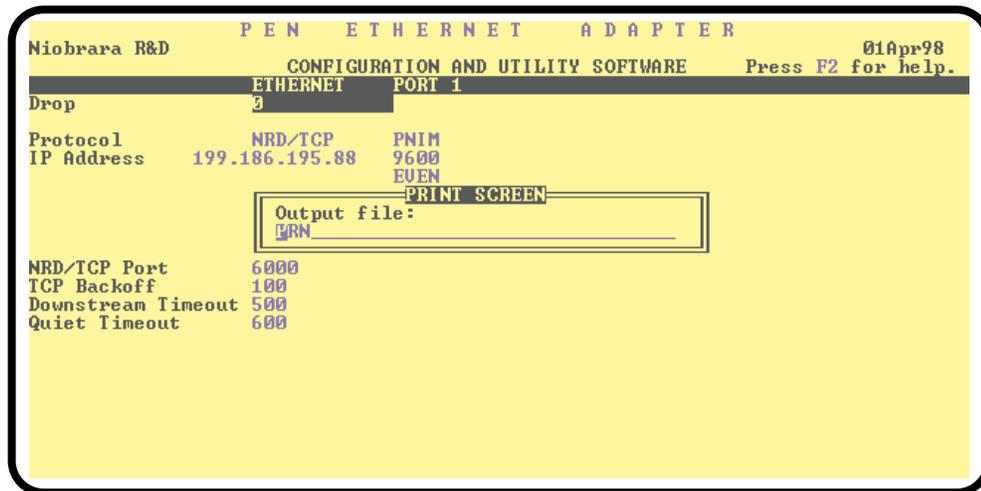


Figure 5-4 F1 Print Screen

The new window prompts for an output filename. The default is PRN which prints to the DOS default printer. If a valid DOS filename is typed into the field, PENS will print the information to that filename as an ASCII text file.

## F2 Help Window

Pressing the F2 key will present the help window shown in Figure 5-5. Pressing any key will return to the previous location

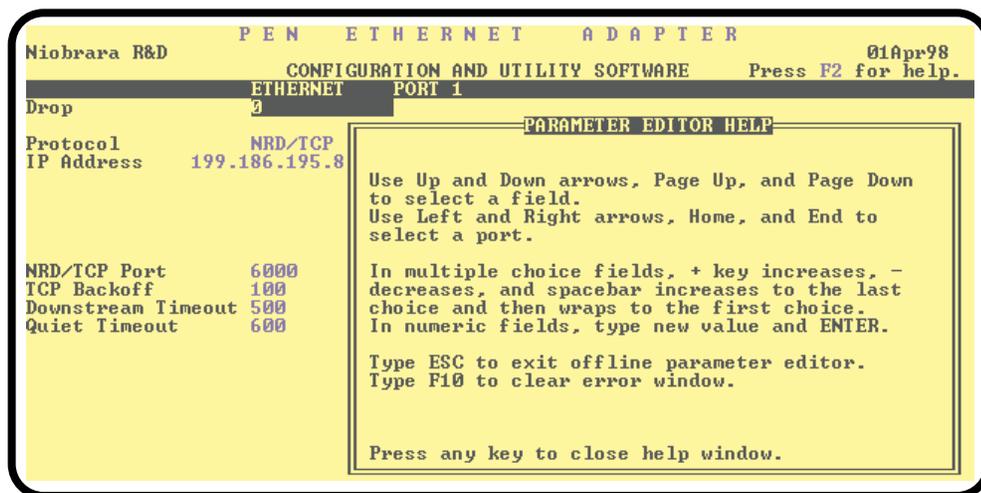


Figure 5-5 F2 Help Window

## F3 Statistic Viewer

Pressing the F3 key while on a port will invoke the statistic register viewer. This window will display the statistical registers for a specific port. The port selection may be changed by pressing the space bar or the + or - keys. Pressing the 0 (zero) or the z key will result in the clearing of all of the statistical parameters for the selected port. Press the ESC key to exit back to the main screen.

The Statistics Registers are quite helpful for debugging an application. Each data port has a group of 32 registers which are incremented when a specific action occurs.

The Ethernet port has its own set of statistics as shown in Figures 5-6 and 5-7.

Pressing the Page Down key will advance the statistic viewer to a new page of statistics. Pressing the Page Up key will return to the first page. Pressing the left arrow key, right arrow key, - key, + key, or space bar will change the port displayed. Pressing the F9 key will provide a shortcut to the SY/MAX setup window for changing the route etc.

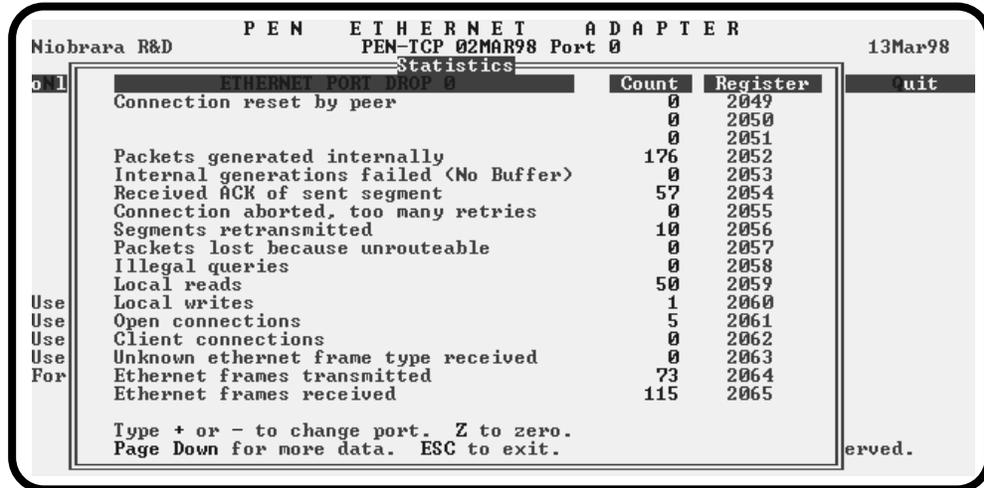


Figure 5-6 Ethernet Port Statistical Screen (Page 1)

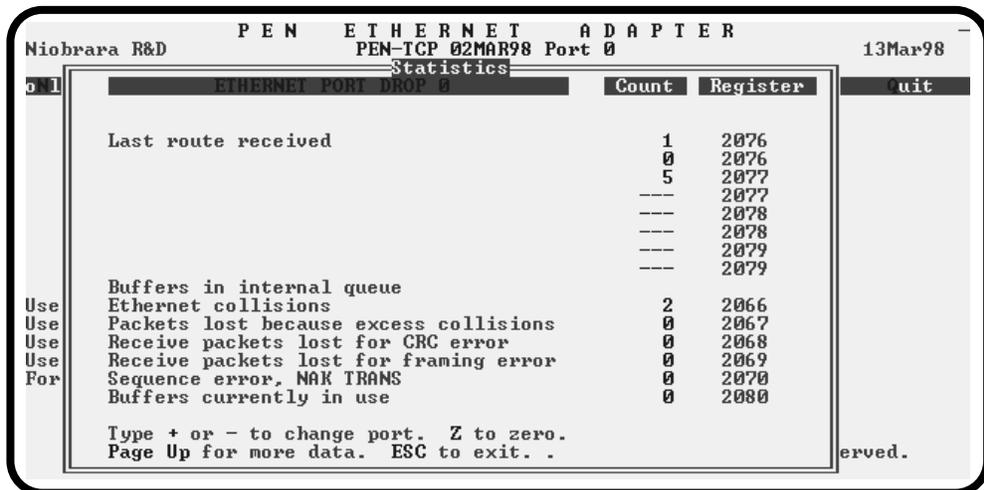


Figure 5-7 Ethernet Port Statistical Screen (Page 2)

Below is a list of the currently active registers for the Ethernet Port and the conditions which cause them to be incremented. For a complete table of these registers see page 61. When one of the error registers is incremented, the RED E-NET ERROR light on the module will be lit for one second.

- **Valid Command/Reply packets received.** This register is incremented when a valid packet is received from another SY/MAX Ethernet device.
- **Incoming packet lost because no buffer.** This register may be incremented as a result of trying to exceed the throughput of the port. This may happen if several high baud rate sources are routed to a low baud rate target. Try slowing down the polling of the high baud rate sources. Also check the buffer limit setting. The default value is 16. If this setting is set to a lower value, A burst of a

few messages may fill the available allocated buffers. Check the *Buffers currently in use* statistic to see how many buffers are full.

- **Retry packets received.** This register increments when another Ethernet device request a retry of the message that this port routed to it.
- **Packets generated internally.** This register is incremented when the port generates a message to be transmitted from the port to the attached device. This may occur from an Auto-transfer READ or WRITE.
- **Internal generations failed (No buffer).** Check the Auto-transfer interval and slow it down. (increase the value)
- **Packet sent and ACK received.** A valid transmission has occurred to the attached Ethernet device.
- **Transmit retries exhausted, packet lost..** If errors occur on the transmission, eventually the retries will be exhausted and the transmission will fail. Check the cabling and make sure that a 50 ohm terminator is on each end of the coax..
- **Transmit retries.** Incremented when a negative acknowledgment or the failure of a positive acknowledgment has occurred after a transmission.
- **Packets lost because unrouteable.** Check the route of the sending devices routed to the port. Use the *Last route received* statistics to determine the route incoming on the port.
- **Illegal operation request.** Check the command being sent to the port.
- **Priority reads performed locally.** Incremented when a Priority read has been received on the port from an external device. This means that the read was routed to the module and operated on the setup register, mailbox register, or statistics registers.
- **Priority writes performed locally.** Incremented when a Priority write has been received on the port from an external device. This means that the write was routed to the module and operated on the setup register, mailbox register, or statistics registers.
- **Non-Priority reads performed.** Incremented when a Priority read has been received on the port from an external device. This means that the read was routed to the module and operated on the setup register, mailbox register, or statistics registers.
- **Non-Priority writes performed.** Incremented when a Non-Priority write has been received on the port from an external device. This means that the write was routed to the module and operated on the setup register, mailbox register, or statistics registers.
- **Non-Sy/Max Ethernet frames received.** Incremented when packets are routed to the PEN in TCP/IP mode.
- **Ethernet frames transmitted.** Incremented when a command, reply, ACK, NAK, or BUSY frame has been transmitted to the Ethernet.
- **Ethernet frames received.** Incremented when a command, reply, ACK, NAK, or BUSY frame has been received from the Ethernet.
- **Last route received.** These eight fields display the route of the last incoming message received by the port. If fewer than eight drop numbers are included in the route, --- will be displayed for each location after the last drop. If messages are received with no route --- will be displayed in all eight locations. If a port has not received any messages, all locations may display 0. When several messages arrive with different routes, this display may jump back and forth between the routes.

It should be noted that since the PEN is a multitasking system, it may be possible for it to be updating the Last route received while the personal computer is reading those values. The result may be that a route is displayed that is a combination of two or more routes and is therefore not valid. The Last route received is intended for troubleshooting systems where it is unsure what the route is from a particular device.

- **Ethernet collisions.** Incremented when the PEN has detected a collision between a packet it is sending and other traffic on the network.
- **Packets lost because excess collisions.** When the collision limit of 16 collisions on a single packet has been exceeded the PEN will report an error and stop sending the packet.
- **Receive packets lost for CRC error.** Incremented when a receive packet has an error in the checksum.
- **Receive packets lost for framing error.** Incremented when a packet received from the Ethernet has an error in the framing.
- **Sequence error, NAK TRANS.** The PEN keeps a table of the SY/NET Ethernet Sequence numbers from every active SY/NET Ethernet unit on the network. If the PEN port receives a packet with an incorrect Sequence number from another device this register is incremented and a NAK TRANS is sent to the offending device.
- **Buffers currently in use.** This number displays the number of buffers that this port is currently using. This number should remain low (0-3). If the Buffers currently in use climbs to near the Buffer limit, the system should be inspected because there is a bottle neck somewhere. Use the percent of throughput statistic on the ports included in the route statement to see if any are near 100%. If so try to increase the throughput by increasing the baud rate on that section, lowering the baud rate or polling interval of the previous sections, or routing through alternate paths.

Port 1 has the same type of statistics which are shown in Figures 5-8 and 5-9.

```

Niobrara R&D      P E N   E T H E R N E T   A D A P T E R
                  PEN-TCP 02MAR98 Port 0
                  Statistics
  0 1  PORT 1 DROP 1
  Count  Register
Valid packets received, ACK sent      50718   2081
Incoming packet lost because no buffer 0       2082
Invalid packets received, NAK sent    0       2083
Packets generated internally          49557   2084
Internal generations failed (No buffer) 0       2085
Packets sent and ACK received         50718   2086
Transmit not ACKed, packet lost       0       2087
Transmit retries                       0       2088
Packets lost because unrouteable      0       2089
Illegal operation requests             0       2090
Priority reads performed locally        0       2091
Priority writes performed locally       0       2092
Non-priority reads performed           0       2093
Non-priority writes performed          0       2094
Receiver parity or framing             0       2095
Characters transmitted                 31079   2096
Characters received                    36884   2097

Type + or - to change port. Z to zero.
Page Down for more data. ESC to exit.
erved.

```

Figure 5-8 Port 1 Statistical Screen (Page 1)

```

Niobrara R&D      P E N   E T H E R N E T   A D A P T E R
                  PEN-TCP 02MAR98 Port 0
                  Statistics
-----
PORT 1 DROP
-----
Count  Register
Transmit percent of capacity      0    2096
Receive percent of capacity      0    2097
Last route received                1    2108
                                   0    2108
                                   5    2109
                                   ---   2109
                                   ---   2110
                                   ---   2110
                                   ---   2111
                                   ---   2103

Use
Use
Use
Use
For
Channel delay byte count          0    2104
Messages in queue                 0    2096
Buffers currently in use          0    2112

Type + or - to change port.  Z to zero.
Page Up for more data.  ESC to exit.

```

**Figure 5-9 Port 1 Statistical Screen (Page 2)**

Below is a list of the currently active registers for Port 1 and the conditions which cause them to be incremented.

For a complete table of these registers see page 63. When one of the error registers is incremented, the RED ERROR light on the module will be lit for one second.

- **Valid packets received, ACK sent.** This register is incremented when a valid packet is received from an external source connected to the port.
- **Incoming packet lost because no buffer.** If this register increments, check the cabling on that port or the target port for the routed message. If CTS is not properly jumpered, the port will not be able to transmit and the buffers will fill. Use the *Utility, CTS Monitor* to check the state of CTS it should be ON.

This register may also be incremented as a result of trying to exceed the throughput of the port. This may happen if several high baud rate sources are routed to a low baud rate target. Try slowing down the polling of the high baud rate sources. Check the *percent of capacity* on the transmit and receive lines on the ports that the message is routed through. Also check the buffer limit setting. The default value is 16. If this setting is set to a lower value, A burst of a few messages may fill the available allocated buffers. Check the *Buffers currently in use* statistic to see how many buffers are full.

- **Invalid packet received, NAK sent.** If this register increments, check the parity settings, or the BCC/CRC settings on the module and the attached devices. Telephone line interference or flow control settings (XON/XOFF) on a modem might cause NAKs to be sent.
- **Packets generated internally.** This register is incremented when the port generates a message to be transmitted from the port to the attached device. This may occur from an Auto-transfer READ or WRITE or by a translation like IDEC or MODBUS.
- **Internal generations failed (No buffer).** Check CTS wiring. Check the Auto-transfer interval and possibly slow it down. (increase the value)
- **Packet sent and ACK received.** A valid transmission has occurred to the attached device.
- **Transmit retries exhausted, packet lost..** If errors occur on the transmission, eventually the retries will be exhausted and the transmission will fail. Check the cabling, and communication parameters (baud rate, parity, data bits, stop bits, mode).
- **Transmit retries.** Incremented when a negative acknowledgment or the failure of a positive acknowledgment has occurred after a transmission.

- **Packets lost because unroutable.** Check the route of the sending devices routed to the port. Use the *Last route received* statistics to determine the route incoming on the port.
- **Illegal operation request.** Check the command being sent to the port.
- **Priority reads performed locally.** Incremented when a Priority read has been received on the port from an external device. This means that the read was routed to the module and operated on the setup register, mailbox register, or statistics registers.
- **Priority writes performed locally.** Incremented when a Priority write has been received on the port from an external device. This means that the write was routed to the module and operated on the setup register, mailbox register, or statistics registers.
- **Non-Priority reads performed.** Incremented when a Priority read has been received on the port from an external device. This means that the read was routed to the module and operated on the setup register, mailbox register, or statistics registers.
- **Non-Priority writes performed.** Incremented when a Non-Priority write has been received on the port from an external device. This means that the write was routed to the module and operated on the setup register, mailbox register, or statistics registers.
- **Receiver parity or framing.** Check the baud rate, parity, data bits, and stop bits.
- **Characters transmitted.** Incremented when a BYTE of information is transmitted from the port.
- **Characters received.** Incremented when a BYTE of information is received to the port.
- **Transmit percent of capacity.** This is a time averaged calculation of the percent of theoretical throughput of the port. This calculation is based upon the Characters transmitted within a certain time and takes into account the baud rate, number of data bits, stop bits, and parity bits.

This average is reset each time page 2 of the statistics is entered, when the port monitored is changed, or when the z or 0 key has been used to zero the statistics fields. Due to the latency between the personal computer performing the read and the reply returning, it is possible to witness values greater than 100%. Since each reading by the personal computer is included in the average allowing this statistic to run for a few minutes will report a more accurate value.

- **Receive percent of capacity.** This is a time averaged calculation of the percent of theoretical throughput of the port. This calculation is based upon the Characters received within a certain time and takes into account the baud rate, number of data bits, stop bits, and parity bits.

This average is reset each time page 2 of the statistics is entered, when the port monitored is changed, or when the z or 0 key has been used to zero the statistics fields. Due to the latency between the personal computer performing the read and the reply returning, it is possible to witness values greater than 100%. Since each reading by the personal computer is included in the average allowing this statistic to run for a few minutes will report a more accurate value.

- **Last route received.** These eight fields display the route of the last incoming message received by the port. If fewer than eight drop numbers are included in the route, --- will be displayed for each location after the last drop. If messages are received with no route --- will be displayed in all eight locations. If a port has not received any messages, all locations may display 0. When several messages arrive with different routes, this display may jump back and forth between the routes.

It should be noted that since the PEN is a multitasking system, it may be possible for it to be updating the Last route received while the personal computer is reading those values. The result may be that a route is displayed that is a combination of two or more routes and is therefore not valid. The Last route received is intended for troubleshooting systems where it is unsure what the route is from a particular device.

- **Channel Delay byte count.** This value displays the number of bytes including PADs and ENQs sent after the checksum of a SY/MAX message and before an acknowledgment is received. This value is quite helpful in fine-tuning modem applications as it displays the delay time in the modem circuit. Pressing the "T" key on the keyboard will take the reading from the Channel Delay byte

count register, add 10 to this value, and write this new value to the PAD count control register for that serial port.

- **Buffers in internal Queue.** This value displays the number of messages in queue waiting to be sent out of this port. On a single-threaded protocol mode such as PNIM, PLOGIC, RNIM, Modbus Host or Gate, or Chevron, this value will show how many messages are waiting to be sent out the port and a value larger than 0 or 1 may appear.
- **Buffers currently in use.** This number displays the number of buffers that this port is currently using. This number should remain low (0-3). If the Buffers currently in use climbs to near the Buffer limit, the system should be inspected because there is a bottle neck somewhere. Use the percent of throughput statistic on the ports included in the route statement to see if any are near 100%. If so try to increase the throughput by increasing the baud rate on that section, lowering the baud rate or polling interval of the previous sections, or routing through alternate paths.

## Offline Functions

### "Read from disk to memory"

This function reads an PEN configuration file into the offline memory. The file should have been created by the "Write from memory to disk" function described below and must have a .PEN extension. When "Read from disk to memory" is selected, a window will open and ask for the name of the file to read. The bottom part of the screen will show a list of all files with the extension .PEN in the current directory. Any subdirectories will be shown in square brackets. Any drive names will also be shown in square brackets, [b: ]. The parent directory (of which the current directory is a subdirectory) is shown by the word "parent" in square brackets. You may either type the name of the file to read or you may use the arrow keys to move the highlight to the desired filename. Pressing **ENTER** with the highlight on a filename will select that file for reading. Pressing **ENTER** with the highlight positioned on a directory (drive) name (either a subdirectory or [parent]) will change the current directory (drive) to that directory (drive) and will show the .PEN files in the new directory (drive). If there are more files than will fit on the screen, pressing the right arrow with the highlight at the right edge of the screen will scroll the display sideways to show more files. Typing the **ESC** key will return to the offline function menu without loading a file or otherwise modifying offline memory.



Figure 5-10 oFfile Read from Disk to Memory

### "Write from memory to disk"

This function saves a copy of the four ports and global configuration parameters from the offline memory to a disk file. "Write from memory to disk" uses the same point and shoot file selection described for "Read from disk to memory" above. To create a new file you must type the name. The name

should be a valid MS/DOS filename but should not include any path name or extension. The program will append an extension of .AIM to the name and the file will be placed in the directory which is shown in the bottom half of the screen. To create a file in a directory other than the current one, use the arrow and **ENTER** keys to traverse the directory tree until a listing of the desired directory is shown in the bottom half of the screen. Then type in the file name and press **ENTER**. If you specify (either by typing or by pointing) a file that already exists, you will be prompted for approval before that file is overwritten.

### **"Edit configuration in memory"**

Just like the online portion of the program, this function displays a screen with the parameters for a single port. As described above, changes here effect the offline memory and not any attached PEN.

### **"Send memory to module"**

This function will send the configuration in memory to the PEN module by way of the SY/MAX setup parameters. In order to send the configuration to the PEN it is necessary for the personal computer to communicate with the PEN. Try going oNline before sending a configuration.

Be cautious when sending a configuration. Go oNline and notice which port the connection is being made to the module. Examine the configuration before sending to make sure that the port connecting to the personal computer will not change from the current settings, otherwise communication may be lost during the send.

### **"Fetch memory from module"**

Use this function when you wish to copy the configuration parameters from a connected PEN module to the offline memory for editing, printout, or saving on disk.

### **"Send memory to the PEN"**

This function transfers all five ports' configuration parameters from offline memory to the PEN. This function can be used to load configuration back into the PEN after it has been Fetched and Edited or if it has been read from a previously saved disk file.

### **"Print configuration in memory"**

This function will produce a report showing the settings of all parameters in offline memory. When this function is selected, you will be prompted for an output filename with the default value of PRN shown. To send the report to the PRN device (normally the parallel printer port), simply press **ENTER**. To send the report to a different port or to a file, type the name and then press **ENTER**. Online configurations may be printed with the **F1** print screen key.

### **"Delete configuration file"**

This function will show a point and shoot menu of the available PEN configuration files. Select the file to be deleted and press **ENTER**.

### **"Quit offline functions"**

Selecting the quit item will cause a return to the main menu bar. Pressing the **ESC** key will have the same effect.

## **Utilities**

The Utilities menu provides access to useful maintenance and testing functions of the PENSWARE software.

### **View registers**

Selecting the View registers menu item will invoke a SY/MAX register data viewer/modifier. This viewer continuously performs a block read of 20 registers and displays the contents of those registers in hex, unsigned integer, signed integer, and binary. The status register associated with the data register is

also displayed in hex. Like any other online or offline function involving communication, the register viewer is dependent on the values located in the SETUP Sy/Max menu. Mode, Baud rate, Parity, Route, etc. must be properly set for proper communication.

Niobrara R&D		P E N E T H E R N E T A D A P T E R							13Mar98
		PEN-TCP 02MAR98 Port 0							
CONFIGURATION AND UTILITY SOFTWARE									
REGSTR	HEX	UNSIGN	SIGNED	BINARY				STAT	
1	03E9	1001	1001	0000	0011	1110	1001	0000	
2	0016	22	22	0000	0000	0001	0110	0000	
3	0006	6	6	0000	0000	0000	0110	0000	
4	07CE	1998	1998	0000	0111	1100	1110	0000	
5	0000	0	0	0000	0000	0000	0000	0000	
6	0000	0	0	0000	0000	0000	0000	0000	
7	0000	0	0	0000	0000	0000	0000	0000	
8	FB2E	64302	-1234	1111	1011	0010	1110	0000	
9	0000	0	0	0000	0000	0000	0000	0000	
10	0000	0	0	0000	0000	0000	0000	0000	
11	0000	0	0	0000	0000	0000	0000	0000	
12	0000	0	0	0000	0000	0000	0000	0000	
13	0000	0	0	0000	0000	0000	0000	0000	
14	0000	0	0	0000	0000	0000	0000	0000	
15	0000	0	0	0000	0000	0000	0000	0000	
16	0000	0	0	0000	0000	0000	0000	0000	
17	0000	0	0	0000	0000	0000	0000	0000	
18	0000	0	0	0000	0000	0000	0000	0000	
19	0000	0	0	0000	0000	0000	0000	0000	
20	0000	0	0	0000	0000	0000	0000	0000	

NR&D Sy/Max  
Register Viewer  
Press F2 for Help

**Figure 5-11 View Registers**

The Up and Down arrow keys are used to move from register to register.

The Page Up and Page Down keys move in increments of 10 registers.

The Left and Right arrows move from column to column on the same register.

Pressing the F9 key will present the SY/MAX setup window. This is useful for changing the route or other parameters without returning to the main menu.

This register viewer is highly useful in that it allows easy editing of the data in the register being viewed. By pressing 0..9 in the decimal fields or 0..9, or A..F in the hex field, an editing mode is entered. New data may be entered at this time. Pressing the Enter key or moving to a new field with the arrow keys will cause the new data to be written to the edited register. If the cursor is located in the REGISTER column the block of registers being viewed may be adjusted by entering a new register number. To edit the binary values, press HOME when on the binary field. Move the cursor to the desired bit and enter a '0' or a '1' and press enter to accept.

Pressing Esc will exit from the Register viewer and return to the main menu. Pressing Esc while editing a data field will result in canceling the edit and the modified data will not be written to the register.

The STAT field displays the status register associated with the data register. The STATUS field is a read only display and can not be modified by the Register Viewer. Two common values are E000 and A000. A000 is the hex representation that the PLC recognizes as a PLC OUTPUT register. E000 is for a PLC INPUT register. This allows easy recognition of registers controlled by the PEN as inputs and used by the PLC as outputs.

## View Statistics

The statistics pages are described on page 44.

## Terminal Emulator

Selecting the Terminal emulator from the Utilities menu will invoke a terminal emulator according to the setup selected in the Setup menu. The terminal emulator opens as shown in Figure 5-12.

```
Type ctrl-End to exit terminal. Type F7 to begin capture to a file.
Type F9 to change terminal communication setup.
To send hex sequence, type INSERT key, enter hex codes, type ENTER.
r1<0D>
0<0D>
r1,10<0D>
0 0 32768 0 0 0 0 4660 65278 1234<0D>
w12,55,67<0D>
<0D>read12<0D>
55<0D>
s12.1<0D>
<0D>r12<0D>
55<0D>
s12.16<0D>
<0D>r12<0D>
32823<0D>
c12.1<0D>
<0D>r12<0D>
32822<0D>
Enter hex codes to send: 10 05
<10><05>█
```

**Figure 5-12 Terminal Emulator**

The terminal sends the ASCII code for the alpha-numeric characters out the selected COM port. Functions keys F1 through F4 and the keypad arrows send ANSI (i.e. VT100) codes. F7 is reserved for starting a file capture. F8 will close the capture file. The backspace key sends ASCII BS (08 hex). The Delete key sends and ASCII DEL (7F hex). The Insert key allows the transmission of ASCII hexadecimal characters directly from the hex numbers separated by spaces.

The terminal displays printable ASCII characters which are received on the port. Non-printable characters are displayed as the hexadecimal value enclosed in <>, such as <0D><0A> indicates the carriage return, line feed characters. The terminal is always in this "monitor" mode and therefore ANSI output emulation is not provided.

Pressing F9 will invoke the Terminal Emulator Setup window. This is useful for changing the port parameters without returning to the main menu.

**Ethernet Nodes**

The Ethernet Nodes screen is valid only in the SY/MAX 802.3 protocol mode and provides a list of the SY/MAX addresses of devices known to the PEN. An entry in the table indicates that the devices is either active on the network or has been active since the PEN was powered up. The address of the PEN is highlighted.

**RNIM Slave**

The RNIM Slave utility is used for configuring PEN-SA or PEN-TCP-SA units for stand-alone operation where the Slave Device #1 doesn't have registers 6995 - 6999 to store the configuration parameters. POWERLOGIC PowerMeters, CM100s, PowerLink breakers, and Modbus Devices are examples where the PEN would need to be configured by the personal computer.

The RNIM Slave utility uses the setup from Setup, RNIM Slave to have the personal computer's COM port pretend to be CM#1. The screen displays the settings of registers 6995, 6996, 6997, 6998, and 6999 as well as the communication progress. The PEN will try all of the baud rate and parity combina-

tions as it attempts to communicate with CM#1. The relative speed of the message will be displayed on the screen as the PEN gets closer to the settings of the PC.

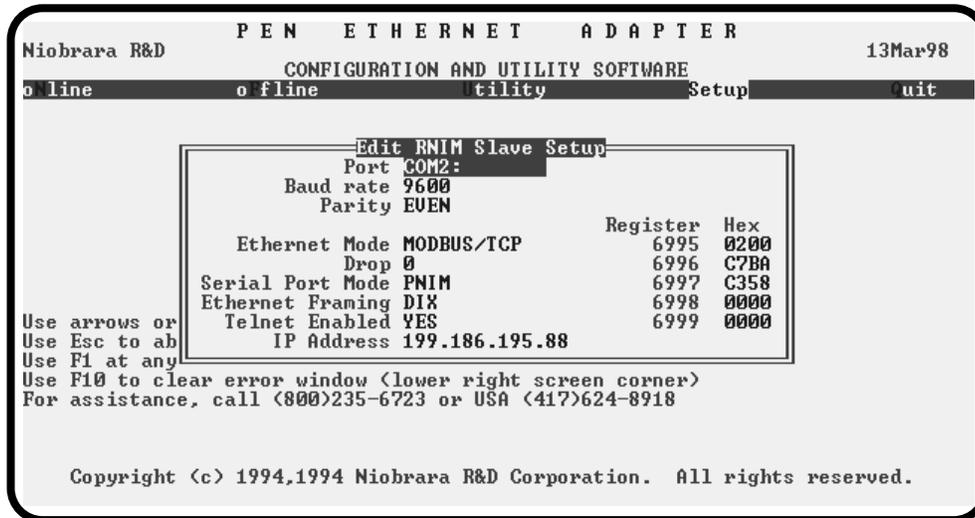


Figure 5-13 RNIM Slave Screen

## SETUP

The setup menu accesses the setup parameters for the personal computer to enable it to communicate with the PEN and the terminal emulator. The parameters chosen will depend on the exact equipment involved in making the connections.

### SY/MAX SETUP

The connection type is mainly determined by the method of connection to outside world and may be broken into several groups: the personal computer's COM: port, the SFI-610 Ethernet card, and the SY/LINK Network Interface Card.

#### Personal Computer COM: port

If the connection from the personal computer is made through one of its serial ports then the Connection type should be one of the following:

- Sy/Max COM:
- Net-to-Net COM:
- Gateway COM:

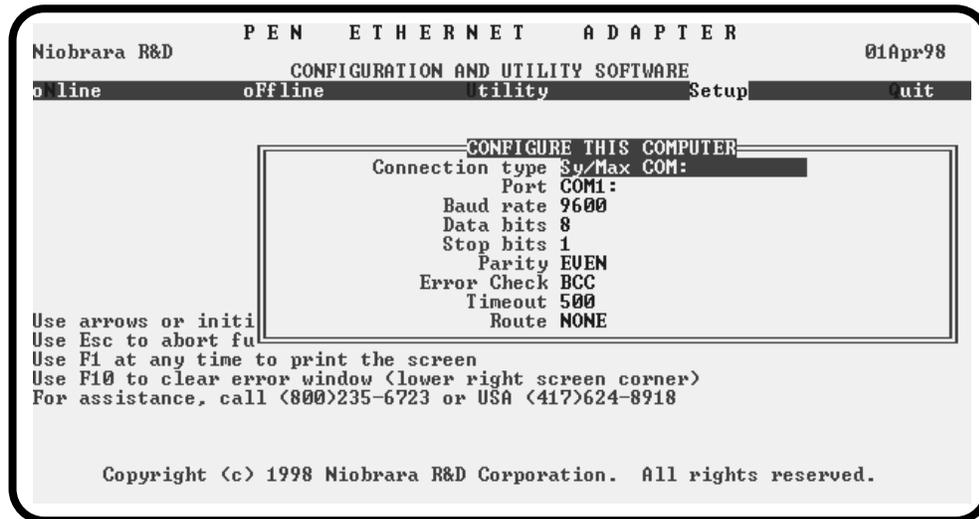
Sy/Max COM: is the default and most likely will be the one used. In this mode the personal computer will communicate through one of its COM: ports as though it were a SY/MAX device such as a PLC. The full SY/MAX protocol is supported including routing so SY/MAX COM: may be used through SY/MAX mode ports on NIMs and Niobrara Routing Modules with appropriate routing. This mode is to be used when a direct connection from the personal computer COM: port is made to the PEN. In most cases an RS-232<>RS-422 conversion is required and the Niobrara SC406 or SC902 cables make this conversion very convenient. Note: The SC406 and SC902 cables require the use of the provided power supply with the cable.

Net-to-Net COM: is used when connecting to a NIM, SY/LINK, MEB, EPE5, or SPE4 that is set to Net-to-Net mode. The first drop number in the route will be that of the address of the Net-to-Net port.

Gateway COM: is used when connecting to an SPE4/MEB/EPE5 port that is in Gateway mode. For more information about Gateway mode see on page <Gateway Mode>.

**Port** - When one of the COM: connection types is selected a particular port of the personal computer must be selected. Available choices are: COM1:, COM2:, COM3:, and COM4:. Select the port which will be used to connect to the PEN.

**Baud rate** - The Baud rate selected here is the baud rate of the personal computer serial port selected. This value should be set to match the device connected to the personal computer. A PEN has a default baud rate of 9600 and if a direct connection is made to the PEN this is the setting that should be made on the personal computer. If the baud rate of the port of the PEN has been changed this value may need to be adjusted.



**Figure 5-14 SY/MAX Setup Screen**

**Data bits** - When in SY/MAX or Net-to-Net modes the data bits is required to be 8 and may not be changed. The SY/MAX protocol requires 8 data bits. The Gateway mode uses ASCII messages which do not require the full 8 data bits and may be set to 8 or 7 depending on the attached device.

**Stop bits** - The stop bits are normally set to 1 but may be adjusted to 2 for some particular application. The communication ports of the PEN are normally set for 1 stop bit.

**Parity** - SY/MAX and Net-to-Net modes normally use EVEN parity and that is the default for the communication ports on the PEN. Other choices are ODD and NONE.

**Route** - The route is used to determine the path from the personal computer to the PEN. If a direct connection is made from the personal computer to the PEN, i.e. without going through a SY/NET network, an Ethernet network, another MEB, or an SPE4, this value is set to NONE by pressing the Delete key. If a SY/MAX connection is made to a SY/MAX mode port on an NIM or SPE4 the first drop will be that of the drop number of the NIM or SPE4 port. If any Net-to-Net drops are included between the port connected to the personal computer and the port connected to the PEN, they must be included in order of occurrence from the personal computer to the PEN. The last drop number listed will be that of the NIM or SPE4 SY/MAX mode port that is connected to the PEN. Up to 8 total drops are supported by the SY/MAX protocol.

If the personal computer is in Net-to-Net mode the first drop will be that of the Net-to-Net port of the NIM, SY/LINK, EPE5, or SPE4 that the personal computer is connected to. Subsequent drops will be included as above.

The Gateway mode route will include the Gateway port on the MEB, EPE5 or SPE4 that the personal computer is connected and any subsequent Net-to-Net and SY/MAX drops to reach the PEN.

## SY/LINK Connection

PENSW provides full support of the Square D SY/LINK network interface card. Setup for the network interface is provided along with setup for the RS-422 port on the card.

**Connection type** - The RS-422 port may be set to SY/MAX or Net-to-Net modes. For a direct connection to the PEN from the RS-422 port of the SY/LINK card choose the Sy/Link Direct mode. If an indirect connection from the RS-422 port of the card is made through other Net-to-Net ports choose Sy/Link Net-to-Net. If the RS-422 port is not used and the connection is made through the SY/NET network to another NIM, the choice does not matter.

**Base address** - This is a hex value that represents the SY/LINK's cards address range selected by DIP switches on the card. Select the same range that is set on the card.

**RS422 Baud rate** - Select the baud rate to match the external device, normally 9600.

**RS422 Data bits** - Select the data bits to match the external device, normally 8.

**RS422 Stop bits** - Select the stop bits to match the external device, normally 1.

**RS422 Parity** - Select the parity to match the external device, normally EVEN.

**Sy/Net speed** - Select to match the speed settings of the other devices on the SY/NET.

**Sy/Net size** - Select to match the setting on the other SY/NET devices.

**Route** - The first drop in the route defines the network address of the SY/LINK board. Since the personal computer is connected to the SY/LINK card through the edge connector of the card, port 0, the drop number must start with 0. The remaining two digits of that drop should be selected not to match any other device on the SY/NET. For instance, there are three NIMs on the network addressed 01, 02, and 03. It seems logical to make the SY/LINK card be at address 04 so the first drop in the route field will be 004. The next drop will be that of the NIM port connected to the PEN, or another Net-to-Net port. If Sy/Link Direct was selected and the PEN is connected directly to the RS-422 port of the SY/LINK card the full route statement would be 004 104 as the RS-422 port is considered to be port 1.

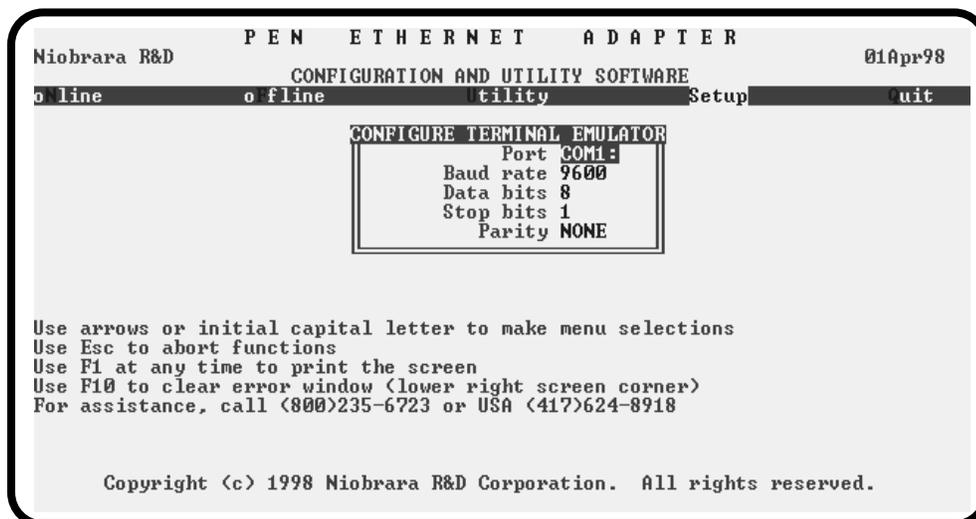
## SFI-610 SETUP

PENSW provides support for the SFI-610 Ethernet card for the personal computer. The SFI-610 card requires initialization with the SFI610.EXE program before it may be used with PENSW. This initialization configures the SFI-610 card for a specific SY/NET drop number.

The only adjustable setting of the SFI-610 is the Route. The first drop number in the Route must be the drop number for which the SFI-610 has been configured. The remaining drops will include the path to the target.

## Terminal Emulator SETUP

The Terminal Emulator setup allows an individual setup for the operation of the terminal emulator. For instance, this separate setup will allow COM1 to be used for the PEN SY/MAX connection and COM2 to be used for a terminal emulator connection.



## Figure 5-15 Terminal Emulator Setup Screen

**Port** - Available choices are: COM1:, COM2:, COM3:, and COM4:. Select the port which will be used to connect to the external device.

**Baud rate** - The Baud rate selected here is the baud rate of the personal computer serial port selected. This value should be set to match the device connected to the personal computer.

**Data bits** - Selects the number of data bits for the message packet. Choices are 8 or 7 depending on the attached device.

**Stop bits** - The stop bits are normally set to 1 but may be adjusted to 2 for some particular application.

**Parity** - Choices are EVEN, ODD, and NONE.

## Register Viewer Setup

The Register Viewer Setup allows an individual setup for the operation of the Utility Register Viewer.

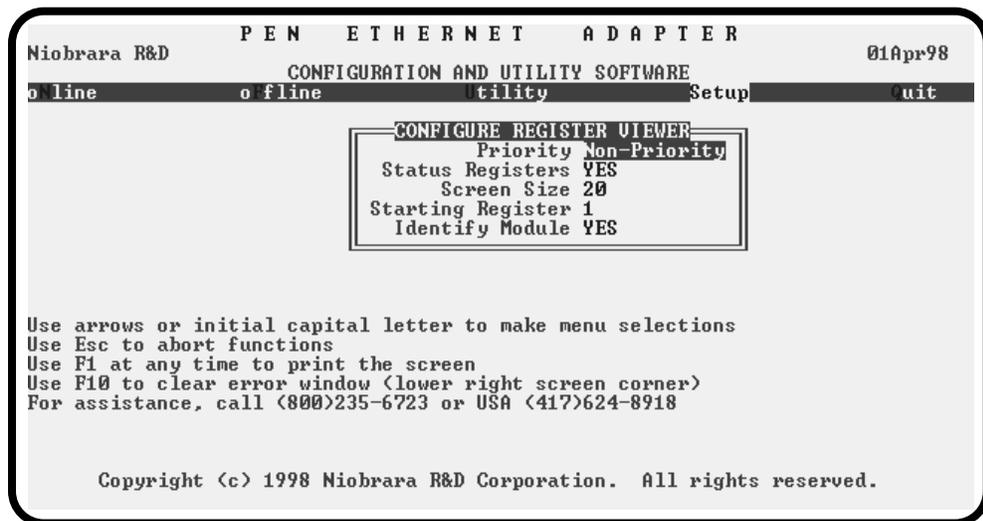


Figure 5-16 Register Viewer Setup Screen

**Priority** - The Priority setting allows the choice of Priority or Non-Priority SY/MAX messages for the read and write operations of the register viewer. The default is Non-Priority.

**Status Registers** - This setting allows the reading of the status bits (bits 17 through 32) of a SY/MAX register. If set to YES, the Priority setting must be NON-PRIORITY when the target is a SY/MAX PLC. The default setting is YES.

**Screen Size** - Selects the number registers to be read per operation and displayed on the screen. The valid range is 1 through 20 inclusive. The default value is 20.

**Starting Register** - The starting register value determines the first register polled when the register viewer is entered. The valid range is 1 through 8192 inclusive with the default value of 1.

**Identify Module** - This option determines if the register 8188 is read in the target device to determine the SY/MAX ID of the target. The default value is YES.

## RNIM Slave Setup

The RNIM Slave utility is used for configuring PEN-SA or PEN-TCP-SA units for stand-alone operation where the Slave Device #1 doesn't have registers 6995 - 6999 to store the configuration parameters. POWERLOGIC PowerMeters, CM100s, PowerLink breakers, and Modbus Devices are examples where the PEN would need to be configured by the personal computer.

The RNIM Slave Setup configures the parameters used by the Utility, RNIM Slave. The screen displays the settings of registers 6995, 6996, 6997, 6998, and 6999 as well as the communication progress.

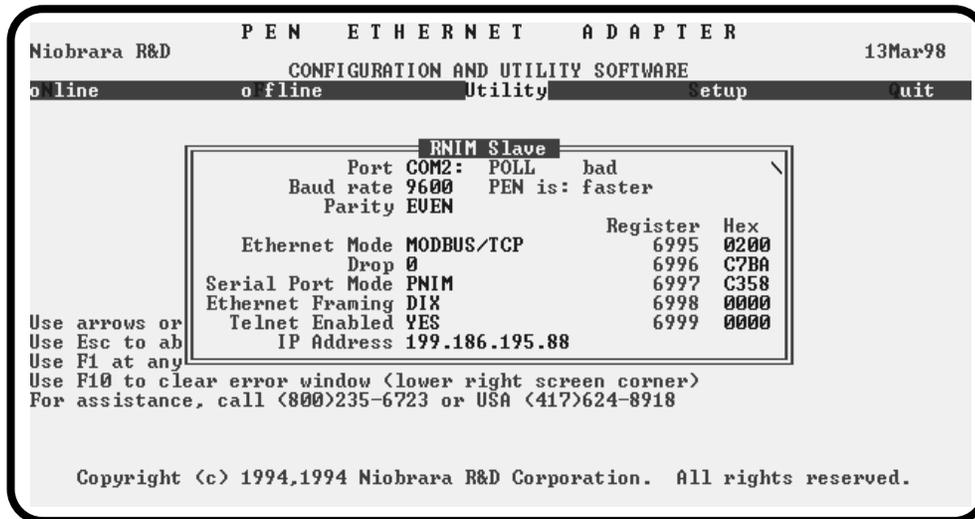


Figure 5-17 RNIM Slave Setup Screen

### Load from File

The Load from File option allows the user to select from multiple SY/MAX setups. Simply enter the filename of the setup desired and PENSX will use that setup. PENSX always saves the current setup as PENSX.STP regardless if a new setup has been loaded. The idea is that you configure the setup as you like, save it to PENSX.STP by selecting Y for yes when prompted, quit PENSX to DOS, and copy PENSX.STP to a new filename with the extension .STP. The following DOS command copies the PENSX.STP to a new name PEN01.STP:

```
C:\PEN> copy pensw.stp pen01.stp
```

### Command Line Parameters

PENSX may be started from the DOS command line with a sequence of letters which represent the keystrokes necessary to perform any operation. This allows batch processing of various commands such as downloading of stored setup files. The special characters /R, /D, and /E refer to the Return key, Delete key, and Escape key respectively. The parameters are not case sensitive. The following example loads a new SY/MAX setup PEN01.STP, to perhaps change the route to the PEN, loads the configuration file TEST.PEN into an PEN, then quits. It is assumed that the PEN is connected to the computer and the rest of PENSX setup is correct.

```
>PENSX SLpen01/RFRtest/RFSQ
```

The S selects Setup, the L selects Load setup file, pen01 is the filename of the setup, /R is the return to accept the filename, the F is for oFfline, the R is to Read a configuration file, test is the filename, /R is the return to accept the filename, F selects oFfline again, S sends the configuration to the module, and finally Q for Quit.

## 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 PENSW 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 PENSW programs is a convenient interface to the PEN's registers.

### PEN Register Overview

Table 6-1 represents an overview of the local registers present within the PEN. All registers must be read or written through the E-Net ports.

**Table 6-1 Module Register Overview**

Register	Function
1..2048	Mailbox registers for user applications
2049..2176	Statistics Registers (See Tables 6-2 and 6-4)
2177..2999	Reserved for future use, do not modify
3000..3302	Ethernet Addresses (See Table 6-5)
3303..7999	Reserved for future use.
8001..8162	Setup and Configuration (See Tables 6-6, 6-7, 6-9)
8176..8188	Module identification (See Table 6-11)

### 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 6-2.

**Table 6-2 SY/MAX Ethernet Port Statistics Registers**

<b>Register</b>	<b>Incremented when the following occurs:</b>
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.

**Table 6-3 TCP/IP Ethernet Port Statistics Registers**

<b>Register</b>	<b>Incremented when the following occurs:</b>
2049	TCP/IP RESET received.
2050	SNIC ran out of Ring Buffers.
2051	Reserved
2052	TCP Buffer pulled from Free Queue.
2053	Free Queue is Empty (out of buffers).
2054	Packet transmitted successfully and acknowledged by peer.
2055	Connection abandoned.
2056	Retransmitted un-ACKed packet.
2057	Packet lost because of unrecognized or illegal drop or bad route.
2058	Illegal TCP/IP Query request on local registers.
2059	Incoming TCP/IP Read performed upon local registers.
2060	Incoming TCP/IP Write received and performed upon local registers.
2061	Total number of TCP connections open.
2062	Total number of Client TCP connections open.
2063	Non-Modbus TCP/IP 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 6-4.

**Table 6-4 Port 1 Statistics Registers**

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

## IP Address

The PEN-TCP requires a 4 byte IP address which it reads from CM#1, registers 6996 and 6997. If the values in these registers provide a valid IP address, they are copied into PEN registers 2900 and 2901.

## TCP/IP Port Number

The MODBUS/TCP mode always uses TCP port 502. This value is not adjustable.

## 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 6-5). 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:

$$3000 + \text{Drop} * 3 = \text{First two bytes of Ethernet Address}$$

$$3001 + \text{Drop} * 3 = \text{Middle two bytes of Ethernet Address}$$

$$3002 + \text{Drop} * 3 = \text{Last two bytes of Ethernet Address}$$

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

**Table 6-5 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 6-6.

**Table 6-6 Module Setup Identification Registers**

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

## Ethernet Port Control Registers

**Table 6-7 Ethernet Port Control Registers**

<b>Port 0</b>	<b>Legal Values</b>	<b>Function</b>
8003	0..99	Ethernet SY/MAX drop number.
8004		Reserved
8005		Reserved
8006		Reserved
8007		Reserved
8008	2, 2021	Protocol Mode 2= SY/MAX, 2021 = MODBUS/TCP
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		Options (See Table 6-8 on Page 67)
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

**Table 6-8 Options Register Values**

Option Bit	Function when Bit CLEAR (Default)	Function when Bit SET
1	Ethernet TCP/IP SNAP mode.	Ethernet TCP/IP non-SNAP mode.
2	Telnet enabled for TCP/IP. PEN auto-polls on serial port	Telnet Disable for the E-net port in TCP/IP. Disable auto-polling
3	BOOTP Enabled on Ethernet port in TCP/IP Modes.	Disable BOOTP on Ethernet Port in TCP/IP Modes.
4	DHCP Enabled on Ethernet port in TCP/IP Modes.	Disable DHCP on Ethernet Port in TCP/IP Modes.
5	Not Used	Not Used
6	Not Used	Not Used
7	Not Used	Not Used
8	Not Used	Not Used
9	Not Used	Not Used
10	Not Used	Not Used
11	Not Used	Not Used
12	Not Used	Not Used
13	Not Used	Not Used
14	Not Used	Not Used
15	Not Used	Not Used
16	Not Used	Not Used

## Options

The Options Register allows the modification of the normal operation of several features of the PEN.

- Bit 1 controls the IP framing for the Ethernet port. When the bit is set, the framing will be set from Ethernet II (SNAP) to 802.3 (DIX).
- Bit 2 determines whether the TELNET application is enabled when in TCP/IP mode on the Ethernet port. The default value is TELNET enabled (bit cleared).
- Bit 3 controls BOOTP for the Ethernet port while in TCP/IP mode. If bit 3 is ON then BOOTP is disabled.
- Bit 4 controls DHCP for the Ethernet port while in TCP/IP mode. If bit 3 is ON then DHCP is disabled.

## Data Port Control Registers

The serial parameters of the RS-422 port is displayed in Table 6-9.

**Table 6-9 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, 14	Protocol Mode 11=PNIM, 14=Modbus Gate
8041		Reserved
8042		Reply Timeout in 0.01 second units
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 6-10 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 6-11 provides an overview of these registers.

**Table 6-11 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 6-12.

**Table 6-12 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	

## 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)

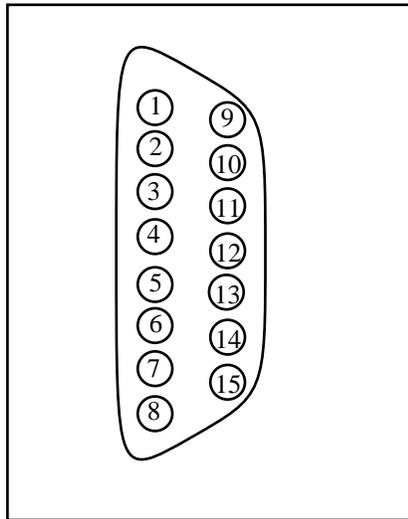


Figure 7-1 AUI Connector Pinout

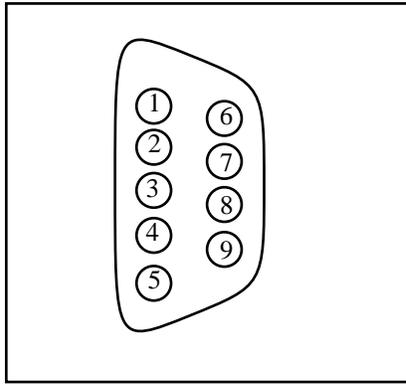
## RS-485 Pigtail Cable Color Code

- 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.

## RS-485 DE9S on the PEN-TCP-SA

The 9 pin female RS-422 connection on the PEN-TCP-SA provides the standard SY/MAX compatible pinout without handshake lines.

- 1 **TX-** (Transmit from the PEN) Connect to IN- on the CM.
- 2 **TX+** Connect to IN+ on the CM.
- 3 **RX-** (Data into the PEN) Connect to OUT- on the CM.
- 4 **RX+** Connect to OUT+ on the CM.
- 5 NC
- 6 NC
- 7 NC
- 8 NC
- 9 Shield



**Figure 7-2 DE9S Pinout**



## 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 8-1 provides the color code for connecting to the Circuit Monitor.

**Table 8-1 PEN RS-485 Wiring Code**

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

### Stand-Alone 9 Pin Wiring

The PEN-TCP-SA uses a 9 pin sub-d connector for its RS-485 connection. A standard POWERLOGIC CAB-107 cable may be used to connect the first CM to the PEN. The wiring is shown in Table 8-2.

**Table 8-2 PEN-TCP-SA RS-485 Wiring Code**

PEN pin	CM Connector	CM Terminal
2	IN +	20
1	IN -	21
4	OUT +	22
3	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+ con-

nections 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 8-3 for an example of connecting 4 CMs to a PEN.

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

**Table 8-3 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 8-4.

**Table 8-4 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.



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# 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

### Media Connection

The first step in troubleshooting the Ethernet connection is determination of a good media connection. Many Ethernet MAU transceivers include indicator indicator lights for POWER, LINK, SQE TEST, POLARITY, TX, RX, or COLLISION.

The POWER light should be ON if the MAU is connected to the PEN and the PEN is powered.

The LINK light usually indicates that the MAU receiver is properly connected to the transmitter at the other end of the twisted pair or fiber. There should be link indications at both ends of the connection and if not, check the cable connection.

The PEN ignores SQE so it doesn't matter if it is turned on or off.

If a Polarity light is on it indicates that the the twisted pairs are connected have their polarity inverted. Most MAUs will automatically compensate for this by software, but it is a good idea to correct the wiring.

If there is a TX light, it will come on when the PEN is transmitting from its E-net port. When the PEN-TCP is powered up, it will send a broadcast message (either a SY/MAX multicast or IP gratuitous ARP) to tell the network it is alive. The TX light should blink when transmitting this and other messages.

The RX light will come on and when there is activity on the network; even if it isn't directed to the PEN. There is almost always some activity on an E-net so the RX light should blink occasionally.

The Collision light will come on when the PEN tries to transmit and the transmission collides with other network traffic. Collisions may be fairly common on busy networks. If the collision light is always on check for a missing terminator, bad tee, or broken coax on a 10Base2 network.

### SY/MAX Connection

The first step is to make sure that the correct values are loaded in Registers 6995 - 6999 in CM#1. If the SY/MAX address is correct in R[6995] in the unit is in SY/MAX Ethernet mode then the PEN should be ready for communication.

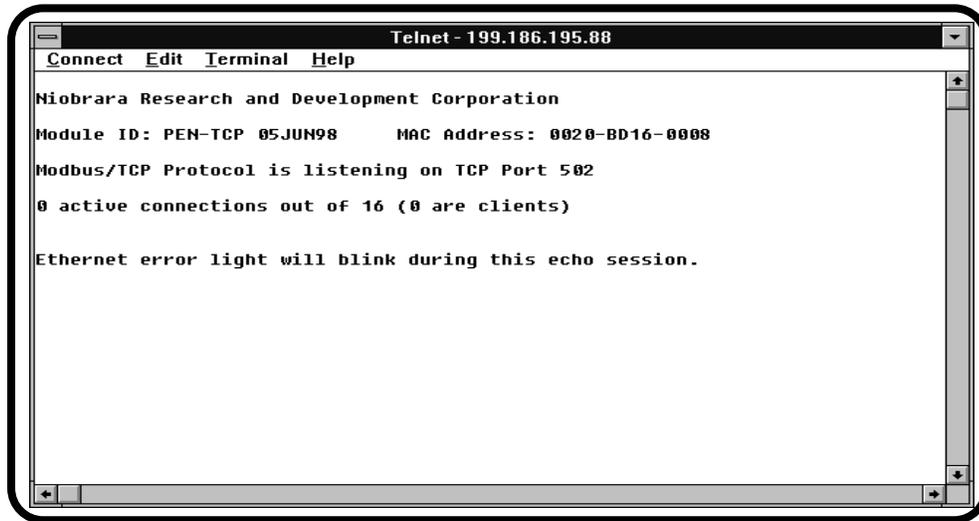
If the red E-net Error light is blinking rapidly then the unit is probably in the duplicate address state and will not communicate over its E-net port. Somewhere on the network another SY/MAX devices is set for the same address as the PEN and it is also in a duplicate address error condition. The solution is to change the address of one of the units and probably cycle power to reset the units.

The "Utility, Ethernet Nodes" menu item in PENSW, EPE5SW, and MEBSW is handy for seeing which SY/MAX addresses are present on a network.

## TCP/IP Connection

The first step is to make sure that the correct values are loaded in Registers 6995 - 6999 in CM#1. If the correct, then the next step is to try to PING the PEN-TCP from a computer connected to the network. The PING utility is usually included with the TCP/IP stack on a computer and simply sends an ICMP echo request to a target IP address. The target device echoes the data back to the sender. When the PEN-TCP is responding to a PING, it blinks its E-net Active light.

A good way to check to be sure that the IP address that responds to a PING is really a PEN-TCP is to TELNET to the IP address. If bit 14 is clear in register 6995 in CM#1 then the TELNET server in the PEN is enabled. When a computer TELNETs to a PEN-TCP, the PEN will respond with a message indicating that this is a PEN and give the IP address, MAC address and echoes characters typed from the computer. The red E-net Error light blinks while the TELNET server has an open connection. The PEN will close an idle TELNET connection after 10 seconds of inactivity. See Figure 9-1.



**Figure 9-1 PEN-TCP Telnet Screen**

If the PEN-TCP determines that another device on the network has the same IP address as itself then it will blink its red E-net Error light rapidly until the other device goes away or the IP address of the PEN is changed. When in this state, the PEN-TCP will still attempt to reply to IP messages directed to it. When the PEN boots or when its IP address is changed, it sends a gratuitous ARP message to inform the network that it is alive.

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# Appendix A

## MODBUS/TCP Protocol Specification

The absolute latest information regarding MODBUS/TCP may be obtained at <http://www.modicon.com/openmbus/> on the Internet.



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## Appendix B

### NR&D Internet Access

Niobrara is now on the World Wide Web! Our Internet home page is at

**<http://www.niobrara.com>**

You will find the latest software and manuals available for download as well as application notes.

Technical support questions may be sent to:

**[techsupport@niobrara.com](mailto:techsupport@niobrara.com)**

Marketing questions may be set to:

**[marketing@niobrara.com](mailto:marketing@niobrara.com)**



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