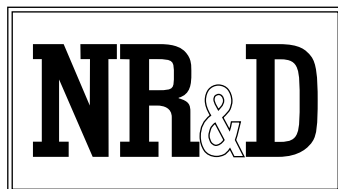# EPE5-TCP

Installation and Programming Manual

This Manual describes the EPE5-TCP SY/MAX® Ethernet Port Expander Module with TCP/IP protocol, its uses and set up. It also describes the use of the EPE5SW programming software.

Effective: 24 January, 2003

NR&D

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1
Introduction

The Niobrara EPE5-TCP is a SY/MAX® and Modbus compatible communication switching and translating module mounted in and powered by the SY/MAX register rack. The EPE5-TCP's Ethernet protocol is selectable between the SY/MAX 802.3 Communication protocol or the Modbus/TCP protocol. The Modbus/TCP protocol uses the standard TCP/IP transport. The EPE5-TCP retains all of the features of the standard **EPE5** with the addition of the TCP/IP Ethernet protocol.

The EPE5's Ethernet Port complies with IEEE 802.3 standards and provides a high speed connection (10Mbit/sec) to host computers, Square D Model 450 and 650 processors, SFI-610 cards, and other EPE5s, MEBs, and PENs while using the SY/MAX 802.3 protocol. The EPE5 and Square D processors can coexist on existing Ethernet networks with other devices and protocols such as DECnet and TCP/IP.

When the Modbus/TCP protocol mode is selected for the Ethernet port, the EPE5-TCP is capable of sending SY/MAX and Modbus messages across IP only routers using the TCP/IP transport. The EPE5-TCP must be configured for its TCP/IP address, subnet mask, and default gateway. The EPE5-TCP acts as both Client and Server at the same time to allow simultaneous bi-directional communication. Incoming SY/MAX or Modbus messages are routed to downstream TCP/IP addresses with the use of a user configurable table that allows up to 200 entries for downstream IP addresses.

All operational parameters are set by internal registers within the EPE5. (There are no DIP switches on the EPE5.) Each parameter may be monitored and modified by standard SY/MAX READ and WRITE messages; either from the front data ports, or from the Ethernet port. An MS-DOS compatible program, EPE5SW, is provided with the module for ease of configuration as well as EPE5SW32, a 32 bit Windows 95/98/NT program, which provides direct Ethernet connectivity to the MEB-TCP using the Windows TCP/IP stack and Modbus/TCP. Automatic Ethernet confugation is supported through BOOTP or DHCP.

The EPE5-TCP is available in the following standard configuration:

- 4 RS-422/485 ports, one ThinWire Ethernet port, the EPE5-TCP-D. The serial ports are user configurable for 4-wire RS-422, 4-wire multidrop RS-485, or 2-wire multidrop RS-485 use.

- 4 RS-422/485 ports, one AUI Ethernet port, the EPE5-TCP-A. The serial ports are user configurable for 4-wire RS-422, 4-wire multidrop RS-485, or 2-wire multidrop RS-485 use.

The front panel layout is displayed in Figure 1-1.

The EPE5 provides 2048 processor equivalent mailbox registers accessible through any port including the Ethernet port. The EPE5 allows bi-directional access to the register rack backplane for these 2048

registers. This function can be used to off-load communication from a processor by allowing attached devices to poll the mailbox in the EPE5 and letting the processor write new data as it changes. Thus allowing external devices a high speed path to the PLC without being channeled through the PLC's communication port.

The EPE5 also offers an E-PEER mode for the Ethernet port that allows a high speed peer to peer data exchange between EPE5 units on the Ethernet network (SY/MAX 802.3 only). The E-PEER feature is functionally similar, but not compatible with, the SY/PEER network on the Square D Model 600 processor. On an independent Ethernet network with no other traffic, the E-PEER network is deterministic. The E-PEER may also be used on a normal Ethernet network with SY/NET, DECNet, NOVEL, and other traffic to provide a convenient method for sharing data between processors without processor intervention.

This manual provides a few examples of applications for each of the modes available for the ports. Further technical notes of exact applications are also available. Consult your distributor for further details.
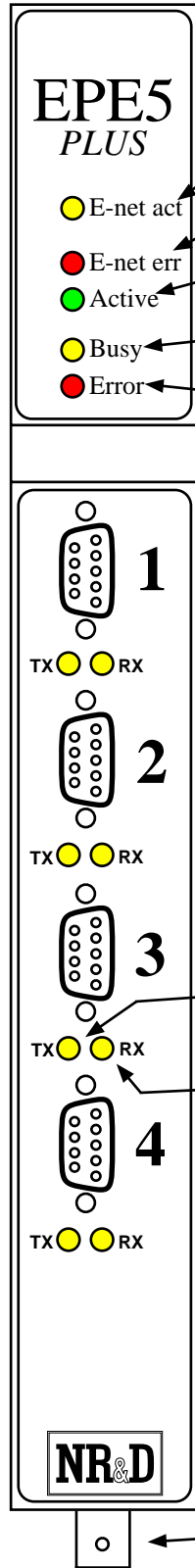
Status Indicators (LEDs)

E-net act (Green) - lights when the module is entertaining Ethernet communication.

E-net err (Red) - lights to indicate an error in Ethernet communication.

Active (Green) - lights when module is powered and has passed self-test.

Busy (Yellow) - Frequency and intensity indicate level of CPU activity.

Error (Red) - Lights for one second each time one of the statistical error registers is incremented.

Communication Ports

Ports 1-4

Female RS-422/485 (EPE5-D)

Serial communication ports for connection to peripheral devices. Ports 1-4 feature full RTS/CTS handshaking, and support all available modes. User configurable for 4-wire RS-422, 4-wire multidrop RS-485 or 2-wire multidrop RS-485.

Communication Indicators (LEDs)

TX (Yellow) - Lights when data is transmitted from port.

RX (Yellow) - Lights when data is received at port.

Ethernet Port

Selectable SY/MAX 802.3 compatible Thin-wire Ethernet with selectable NR&D's E-Peer mode or Modbus/TCP (TCP/IP) protocol

EPE5-TCP-D units include the ThinWire port. EPE5-TCP-A units include a 15 pin AUI port.,

Figure 1-1   EPE5 Front Panel

2
Installation

This chapter is divided into four sections:

1   EPE5SW configuration software installation.

2   EPE5 module installation.

3   EPE5 Ethernet port configuration.

4   Ethernet network installation.

It is important to follow these procedures exactly to avoid Ethernet address conflicts which could result in stoppage of network traffic. If the EPE5 is connected to a live Ethernet without having a unique SY/MAX 802.3 address or IP Address, stoppage of communication to the other device will immediately occur.

WARNING

Connecting two SY/MAX 802.3 Ethernet devices with the same SY/NET address on the same network will result in both devices halting network communication. Both units must be manually reset to clear this condition. The halting of communication may effect equipment under control of the programmable control system. Make sure that all network devices have different address. Use Table <Ethernet Drop Number Reference Table> on Page <Ethernet Drop Number Reference Table> to keep an accurate record of network devices in use.

EPE5SW Installation

1   The EPE5SW software is included on a 3.5" 720K MS-DOS diskette along with all NR&D PLC related software. For ease of installation, use the INSTALL program on the floppy. Select the EPE5SW file for installation and allow the INSTALL program to perform the decompression.

2   To manually install EPE5SW, run the PKUNZIP program with the following parameters:
        A:>PKUNZIP -d EPE5SW.ZIP C:\EPE5*.*
    This will run PKUNZIP from the floppy, create the directory EPE5 on the c drive, expand all files from EPE5SW.ZIP into the \EPE5\ directory.

3   To start the EPE5SW after installation, perform the following:

    > C:

    > CD \ EPE5

> **EPE5SW**

The screen should look like Figure 2-1.


```
        E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                                                        01Jun95
                    CONFIGURATION AND UTILITY SOFTWARE
oNline              oFfline              Utility            Setup        Quit




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


       Copyright (c) 1994 Niobrara R&D Corporation.  All rights reserved.
```

Figure 2-1   EPE5SW Startup Screen

4   Press S for Setup. A sub-menu will appear which allows the selection of the Sy/Max connection or Terminal Emulator Connection configuration parameters. These setup parameters affect only the configuration of the personal computer, not the EPE5.

5   Press S for Sy/Max. The screen should appear as in Figure 2-2.

6   Determine the type of connection from the personal computer to a RS-422 port of the EPE5. For most cases this will involve a direct connection from a COM port of the computer to the EPE5. 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 EPE5.

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 EPE5SW configuration software is now installed and ready for communication to the module. For more information about the setup parameters of EPE5SW see page 156.


```
        E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                                                        01Jun95
                    CONFIGURATION AND UTILITY SOFTWARE
oNline              oFfline              Utility            Setup        Quit


                           =CONFIGURE THIS COMPUTER=
                     Connection type Sy/Max COM:
                              Port COM1:
                         Baud rate 9600
                         Data bits 8
                         Stop bits 1
                            Parity EVEN
                       Error Check BCC
                             Route NONE
Use arrows or initi
Use Esc to abort fu
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


       Copyright (c) 1994 Niobrara R&D Corporation.  All rights reserved.
```

Figure 2-2   EPE5SW SY/MAX Configuration Screen

EPE5 Module Installation

```
                                          WARNING

DO NOT remove or install the EPE5 with power applied to the rack.  Turn OFF the power at the
power supply.  Damage to the equipment may occur if power is not removed prior to installation
or removal of modules.
```

1   Remove power from the register rack.

2   Mount the EPE5 module in an available slot in the register rack. **Do not connect the Ethernet cable to the module yet.**

3   Apply power to the rack. The lights on the top panel of the module should flash to indicate that the module is active. The Active light should be green and the Busy may flash periodically. The lights beneath ports 1-4 illuminate only when data is passing through the port.

Ethernet Port Configuration

Automatic Configuration using BOOTP or DHCP

The EPE5-TCP may be automatically configured for Modbus/TCP operation from a BOOTP or DHCP server on the Ethernet network. By factory default, the EPE5-TCP has BOOTP/DHCP support enabled. On power-up it will attempt to reach a BOOTP or DHCP server using both Ethernet II (DIX) and 802.3 (SNAP) framing until it obtains a valid IP Address or one is entered manually through one of its other ports. As long as the BOOTP/DHCP client is enabled, the EPE5 will attempt to get a new IP Address every time it powers-up. If the MEB has a valid Ethernet configuration then it will give up on BOOTP/DHCP after 18 seconds.

The EPE5-TCP has its MAC Address displayed on a sticker on the angled portion of the front panel just above Port 1. This 12 digit hexadecimal number is used by the Network Administrator to configure the BOOTP or DHCP Server to reserve a specific IP address for the EPE5. The BOOTP or DHCP Server should be configured to provide the IP Address, Subnet Mask, and Default Gateway.

While the EPE5 is attempting to connect with a BOOTP/DHCP Server it will turn on its BUSY light. If it does not have a valid IP Address then it will also turn on its Ethernet Error light. As soon has the EPE5 has obtained a valid IP address, it may be completely configured using the EPE5SW32 software by selecting Modbus/TCP as the "Connection Type", entering the IP Address for the "Host", and 255 for the Index.

Manual Configuration using EPE5SW or EPE5SW32

1   Connect the personal computer to the EPE5 using a RS-422 connection. The EPE5 should receive its initial configuration by direct connection from an MS/DOS® personal computer COM: port (See Figure 2-3). Niobrara's SC902 (or SC406) RS-232 to RS-422 converter cable can be used to make this connection. Ports 1-4 provide full handshaking of the RTS/CTS pins and do not provide power for the smart cable. **The external power supply for the Smart Cable must be used**. The

factory default configuration for the module is that all ports are SY/MAX, 9600 baud, 8 data bits, EVEN parity, 1 stop bit so any port may be used for configuration.
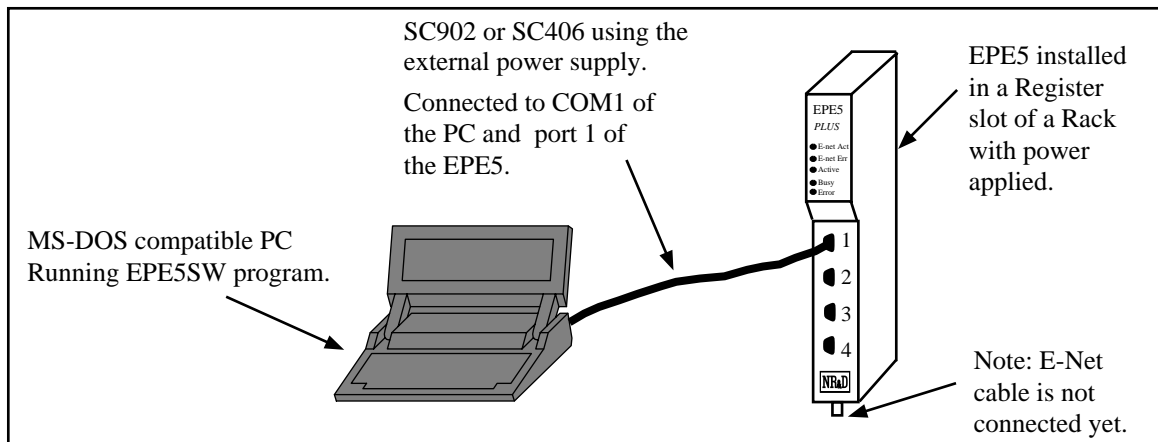
Figure 2-3   EPE5 Initial Configuration Setup

2   Start EPE5SW on the personal computer.

3   Press N for oNline. The EPE5SW will attempt to communicate to the EPE5 and display the parameters of the module. The yellow TX and RX lights under the EPE5 serial port should be flashing quickly. The yellow busy light at the top of the module should be slightly brighter. If the setup parameters are correct, the screen should appear as in Figure 2-4.

   If an error occurs in communicating with the EPE5, an error window will open in the lower right corner. F10 will clear the error. Check the COM port setting, route setting, and your cabling. For a direct connection as in Figure 2-3, the default settings should work. For more information about the setup parameters of EPE5SW see page 156.

4   The arrow keys are used to maneuver from cell to cell. The gray +, and - keys and space bar are used to toggle through the available values for each cell. This is an online process and each change made occurs in the module and stored in its nonvolatile memory.

5   Move the cursor to the upper left hand area to set the Ethernet Address.

6   Set the Ethernet Address to a value not used elsewhere on the network (SY/MAX 802.3) and press Enter. This value is not critical if Modbus/TCP protocol mode is selected.

7   Select the Ethernet Protocol desired for operation. It is recommended that the SY/MAX 802.3 protocol be used when possible as it is faster than Modbus/TCP. If IP routing is required, select Modbus/TCP and complete the following steps:.

   a.   Enter the IP Address for this EPE5. This value must be unique on the IP network.

   b.   Enter the Subnet Mask for this IP network segment.

   c.   Enter the Default Gateway IP Address, or enter 0.0.0.0 if there is none.

8   The EPE5 is now ready to be connected to the Ethernet Network.

<div style="border:2px solid black">

WARNING

Connecting two SY/MAX 802.3 Ethernet devices with the same SY/NET address on the same network will result in both devices halting network communication. Both units must be manually reset to clear this condition. The halting of communication may effect equipment under control of the programmable control system. Make sure that all network devices have different address.

</div>

```
            E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                                                          29Oct96
                        CONFIGURATION AND UTILITY SOFTWARE    Press F2 for help.
                     ETHERNET     PORT 1     PORT 2     PORT 3     PORT 4
Drop                 0            100        101        2          102
On Ethernet          YES          NO         NO         NO         NO
Protocol             NRD/TCP      PNIM       SY/MAX     SY/MAX     SY/MAX
Baud Rate            199.186.195.27  9600    9600       9600       9600
Parity               255.255.255.0   EVEN    EVEN       EVEN       EVEN
Data Bits            199.186.195.1   8       8          8          8
Stop Bits                         1          1          1          1
Buffer Limit         16           16         16         16         16

Error Check                                  BCC
Route Appendix                               NONE
Route Replacement                            OFF

Transfer Interval                            100
Transfer Route                               NONE
Read Count                                   0
Read From                                    128
Read To                                      0
Write Count                                  0
Write To                                     0
Write From                                   10
```

Figure 2-4   oNline Edit Screen

Network Installation

The EPE5 is connected to other Ethernet devices by way of cables and connectors to form a Local Area Network. The following table provides the NR&D part number of connectors and cables for constructing the network:

Table 2-1   Ethernet Connectors and Cables

NR&D Part Number	Square D Equivalent Part Number	Description
EN1	CC601	Ethernet Cable (thin wire 6ft long)*
EN611	CCK611	Ethernet Cable End
EN612	CCK612	Ethernet Cable TEE Connector
EN613	CCK613	Ethernet Cable Terminator
EN614	CCK614	Ethernet Cable Extension (Barrel)

* The standard length for the EN1 is 6 feet. Other lengths are available from the factory. Order special lengths with the following number: EN1-x where x is the length in feet for the cable. For example, EN1-100, would represent a 100 foot long EN1 cable. For custom assembly by the customer, use two (2) EN611 Ethernet Cable Ends and an appropriate length of Belden® 9907 or 89907 or equivalent. This is a 50 ohm impedance coaxial cable for use on IEEE 802.3 10 Base 2 trunks.

The following figures illustrate the products in Table 2-1.

Ethernet Cable End (EN611)
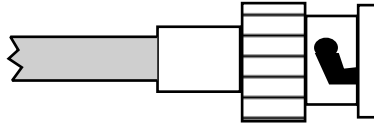
Figure 2-5   Ethernet Cable End (EN611)

The EN611 is a female socket and provides a locking connection for the cable to a TEE or barrel connector. Two cable ends are required for each cable.

Ethernet TEE Connector (EN612)
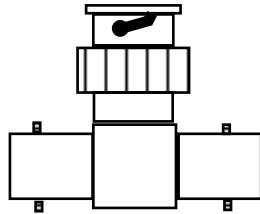
Figure 2-6   Ethernet TEE Connector (EN612)

The EN612 is a TEE connector for connecting the EPE5 to the network. It consists of a female and two male connectors. The female connector attaches to the male extending from the EPE5. The male connectors mate with the female cable ends on a cable as well as the terminators.

Ethernet Terminator (EN613)
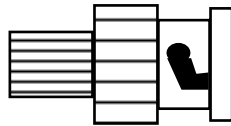
Figure 2-7   Ethernet Terminator (EN613)

The terminator is a female socket with an internal 50 ohm resistor. The terminator is used to terminate the end of a network. The terminator attaches to one of the male connectors on a TEE connector. Two terminators are required for each network; one at each end.

Ethernet Cable Extension or Barrel (EN614)
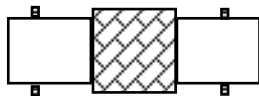
Figure 2-8   Ethernet Cable Extension or Barrel (EN614)

The Barrel connector consists of two male connectors back to back. The barrel is used to connect two network cables together to make a longer cable. The barrel may also be used to replace a TEE for future expansion or replacement of an Ethernet unit.

A small Ethernet thin wire network without repeaters will be something like Figure 2-9.
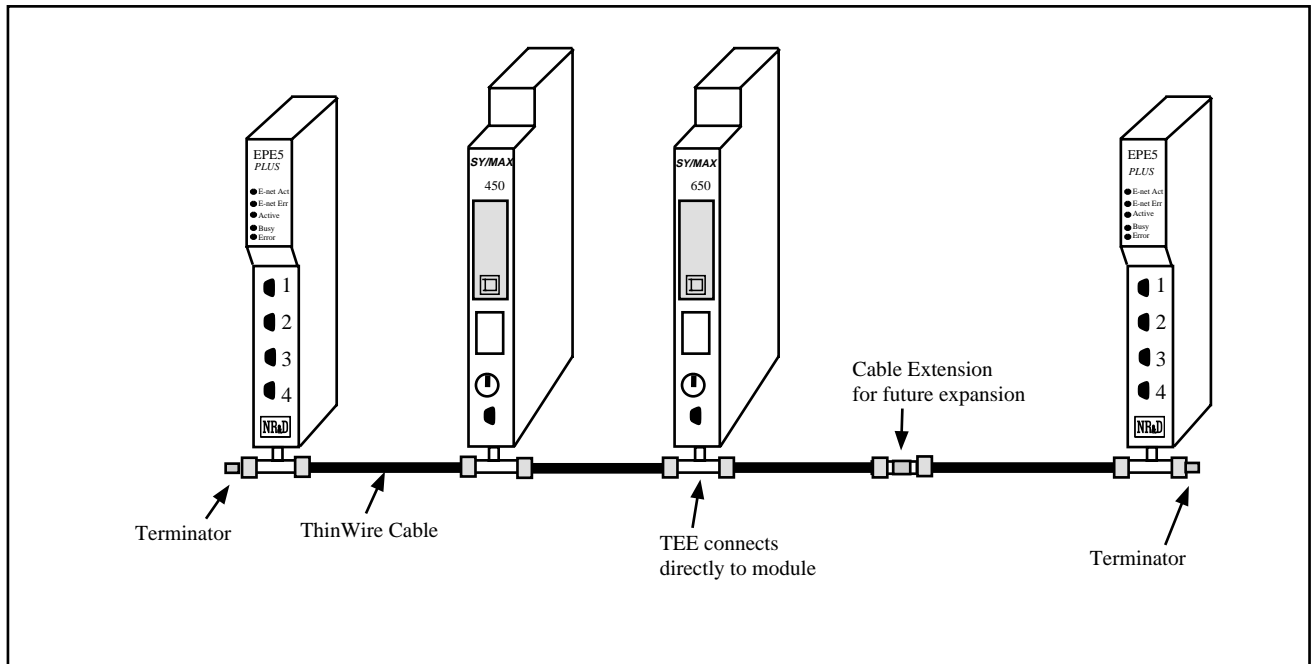
Figure 2-9   ThinWire Ethernet network

The following table indicates the 802.3 Ethernet Specification for SY/NET.

Table 2-2   SY/NET 802.3 Ethernet Specifications

Type	IEEE 802.3 10Base2 ThinWire Ethernet
Nodes per segment	30
Nodes per network	100 (using repeaters)
Maximum segment length	600 ft. (185 m)
Maximum end-to-end network length	3034 ft. (925 m), using repeaters.
Minimum cable length between nodes	20 inch (0.5 m)
Maximum drop length	Less than 1.5 in. (4 cm), directly connect TEE to male connector.

Ethernet Connection

1   Connect a coaxial TEE to the connector on the bottom of the EPE5. This connection must be
     made directly. It is not permitted to use any length of cable from the TEE to the connector on the
     EPE5. See Figures 2-10, 2-11, and 2-12.
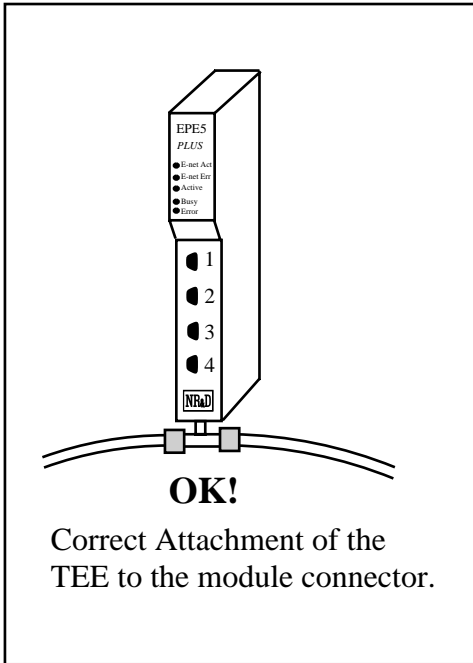
Figure 2-10   Correct TEE connection
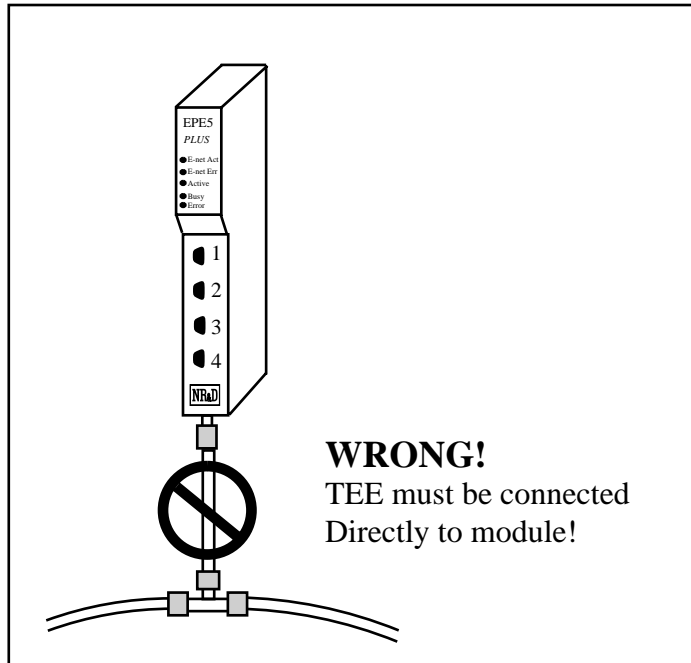
Figure 2-11   Incorrect TEE connection
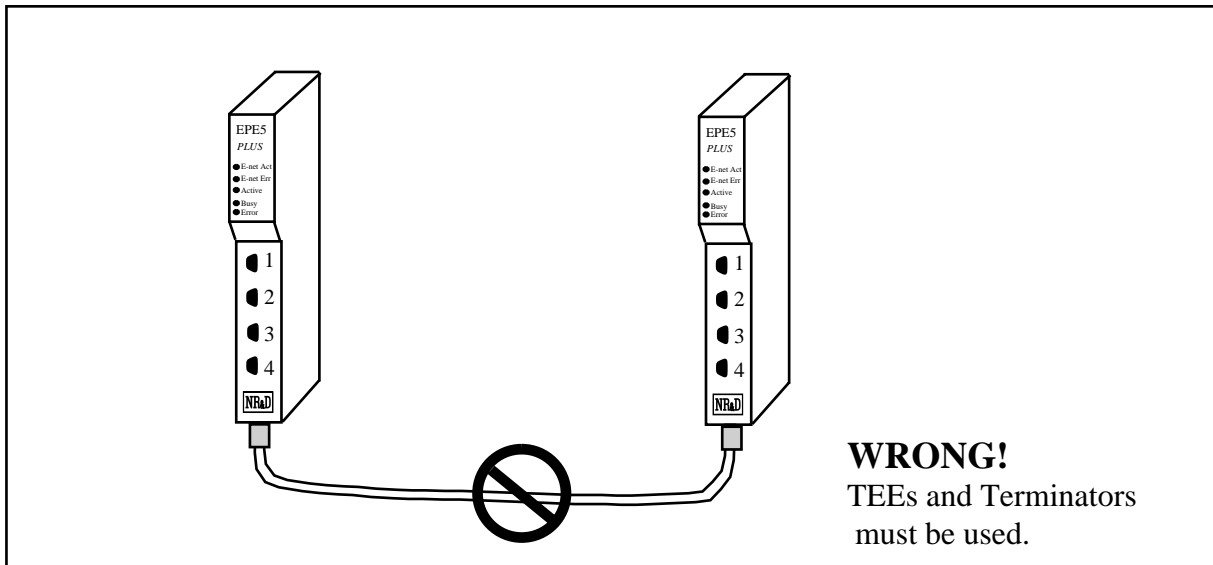
Figure 2-12   Incorrect Cable Connection

2   Cycle power on the rack containing the EPE5. (Turn OFF then ON the Power supply.)

3   If the EPE5's Ethernet address has been well chosen (different from all other address on this network) then the E-NET Error light should not be flashing. If this light is flashing, then there is another unit on the network with this address. Using EPE5SW, go oNline and change the address of the Ethernet port to one that is not on the network. The red light should quit blinking. The other device with the same network address must be manually reset also.

4   Attach one or more devices to the EPE5 ports. Refer to Chapters 25 and 26 for port and cable pinout diagrams. An RS-422 breakout box is useful in verifying the correct connection of input devices.

5   Use the EPE5SW program to configure port parameters for the devices attached.

Module Rack Addressing

To allow the PLC to access the mailbox registers through the backplane, the module must be rack addressed.. Using Square-D programming software, allocate rack address register space to the module. You may allocate as few as 0 or as many as 2048 registers depending on the needs of the application.

>   **Note:** The scan time of the processor is directly related to the number of externally addressed registers. Allocating more registers than needed can have an adverse impact on the speed of the system. See the manual for the processor for more information on optimizing scan speed.

For more information about Rack Addressing the local mailbox registers see Chapter 24 on page 161.

3

Configuration

Each port of the EPE5 is independently configured for the desired drop number, baud rate, number of data bits, parity bit, protocol mode and other parameters.

> **Note:** This is different than the configuration of the SPE4 modules. The drop number of each port is independent of each other port.

Modification of the configuration registers may be accomplished by writing to them with any device capable of generating SY/MAX write messages but is most conveniently accomplished with the MS/DOS compatible program EPE5SW provided with the module at no cost. EPE5SW must be used through a module data port configured as SY/MAX or Net-to-Net, or Gateway, or through the Ethernet port. The computer running EPE5SW can be connected directly to the module, through the SY/NET network, or through the Ethernet network.

The configuration and mailbox registers are maintained in nonvolatile memory. This memory is powered by batteries in the rack power supply in the absence of AC power and by an internal capacitor for at least a week when the module is removed from the rack.

Each port must have certain parameters configured for proper operation. These parameters include:

- **Drop Number** - The drop number is the SY/MAX address for that port. The drop number is included in the Route portion of all SY/MAX communication messages and helps to determine the particular units involved in the communication. There are two types of drop numbers:

    — **Ethernet Drop Number** - The Ethernet Drop Number must fall within the range of 00 through 99. This number must be unique from all other SY/MAX 802.3 Ethernet units on the network. If two Ethernet ports have the same Ethernet Drop Number, they will stop communicating and must be manually reset. The factory default Ethernet Drop Number is 00.

    — **Data Port Drop Number** - The Data Port Drop Number must fall within the range of 000 through 199. This number must only be unique with a particular EPE5. It is permissible to have other EPE5 units on the same network with similar Data Port Drop Numbers as long as their Ethernet Drop Number is different.

      The factory default Data Port Drop Numbers for Ports 1 through 4 of the EPE5 are 001, 101, 002, and 102. For most circumstances these need not be changed. When connecting to a NIM (CRM-510) in Net-to-Net mode, the Data Port Drop Number must be set to match the NDN of the NIM port.

- **On Ethernet -** The On Ethernet setting allows a serial port to be considered a node on the SY/MAX Ethernet. The drop number of the serial port must be unique to the Ethernet network.

- **Protocol Mode** - The Protocol setting controls the operation of the Data Port. Possible values are SY/MAX, Net-to-Net, Peripheral, Transparent, Share, PLogic, Idec, Gateway, Multidrop, Modbus Host, PNIM, RNIM Master, RNIM Slave, and Modbus Gate. The factory default value is SY/MAX mode. These modes are described in later chapters.

- **Baud Rate** - The Baud Rate setting must be made to match the peripheral device. Possible values are 50, 75, 110, 134.5, 150, 300, 1200, 1800, 2400, 3600, 4800, 7200, 9600, 14400, and 19200. The factory default value is 9600 baud. Most SY/MAX devices operate at 9600 baud.

- **Parity** - The Parity setting must match the attached peripheral. Possible settings are EVEN, ODD, and NONE. The factory default value is EVEN. Most SY/MAX devices operate at EVEN parity.

- **Data Bits** - The Data Bits setting must match the attached peripheral. Possible settings are 7 bits and 8 bits. The factory default value is 8 bits. All SY/MAX devices must operate with 8 data bits.

- **Stop Bits** - The Stop Bits setting must match the attached peripheral. Possible settings are 1 and 2. The factory default value is 1. Most SY/MAX devices operate with 1 stop bit.

- **Buffers** - The Buffers setting reflects the number of internal message buffers allocated to each port. The possible range is 2 to 32 buffers. The factory default value is 16. There is seldom a need to adjust the number of buffers available to a port.

- **Error Check** - The EPE5 allows the option of choosing the checksum type for the SY/MAX, NET-TO-NET, PLOGIC, MULTIDROP, and PNIM protocols. The PNIM protocol must be set to CRC, all other modes default to the BCC. The CRC mode allows communication with the CRM-512 multimedia NIM, and SY/MATE PLUS ver. 2.x in parity= NONE setting. The CRC check-sum provides a higher level of message security when the parity bit is not being used. When communicating to most SY/MAX devices, the BCC checksum must be used.

- **Driver Mode** - Certain modes of the EPE5-D allow control of the RS-485 driver and receiver operation.

  — The default parameter is point to point (**PT to PT**) where the RS-485 driver and receiver is always enabled . The PT to PT mode operates as a standard RS-422 port and may be used as a 4-wire RS-485 Master. The PT to PT mode allows full duplex operation. This driver mode is available in PERIPHERAL, SHARE, MULTIDROP, and MODBUS port modes.

  — The **FOUR WIRE** mode allows the RS-485 transmitter to tri-state (high impedance) when the CTS line is not asserted. This mode is used when the EPE5 port is a slave on a 4-wire network and is available in PERIPHERAL, SHARE, MULTIDROP, and MODBUS modes.

  — The **HALF DUPLEX** driver mode has the transmit driver enabled at all times, but disables the receiver while transmitting. This mode is useful when canceling an echo from an attached device. This mode is available in PERIPHERAL, SHARE, and MODBUS modes.

  — The **TWO WIRE** driver mode allows the RS-485 transmitter to tri-state (high impedance state) when the CTS line is not asserted. The receiver is also disabled while transmitting for a half duplex, multidrop operation. The TWO WIRE mode is suited for a 2-wire multidrop network and is available in the PERIPHERAL, SHARE, MULTIDROP, and MODBUS port modes.

- **Route Appendix** - The Route Appendix allows the modification of the route of a SY/MAX packet arriving at the port. The route appendix is activated by having the last drop number on the incoming packet to be 205. The drop number 205 is then replaced with the target route placed in the Route Appendix field. For example: A SY/MAX mode port with a drop number of 101 has the Route Appendix set for 016, 018, 001. An external device attached to that port sends a READ message with the route 101,205. The SY/MAX mode port replaces the 205 drop with the Route Appendix and the resulting route would be 101, 016, 018, 001. The Route Appendix is useful for devices such as the EATON PanelMate operator interface which can only handle 2 drop numbers in its route.

- **Route Replacement** - The Route Replacement is an extension of the Route Appendix feature. When the Route Replacement feature is ON, any incoming route on a SY/MAX message is ignored and the route in the Route Appendix is used instead. This feature may be used to adjust the target of operator interfaces without reprogramming the OI.

The Route Replacement/Appendix may be enhanced to include up to 128 eight-drop routes by using Options bit 2. When this Options bit is set for the SY/MAX mode port, incoming route of the form 205,X will have the route located in the Modbus Slave Address Table entry X used for the replacement. The reply will be returned to the sender with the reversed route X,205. This feature may only be used on single-threaded SY/MAX ports and is primarily intended to be used with the PanelMate operator interface.

- **Auto-Transfer** - The Auto-Transfer settings control the operation of the automatic READ, and WRITE, functions for the automatic transfer of data from the peripheral device to the Mailbox register. The Auto-transfer features include Transfer Interval, Transfer Route, Read Count, Read From, Read To, Write Count, Write To, and Write From. The Auto-transfer features are available only on SY/MAX, NET-TO-NET, PLOGIC, IDEC, MODBUS, and PNIM modes.

Accessing mailbox and configuration registers

Reading and writing the EPE5 module's local registers is straightforward and is equivalent to reading and writing the registers in a SY/MAX processor. One case requires some special attention. When an EPE5 is connected to SY/NET through a Net-to-Net connection to a NIM, the NIM will not pass packets whose terminal drop is that of the Net-to-Net port itself. To overcome this, append a dummy drop to the route to the EPE5 which is not the drop of any port in the module. For example, consider a SY/NET configuration with NIM modules number 0 and 1. If an EPE5 is connected to port 101, the drop of port 0 of the EPE5 must be set so that the Net-to-Net port (connected to the NIM) also has drop 101. The route from the top port of NIM 0 to the EPE5's local registers could be 000,101,1. Any drop on SY/NET could also reach the EPE5 with a route of 201,101,1 where 201 is the don't care originating drop.

EPE5 mailbox registers

The mailbox registers within an EPE5 may be rack addressed by the PLC and used as PLC inputs or PLC outputs. By default, all mailbox registers are recognized by the PLC as outputs. Data written to these registers by the PLC appears in the associated mailbox register and may be read by an external device through a port of the EPE5. A mailbox register is converted to a PLC input when an external device writes data to that register. That register will remain as a PLC input until the module is reset by cycling power. A typical application will involve assigning a group of registers as PLC outputs and a different group of registers as PLC inputs.

The register number of the mailbox register is determined as follows:

- PORT: The mail box registers are registers 1 through 2048.

- PLC RACK: The mail box registers are 1 through 2048 plus the start address for that slot minus 1. For example if the module is located in slot 3 of the rack and that slot has registers 245-260 assigned to it, register 250 to the PLC will be register 6 when accessed through a front port of the EPE5.

  The PLC will only be able to write (or read) the first 15 registers within the mailbox area since these are the only registers assigned to the module. The other 2033 registers are still available to the front ports.

NOTICE

The scan time of the processor is directly related to the number of externally addressed registers. Allocating more registers than needed can have an adverse impact on the speed of the system. Only Rack Address those registers needed for the particular application. See the processor's manual for more information on optimizing scan speed.

For more information on the **Mailbox Registers** section on **Page 162.**

RTS/CTS Handshaking

CTS Operation

In all modes, the CTS input of EPE5 ports one through four is available to restrain the EPE5 transmitter. If these pins are left open or driven with active polarity (CTS+ more positive than CTS-), the port will transmit any time it has a message to send. If the CTS pair is driven with inactive polarity (CTS+ less positive than CTS-), the port will hold characters and not transmit them. CTS may be used by slower peripherals such as printers or displays to restrain the EPE5 while the peripheral catches up. CTS restraint cannot be held indefinitely with incoming data as the EPE5 has finite internal buffer capacity.

In Multidrop, Peripheral, Share, Modbus, and RNIM modes, there is and adjustable delay between when CTS is raised and when the port transmits. The RNIM CTS delay is controlled by registers 8042, 8074, 8106, and 8138 for ports 1..4 respectively. The other modes are controlled by the value in registers 8064, 8096, 8128, and 8160. These register values are in 10mS units.

In certain Driver Modes, CTS also controls the enabling of the RS-485 transmit driver. In the FOUR WIRE and TWO WIRE modes, the state of CTS determines whether the transmit driver is tri-stated or enabled. If these CTS pins are left open or driven with active polarity (CTS+ more positive than CTS-), the port will enable its transmit driver. If the CTS pair is driven with inactive polarity (CTS+ less positive than CTS-), the port will tri-state its transmit driver and allow the transmitter to go to a high impedance state. For these driver modes, it is recommended that the RTS of the port be connected to the CTS of the port to allow the transmit driver to only be enabled when data is to be sent. In all other modes, the transmit driver is always enabled.

RTS Operation

The operation of the RTS pair depends on the mode of the port. In SY/MAX, Net-to-Net, PowerLogic, Idec, Gateway, and Transparent mode the RTS pair is used to restrain the attached device sending to the EPE5 and inform it that the EPE5's internal buffers are filling faster than the received messages can be processed or retransmitted. In these port modes, the RTS pair is normally active (RTS+ more positive than RTS-) unless the EPE5 wishes the attached device to stop sending to it in which the pair will go inactive (RTS+ less positive than RTS-) until the EPE5 can catch up.

In Multidrop, Peripheral, Share, RNIM, and Modbus modes, the RTS pair acts in Request to Send fashion. In these port modes, the pair remains inactive (RTS+ less positive than RTS-) until the port has information to transmit and then goes active (RTS+ more positive than RTS-) until all current data has been transmitted. An external device such as a modem or radio normally accepts the RTS pair as a "push to talk" and uses the CTS pair to tell the EPE5 to "go ahead" and transmit.

MNIM Compatibility

The SY/MAX, Net-to-Net, and PLOGIC modes now have the ability (REV 26DEC95 and later) to adjust the number of PAD characters to define the amount of time that the EPE5 port will wait for a response before sending an ENQ. The normal (default) and minimum number of PAD characters sent is 10 characters. Values less than 10 will be ignored and 10 will actually be sent. Registers 8064, 8096, 8128, and 8160 set the number of PAD characters for Ports 1, 2, 3, and 4 respectively.

The Message Inquire Delay Time (number of PADs) should be set to a value that is slightly longer than the actual turnaround time of the transmission media. Table 3-1 displays settings that have been found to work for a few Hayes compatible modems. Use these values as a fine tuning starting point.

Table 3-1   Suggested Number of PADs for Hayes Modem Operation

Baud Rate	Number of PADs
2400	30
9600	60
14400	90

Firmware revisions 12Feb96 and later include the SY/MAX serial port channel delay statistic at registers 2072, 2104, 2136, and 2168 for ports 1 through 4 respectively. These registers display the number of bytes sent between the checksum at the end of the SY/MAX packet and the acknowledgment. Add 10% to this value to determine the number of PADs to set to for that channel.

Pressing the "T" key on the keyboard within EPE5SW while viewing the second Statistics page on a serial port will automatically update the PAD count for the monitored channel.

4
SY/MAX 802.3 Mode

The SY/MAX 802.3 Ethernet protocol is a robust industrial process control communication protocol developed by Square D Company. Full SY/MAX serial communication including PLC programming support is included as well as normal 8 drop routing. The SY/MAX 802.3 protocol on the 10Mb/s Ethernet allows for high data rates, as the EPE5 can process in excess of 26k registers/second. This protocol is defined by the Instruction Bulletin # 30598-775-01A1, SY/MAX 802.3 Communications Protocol and is available only from Square D.

The SY/MAX 802.3 protocol is implemented in a variety of devices including Square D Model 450 and Model 650 PLCs, Square D software SFW390/391 for DEC VAX/VMS computers, Square D SFI610 Ethernet driver for personal computers, Niobrara EPE5, MEB, PEN, and others.

The SY/MAX 802.3 protocol is primarily intended for closed industrial control networks although it will co-exist with other Ethernet protocols such as TCP/IP, DECnet, and Novel on the same physical network. Many production facilities will install an independent Ethernet for process control to provide an additional measure of security. (You don't want someone in Accounting removing a coax terminator and causing the assembly line to come to a screeching halt.)

Because it was developed for industrial control, this protocol has some limitations:

- Only 100 devices may connected to the same network.

- Although it supports up to 8 drops of SY/MAX routes, the protocol is not Ethernet routeable; it will only pass through multi-protocol bridges and repeaters. Because of this, SY/MAX 802.3 is not suitable for WAN.

- Because it is a proprietary protocol, only a limited number of softwares support it.

When wide area networking is necessary, use the Modbus/TCP protocol as described in the next chapter. It uses the TCP/IP protocol and may be routed across IP only routers.

NOTE: The most important thing to remember about SY/MAX 802.3 Ethernet is to set each device to its own unique number between 00 and 99.

5

TCP/IP Ethernet Protocol

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 EPE5-TCP uses TCP/IP to send Modbus/TCP packets across the Ethernet.

User Datagram Protocol (UDP) does not provide for a reliable connection and relies on the application layer for error correction and sequencing. SNMP is the simple network management protocol. FTP is the file transport protocol and TFTP is the trivial file transport protocol. SMTP is the simple mail transport protocol while Telnet is a terminal emulation protocol and NFS is the network file system. The EPE5-TCP does not directly support or respond to UDP, SNMP, FTP, TFTP, SMTP, Telnet, or NFS packets although the internal IP router will process (route) these messages.

The EPE5-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 EPE5-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 C7BAC31E (hex) is normally displayed as 199.186.195.30 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 an 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 5-1 displays the IP classes a nd 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 are also reserved.

Table 5-1   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 5-2 displays the default subnet masks for the three Internet classes.

Table 5-2   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.

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. The EPE5-TCP internal IP router supports multiple gateways which may be useful for subnet routing.

Port Number

Modbus/TCP uses the "well known" port number of 502 decimal and is fixed to this value.

Modbus/TCP Protocol Mode

The Modbus TCP Protocol is enabled by setting the Protocol Mode of the Ethernet Port from SY/MAX to Modbus TCP. The EPE5-TCP translates SY/MAX and Modbus messages to/from Modbus/TCP messages for transportation across IP networks. The Modbus TCP protocol mode is compatible with the Modicon TSX Quantum NOE 211 TCP/IP Ethernet module. 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 EPE5-TCP can be both a Client and a Server at the same time while the PEN-TCP is only a Server.

When the EPE5-TCP routes a command from one of its serial ports to the Ethernet port, it becomes a Client and a TCP/IP connection is formed between the Client and the target Server. The target Server is determined through the use of a 200 entry look-up table in the EPE5 that contains IP entries for possible SY/MAX drop numbers following the SY/MAX drop number of the Ethernet port. The message command is translated into the Modbus/TCP protocol and sent out the Ethernet port.

When the EPE5-TCP forms a connection as a Server and receives a command from the Client, it translates the Modbus/TCP message into SY/MAX (or Modbus...), applies the appropriate downstream route based on the Modbus Ethernet Server look-up table, and routes it to the appropriate port. The reply is in-turn translate into Modbus/TCP and sent back to the Client.

The Client translates the Modbus/TCP reply back to SY/MAX (or Modbus) and routes it back out the appropriate serial port.

Client IP Look-up Table

The EPE5-TCP inspects the drop in the route following the E-net drop number for an entry in its IP look-up table. If there is an entry in the table, the command is translated into Modbus TCP and sent to the appropriate Server, otherwise, an error reply is sent to the source of the command. If the optional downstream route is included in the IP table entry, only the last drop in the route is inserted in the command as the index value.

```
              E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                                                            29Oct96
                         CONFIGURATION AND UTILITY SOFTWARE
oNline            oFfline              Utility              Setup           Quit
        Edit Drop to TCP/IP Routing Table
        DROP   IP ADDRESS        DOWNSTREAM ROUTE
          0    199.186.195.21    NONE
          1    0.0.0.0           NONE
          2    0.0.0.0           NONE
          3    199.186.195.200   101,7,1
          4    199.186.195.200   101,7,2
          5    199.186.195.200   101,7,3
          6    199.186.195.44    1
          7    199.186.195.44    2
          8    199.186.195.44    3
          9    199.186.195.44    4
         10    199.186.195.44    5
         11    199.186.195.44    6
         12    199.186.195.44    7
         13    199.186.195.44    8
         14    0.0.0.0           NONE
         15    0.0.0.0           NONE
```

Figure 5-1   EPE5SW TCP Routing Table

Figure provides a view of a portion of this routing table from the EPE5SW edit TCP screen.

Server Index Look-up Table

The Modbus/TCP protocol only includes one drop of routing information in the message structure, this drop number is called the index. The EPE5-TCP inspects this index on all incomming Modbus/TCP messages and if there is an entry in its look-up table, uses the route in the table for the downstream route. (This is just like the Modbus Slave Table for each of the serial ports.)

Figure 5-2 **EPE5SW** Modbus/TCP Server Index **Table**

Figure provides a view of a portion of this routing table from the EPE5SW edit TCP screen.

Modbus/TCP Example

In this example, the EPE5-TCP #1's E-net port has a Drop number of 33 with an IP address of 199.186.195.22, Subnet Mask of 255.255.255.0, and a Default Gateway of 199.186.195.1. Also Port 2 is in SY/MAX mode with a personal computer attached and its drop number is 12.

EPE-TCP #2 is on the same local network with an IP address of 199.186.195.31, Subnet Mask of 255.255.255.0, and the Default Gate of 199.186.195.1. Port 2 is in PNIM mode with a drop number of 102. Two PowerLogic Circuit Monitors are connected to this port and their drop numbers are 02 and 01 respectively.

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 we set in each Client.

The second Ethernet is connected to the Internet using Gateway #2. Its IP address is 203.23.135.15.

EPE5-TCP #3 is on this network segment and includes a Model 400 PLC connected to Port 1 in SY/MAX mode, drop 105 and three PowerLogic CMs on Port 3, drop 107 in PNIM mode. EPE5-TCP #3 has an IP address of 203.23.135.112. Its Subnet Mask will be 255.255.255.0 and its Default Gateway is 203.23.135.15.

Since EPE5 #1 is the only client in this example, we only need to configure its TCP table and there only really needs to be two entries. So by setting entry 0 to point to EPE5 #2 and entry 1 to point to EPE5 #3, we can use the rest of the route of the incoming message to reach the downstream devices. (see Table <IP table example 1>).

Table 5-3   IP Table Example

Drop	IP Address	Route
0	199.186.195.31	NONE
1	203.23.135.112	NONE

Table 5-4   Server Index Table For EPE5-TCP #2

Drop	TYPE	Route
1	OTHER	102,1
2	OTHER	102,2

Table 5-5   Server Index Table For EPE5-TCP #3

Drop	TYPE	Route
1	OTHER	105
2	OTHER	107,1
3	OTHER	107,2
4	OTHER	107,3

The routes required to be set in the personal computer software to reach the target devices are shown in Table <IP PC routing examples>.

Table 5-6   Personal Computer Routing Examples

Target	Route
EPE5 #2	12, 33, 0, 255
CM #1 on EPE5 #2	12, 33, 0, 1
CM #2 on EPE5 #2	12, 33, 0, 2
EPE5 #3	12, 33, 1, 255
Model 400	12, 33, 1, 1
CM #1 on EPE5 #3	12, 33, 1, 2
CM #2 on EPE5 #3	12, 33, 1, 3
CM #3 on EPE5 #3	12, 33, 1, 4
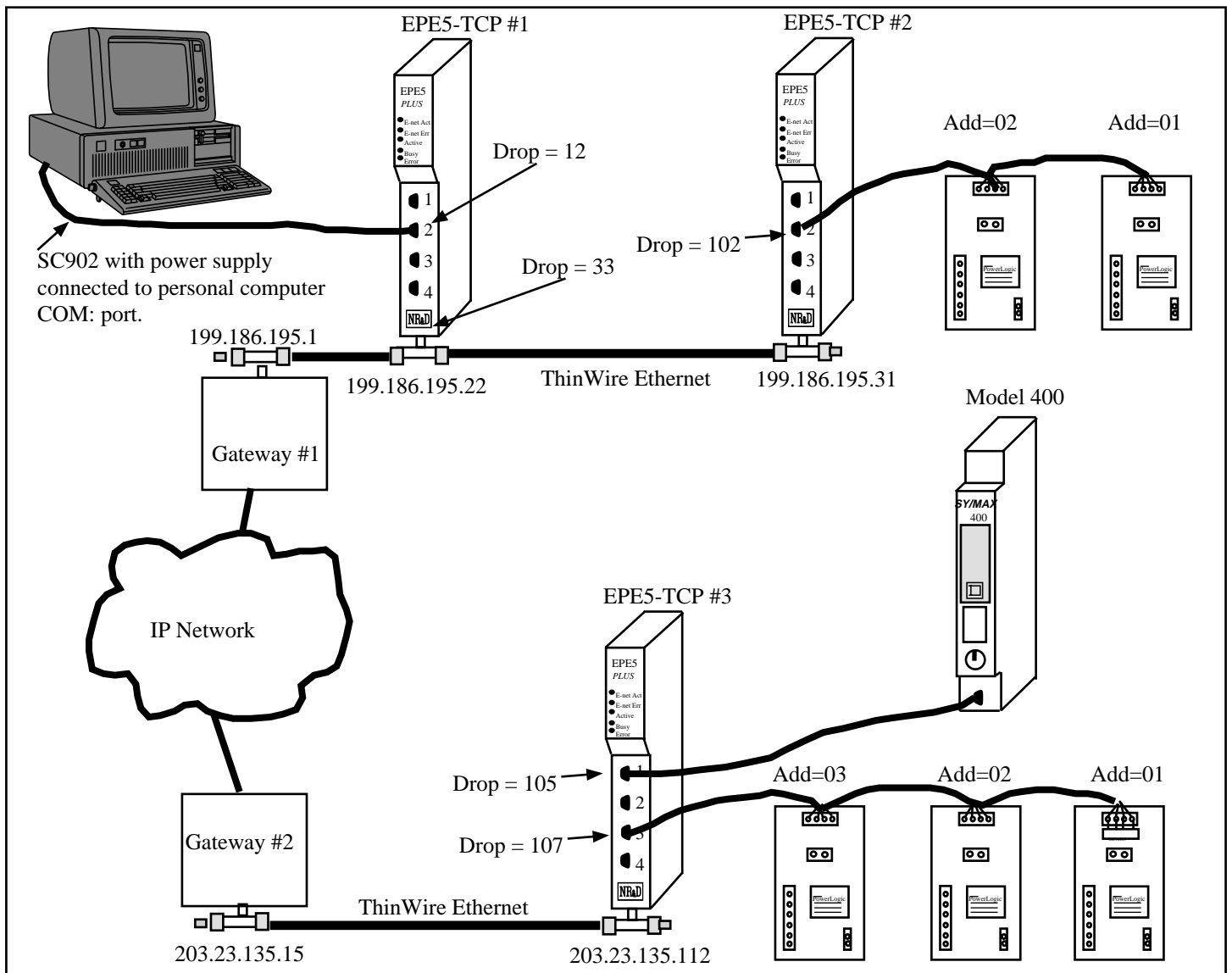
Figure 5-3   TCP/IP Routing Example

The first drop in the PC route is always 12 since that is the drop number of Port 2 of EPE5 #1. The second drop in the route is always 33, the drop number of the Ethernet port of EPE5 #1. The third drop number is the pointer to the TCP Route table entry of the destination IP device. To route to EPE5 #2,

set the third drop to 0 and to route to EPE5 #2, set the third drop to 1. To continue routing to further devices in the target EPE5s, simply add the destination index for the route required in the Server

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6

MBTCP+SY/MAX Ethernet MODE

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The MBTCP+SY/MAX ethernet mode is a combination of the SY/MAX 802.3 and Modbus TCP modes to allow the integration of remote SY/MAX 802.3 and Modbus TCP devices on the same ethernet network. As a server only, the EPE5 will act exactly as it does in each mode separately. As a client, the EPE5 inspects the drop in the route following the drop number of the ethernet port for an entry in the IP lookup table. If there is an entry in the table, the EPE5 translates the command to Modbus TCP, and sends it to the appropriate server. If there is no entry in the table, the command is translated to SY/MAX 802.3, and routed to the appropriate device.

MBTCP+SY/MAX Example

In this example, the EPE5-TCP's E-net port has a Drop number of 20 with an IP address of 206.223.51.147, Subnet Mask of 255.255.255.0, and a Default Gateway of 206.223.51.1. Port 2 is in SY/MAX mode with a personal computer attached and its drop number is 101. Port 3 is in Modbus Gate mode. It's drop number is 102, and a Powerlogic Power Meter is attached.

An EPE5-D is on the same local network. Its E-net port has a drop number of 26. Port 3 is in SY/MAX mode with a drop number of 103. A Model 400 PLC is connected to this port.

A Model 450 is connected to the same local network as the EPE5-TCP. Its ethernet's drop number is 24.

A Model 650 is also connected to the local network. Its ethernet's drop number is 22.

A Modicon Quantum NOE and Processor are connected to the same local network. The NOE's IP address is 206.223.51.148.

An ECM2000 is also connected to the same local network. It's IP address is 206.223.51.156. Attached to the ECM's serial port are two Powerlogic CM's. Their addresses are 2 and 1, respectively.

Since the EPE5-TCP can be a client in this example, we need to configure its TCP table. So by setting the EPE5-TCP's entries 22 through 26, we can use the rest of the route of the incoming message to reach the downstream devices. (see Table <IP table example 1>).

Table 6-1   EPE5-TCP IP Table Example

Drop	IP Address	Route
22	0.0.0.0	NONE
23	206.223.51.148	NONE
24	0.0.0.0	NONE
25	206.223.51.156	NONE
26	0.0.0.0	NONE

Table 6-2   Server Index Table For EPE5-TCP

Drop	TYPE	Route
1	OTHER	20,22
2	OTHER	20,24
3	OTHER	20,26,103
4	MODBUS	102,1

The routes required to be set in the personal computer software to reach the target devices are shown in Table 6-5.

Table 6-3   Personal Computer Routing Examples

Target	Route
EPE5-D	101,20,26
CM #1 on ECM2000	101,20,25,1
CM #2 on ECM2000	101,20,25,2
Model 450	101,20,24
Model 650	101,20,22
NOE	101,20,23,0
Power Meter	101,102,1
Model 400	101,20,26,103

The routes required to be set in the Model 450 to reach the target devices are shown in Table 6-6.

Table 6-4   Model 450 Routing Examples

Target	Route
EPE5-TCP	24,20
CM #1 on ECM2000	24,20,20,25,1
CM #2 on ECM2000	24,20,20,25,2
EPE5-D	24,26
Model 400	24,26,103
NOE	24,20,20,23,0
Power Meter	24,20,102,1
Model 650	24,22

Table 6-5   NOE Routing Examples

Target	IP Address	Index
Model 450	206.223.51.147	2
Model 650	206.223.51.147	1
Model 400	206.223.51.147	3
Power Meter	206.223.51.147	4
Circuit Monitor #1	206.223.51.156	1

Figure 6-1   MBTCP+SY/MAX Routing Example
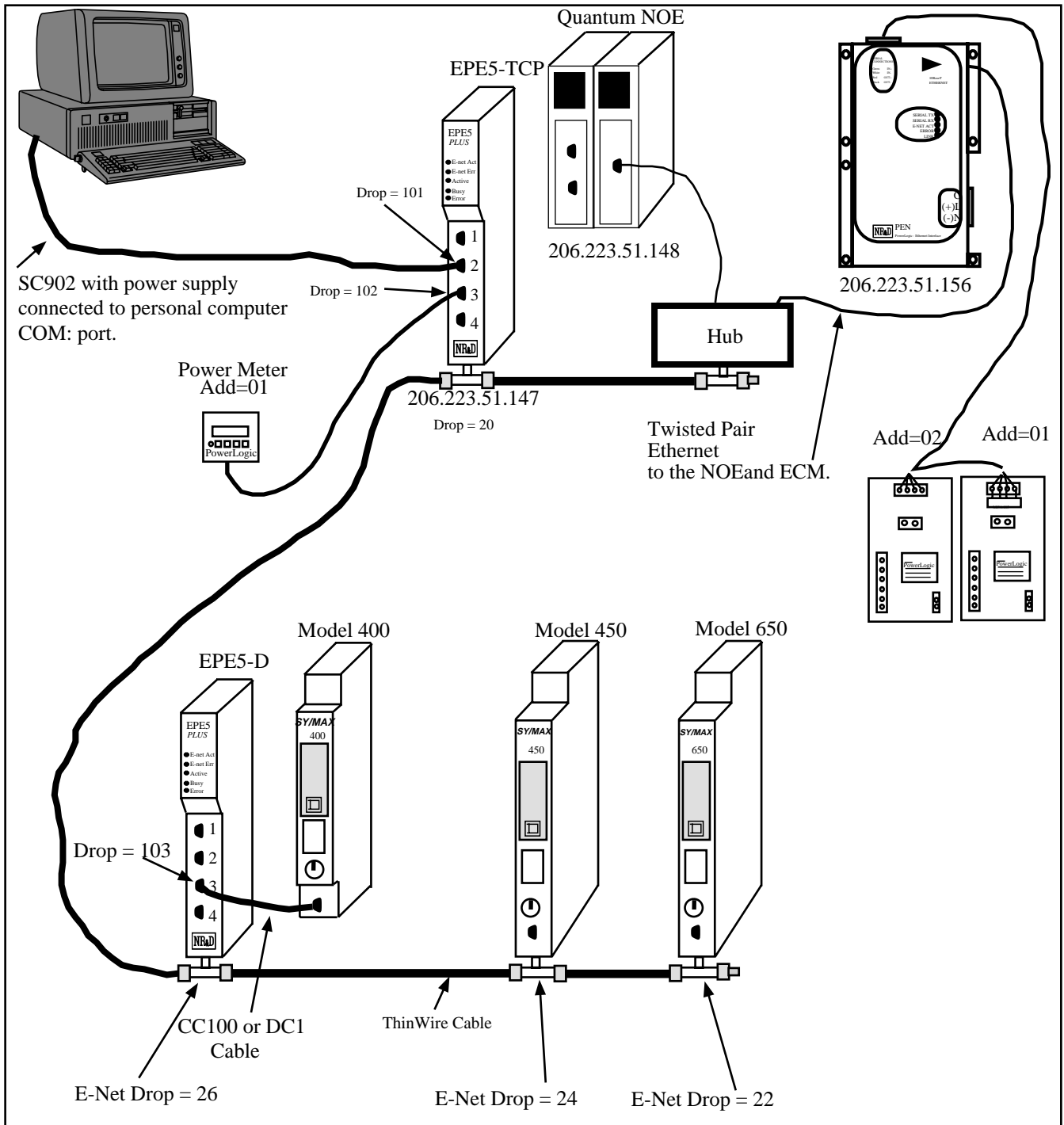
The first drop in the PC route is always 101 since that is the drop number of Port 2 of the EPE5-TCP. The second drop in the route determines the drop number of the outbound port. If the second drop is 20, the third drop number is the pointer to the TCP Route table entry of the destination IP device. To route to the EPE5-D, set the third drop to 26. To continue routing to further devices in the target EPE5, simply add the drop number of the port to be accessed.

The first drop in the Model 450's route is always 24, since that is its own ethernet port. If a Modbus TCP message is desired, the second drop in the route must always be 20, the drop number of the EPE5-TCP's ethernet port. In this case the third drop in the route will also be 20, indicating a route back out of the EPE5-TCP's ethernet port. The fourth drop in the route will point to the IP table of the EPE5-TCP. If the corresponding index in the IP table contains an IP address, the message will be translated to Modbus TCP, and sent to the device with that IP address. The last drop in the route will be an index that the target device uses for further routing.

If it is desirable for the NOE to access SY/MAX 802.3 devices on the network, it can simply connect to the EPE5-TCP, and use the index in the Modbus Routing table to route to the proper device. For example, if the NOE needs to access the Model 650, it connects to 206.223.51.147, and uses index 1. Index 1 in the Modbus routing table is a route of 20,22, causing the message to route back out the E-net port using SY/MAX 802.3 to device 22. If the NOE needs to access the Model 450 or the Model 400, it accesses the same IP address, then uses index 2 or 3, respectively. Note that entries 22,24, and 26 in the TCP table of the EPE5-TCP must be 0.0.0.0 for the outbound message to be SY/MAX 802.3.

In any application where several EPE5-D's exist on a network, and it is desirable to add Modbus TCP devices to the network, one EPE5-TCP can be substituted for one EPE5-D. The EPE5-TCP can use the MBTCP+SY/MAX mode to act as a bridge between any SY/MAX 802.3 network and any Modbus TCP network.

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7
SY/MAX MODE

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Mode 1: SY/MAX

Each of the EPE5's four data ports can be set to SY/MAX mode for connection to a PLC, programming terminal, personal computer, operator interface, or other SY/MAX compatible device. Messages received on one EPE5 SY/MAX port are processed according to the route in the message. If the message is routed to another SY/MAX or Net-to-Net port within the same module, the packet will be retransmitted from that port. If the message has no route or is addressed to a null drop (204) or other drop not within the same EPE5 module, it is processed by the EPE5 itself and, if it is a read or write message, can access internal mailbox or configuration registers.

SY/MAX Routing Example

Figure 7-1, is an example of connecting three SY/MAX rack PLCs, a NR&D AIM4 ASCII Input Module, and a Personal computer together so that they may exchange data and be programmed by a single personal computer by means of the proper routing of communication packets. The Personal computer is connected to Port 2 of the EPE5 using a SC902 cable to its COM1: port. (The external power supply for the SC902 must be used.) The EPE5 has the setup shown in Table 7-1 below:

Table 7-1   SY/MAX Mode EPE5 Setup Example

Port	Drop Number	Mode	Baud Rate	Parity	Data	Stop	Error Check
E-Net	67	SY/MAX	NA	NA	NA	NA	NA
1	001	SY/MAX	9600	E	8	1	BCC
2	002	SY/MAX	9600	E	8	1	BCC
3	003	SY/MAX	9600	E	8	1	BCC
4	004	SY/MAX	9600	E	8	1	BCC

The Model 400 is connected to Port 3 of the EPE5 with a DC1 (CC100) type cable. The AIM4 Print/Prog port is connected to Port 4 of the EPE5 with a DC1 (CC100) cable. The Model 450 is connected to an Ethernet cable to the EPE5 and Model 650. The Model 450 has an E-Net address of 05. The Model 650 has an E-Net address of 44.

The personal computer may be used to program each of the processors as well as the AIM4 and EPE5. Table 7-2 gives the route required for the personal computer to reach each of the devices.
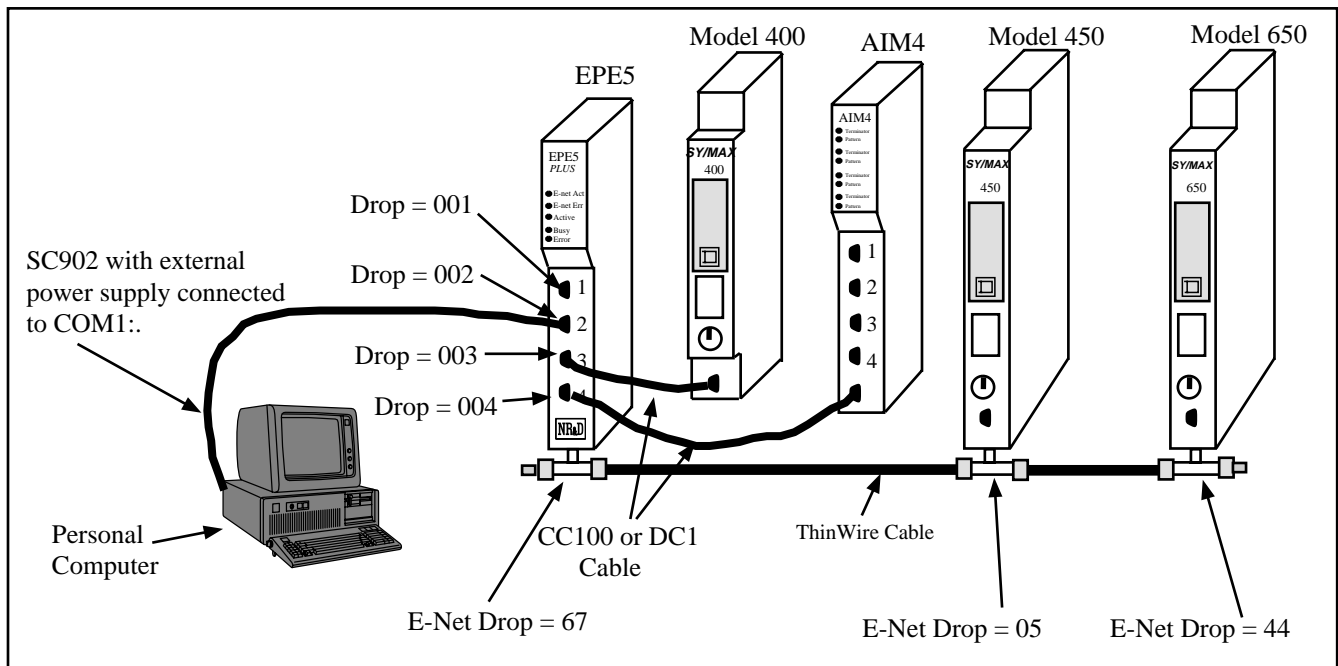
Figure 7-1   SY/MAX Mode Example

Table 7-2   SY/MAX Mode Personal Computer Route Examples

Origin	Target	Route
Personal Computer	Model 400	002, 003
Personal Computer	AIM4	002, 004
Personal Computer	Model 450	002, 067, 005
Personal Computer	Model 650	002, 067, 044
Personal Computer	EPE5	NONE

Each of the PLCs may also use the EPE5 to share information between themselves, the EPE5, and the AIM4 by use of the network WRITE and READ ladder rungs. Table 7-3 shows the routes required for a few of these combinations.

Table 7-3   SY/MAX Mode PLC Route Examples

Origin	Target	Route
Model 400	AIM4	003, 004
Model 400	Model 450	003, 067, 005
Model 400	Model 650	003, 067, 044
Model 400	EPE5	NONE
Model 450	Model 400	005, 067, 003
Model 450	AIM4	005, 067, 004
Model 450	Model 650	005, 044
Model 450	EPE5	005, 067
Model 650	Model 400	044, 067, 003
Model 650	AIM4	044, 067,004
Model 650	Model 450	044, 005
Model 650	EPE5	044, 067

Notice that the route from one processor, for instance the Model 400, to another processor, say the Model 650, is the reverse of the route from the 650 to the 400.

As mentioned before, to access the registers in the EPE5 several routes are available. The routes listed above are all valid but are not all of the possibilities. If the message arriving at the EPE5 port has no route, the last drop in the route is the drop of that port, the last drop in the route is 204 with the next to last drop being the port, or a drop that is not assigned to the module is encountered, then the message will act on the registers in the module. Table 7-4 below illustrates a few examples of equivalent routes to the EPE5.

Table 7-4   EPE5 Equivalent routes for accessing internal registers

Origin	Target	Route	Route	Route	Route
Personal Computer	EPE5	NONE	002, 204	002, 155	121
Model 400	EPE5	NONE	003, 204	003, 099	055, 043
Model 450	EPE5	005, 067	005, 067, 204	005, 067, 006	005, 067, 015, 145
Model 650	EPE5	044, 067	044, 067, 204	044, 067, 112	044, 067, 044

All communication may occur simultaneously and the available possible paths are not limited to the lists above.

8
NET-TO-NET MODE

Mode 2: Net-to-Net

If a data port of the EPE5 is connected to a NIM (CRM-510), a the RS-422 port of a SY/LINK board, or to another EPE5 or SPE4 port, both ports must be configured in Net-to-Net mode and both ports must have the same drop number. By using the Net-to-Net mode the EPE5 may be used as a bridge between SY/NET and Ethernet.

NIM Net-to-Net Example
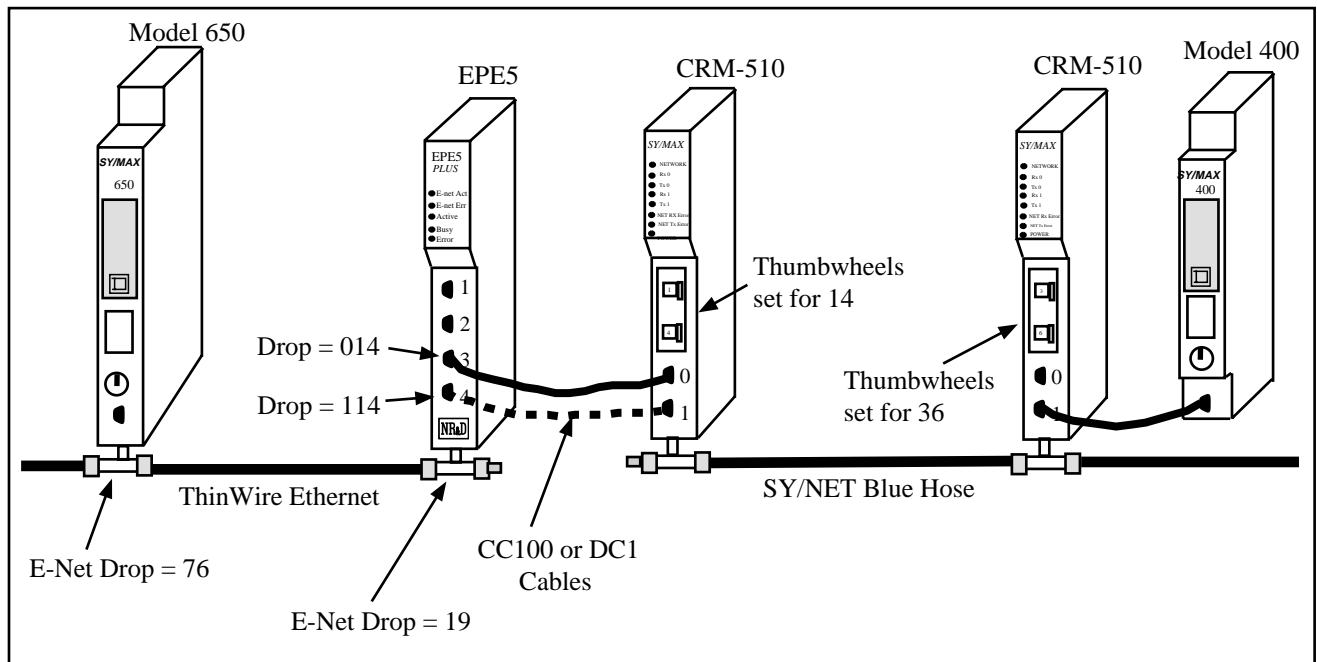
Figure 8-1   NIM Net-to-Net Example

Origin	Target	Route
Model 650	Model 400	076, 019, 014, 136 (Using the solid wire)
Model 400	Model 650	136, 114, 019, 076 (Using the dotted wire)

Table 8-1   EPE5 Setup for NIM Net-to-Net Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Error Check**
E-Net	19	SY/MAX	NA	NA	NA	NA	NA
3	114	Net-to-Net	9600	E	8	1	BCC
4	014	Net-to-Net	9600	E	8	1	BCC

SY/LINK SFI-510 Example

The Square D SFI-510 SY/LINK is a NIM that fits into a full length slot in an IBM compatible computer. Like the CRM-510 NIM, the SY/LINK card has a high speed network port for connection to the "blue hose" SY/NET cable. The SY/LINK has one external RS-422 port and one internal "bus port". The bus port may be considered to be the edge connector on the card that mounts in the personal computer bus. The RS-422 port is like Port 1 of the NIM and the bus port is like Port 0. When a connection is made to the EPE5, the RS-422 port of the SY/LINK card is used. This port must be set to Net-to-Net mode and have the same drop number of the EPE5 port. The settings for the SY/LINK board are made by software on the personal computer. For information regarding the setup of the SY/LINK board consult the Instruction Bulletin 30598-277-01A2 from Square D.
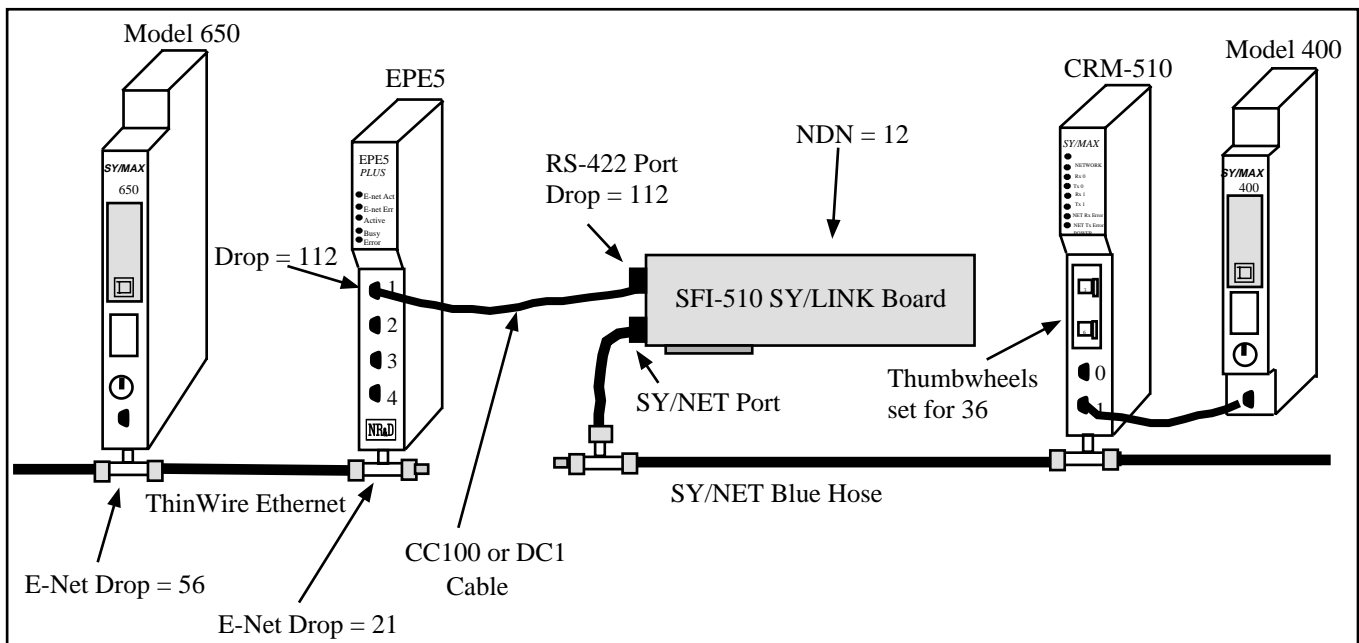
Figure 8-2   SY/LINK Net-to-Net Example

Table 8-2   SY/LINK Net-to-Net Routing Examples

Origin	Target	Route
Model 650	Model 400	056, 021, 112, 136
Model 650	EPE5 Mailbox	056, 021
Model 650	SY/LINK Mailbox	056, 021, 112
Model 400	Model 650	136, 112, 021, 056
SY/LINK	650	012, 112, 021, 056
SY/LINK	400	012, 136
SY/LINK	EPE5 Mailbox	012, 112, 021

Table 8-3   EPE5 Setup for SY/LINK Net-to-Net Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Error Check**
E-Net	21	SY/MAX	NA	NA	NA	NA	NA
1	112	Net-to-Net	9600	E	8	1	BCC

EPE5 Net-to-Net Example

When the SY/MAX limit of 100 nodes is reached on a SY/MAX Ethernet extended LAN, a bridge must be used to further extend the network. A pair of EPE5 units connected in Net-to-Net fashion will serve as this type of bridge. See Figure 8-3.

Additional throughput may be realized by increasing the baud rate to 19200, changing the parity to NONE, and using the CRC Error check. Adding an additional connection between another pair of ports on the EPE5 and splitting the routing load across two ports will also increase throughput.

This type of arrangement is also useful if a modem link is required between Ethernet LANs. The modems may be placed between the EPE5 ports allowing great distances between Ethernet LANs. The Niobrara RM14K rack mount SY/MAX compatible modem is ideal for this application, permitting baud rates of up to 14400 on dial-up, leased line, and radio links.
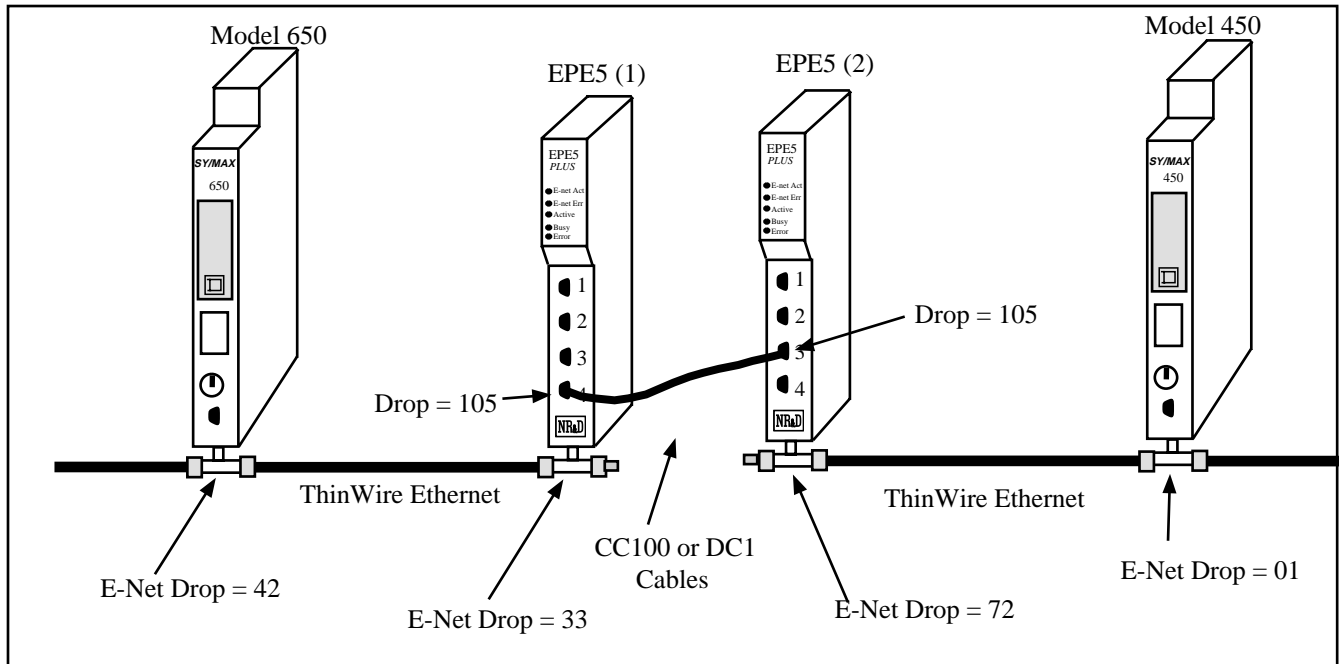
Figure 8-3   EPE5 Net-to-Net Example

Table 8-4   EPE5 Net-to-Net Routing Examples

Origin	Target	Route
Model 650	Model 400	042, 033, 105, 072, 001
Model 650	EPE5 (1) Mailbox	042, 033
Model 650	EPE5 (2) Mailbox	042, 033, 105
Model 450	Model 650	001, 072, 105, 033, 042
Model 450	EPE5 (1) Mailbox	001, 072, 105
Model 450	EPE5 (2) Mailbox	001, 072

Table 8-5   EPE5 (1) Setup for EPE5 Net-to-Net Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	Error Check
E-Net	33	SY/MAX	NA	NA	NA	NA	NA
4	105	Net-to-Net	19200	None	8	1	CRC

Table 8-6   EPE5 (2) Setup for EPE5 Net-to-Net Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Error Check**
E-Net	72	SY/MAX	NA	NA	NA	NA	NA
3	105	Net-to-Net	19200	None	8	1	CRC

The "On Ethernet feature may be used to reduce the number of drops required to pass through the Net-to-Net connection. If the drop number 05 is not used on either Ethernet, both EPE5 units may place drop 105 "On Ethernet". Notice that the drop number 05 is placed on both networks so that each unit will respond to messages sent to 105. Therefore, it is a good idea to also include the drop number 05 in each of the EPE5s to take advantage of the fact that this number is already on the Ethernet. For more information on "On Ethernet" see Chapter 22 on page 131.

Also, for a much higher speed SY/MAX Ethernet bridge, consider using a pair of Niobrara MEB modules. The Modbus Plus ports may be used to provide a 1Mb/sec network hop for much better throughput between the Ethernets.

Table 8-7   EPE5 Net-to-Net Routing Examples with On Ethernet

Origin	Target	Route
Model 650	Model 400	042, 105, 001
Model 650	EPE5 (1) Mailbox	042, 033
Model 650	EPE5 (2) Mailbox	042, 033, 105
Model 450	Model 650	001, 105, 042
Model 450	EPE5 (1) Mailbox	001, 072, 105
Model 450	EPE5 (2) Mailbox	001, 072

SPE4 Net-to-Net Example

When connecting an SPE4 to an EPE5, both ports must be in Net-to-Net mode and have the same Drop number. See Figure 8-4. Unlike the EPE5, the SPE4 ports are not individually configurable for Drop Number. The drop numbers of Ports 1..4 are based off of the drop number of Port 0. So Set the Drop number of the EPE5 port to match the port of the SPE4 to be connected. It is recommended that the SPE4 Ports 1, 2, 3, or 4 be used for this connection as these ports may operate at 19.2K baud. Also for greatest throughput, select parity = NONE, and Error Check = CRC.
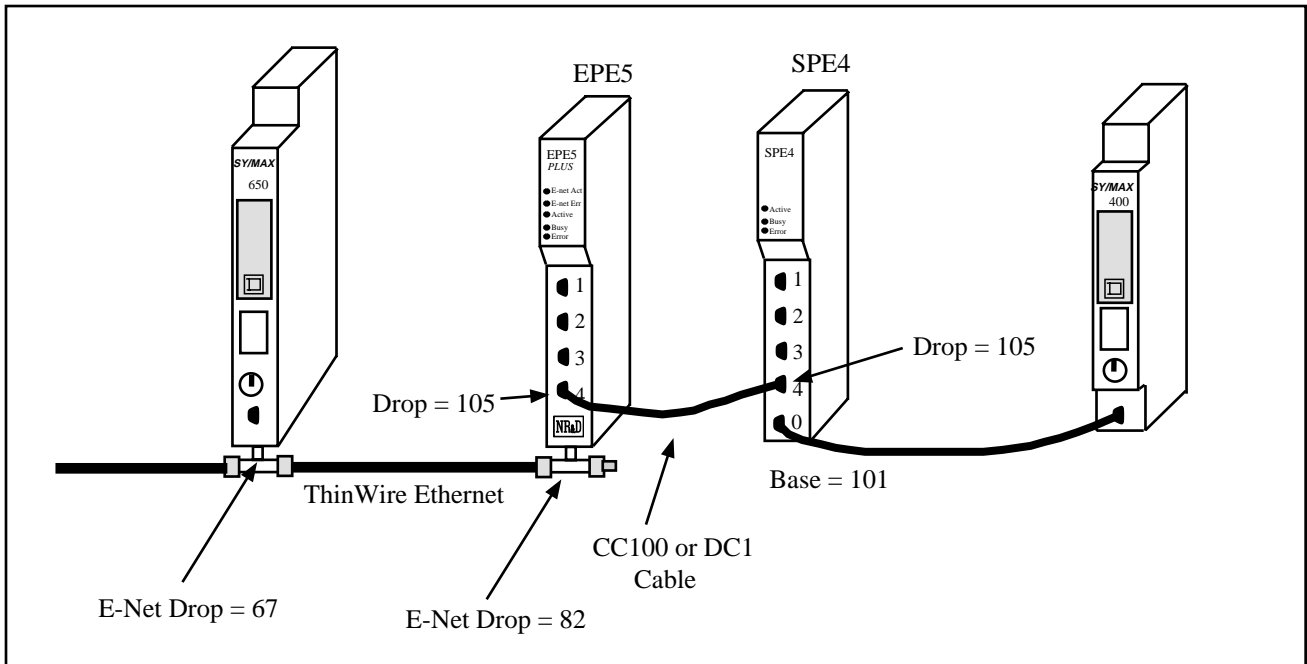
Figure 8-4   SPE4 Net-to-Net Example

Table 8-8   EPE5 Setup for EPE5 Net-to-Net Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Error Check**
E-Net	82	SY/MAX	NA	NA	NA	NA	NA
4	105	Net-to-Net	19200	None	8	1	CRC

Table 8-9   SPE4 Setup for EPE5 Net-to-Net Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Error Check**
0	101	SY/MAX	9600	E	8	1	NA
4	105	Net-to-Net	19200	None	8	1	CRC

Table 8-10   EPE5 Net-to-Net Routing Examples

Origin	Target	Route
Model 650	Model 400	067, 082, 105, 101
Model 650	EPE5 Mailbox	067, 082
Model 650	SPE4 Mailbox	067, 082, 105
Model 400	Model 650	101,105, 082, 067
Model 400	EPE5 Mailbox	101, 105
Model 400	SPE4 Mailbox	NONE

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9
Peripheral Mode

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Mode 3: Peripheral

An EPE5 port set to peripheral mode is capable of receiving SY/MAX network print requests routed to
it through the SY/MAX and Net-to-Net ports in the same module. These network print requests are
translated to raw ASCII and transmitted by the port. Network print messages are generated by a PLC
when a print rung is executed on a PLC communication port which has been configured for network
mode by previously issuing either a read or write rung including a route. The baud rate, data width, and
parity setting of the peripheral mode port should be set to match the attached peripheral device. The
route should consist of the drop number of the port connected to the originating device, any net-to-net
drops, and the drop number of the peripheral mode port. The terminal emulator provided in EPE5SW
may be useful for testing peripheral mode ports.

Driver Mode

The Driver Mode setting for the Peripheral mode allows the control of the RS-485 transmitter and re-
ceiver. For most applications, the PT to PT mode is the proper driver mode. This mode allows full
duplex operation with the transmitter enabled at all times. This can be used to drive a 4-wire multidrop
network as a master.

The FOUR WIRE mode causes the transmit driver to follow CTS. When CTS is enabled, the driver is
enabled. When CTS is not enabled, the driver is allowed to tri-state at a high impedance. This mode is
useful when the port is acting as a slave on a 4-wire multidrop network.

The HALF DUPLEX mode has the transmitter enabled at all times, but the receiver is disabled while
transmitting. This feature is useful for ignoring an echo from the attached device.

The TWO WIRE mode causes the transmit driver to follow CTS and the receiver to be disabled while
transmitting. This mode allows the use of a 2-wire multidrop network.

Figure 9-1   Peripheral mode example

Peripheral Mode Example

Table 9-1   Peripheral Routing Examples

Origin	Target	Route
Model 650	ASCII Display	000, 008, 025
Model 650	Printer	000, 008, 065

Table 9-2   EPE5 Setup for Peripheral Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Driver Mode**
E-Net	08	SY/MAX	NA	NA	NA	NA	NA
1	25	Peripheral	9600	N	7	1	Pt to Pt
4	065	Peripheral	9600	N	7	1	Pt to Pt

The Niobrara SC36P serial to parallel converter cable may be used to interface a Centronics compatible parallel printer to an EPE5 Peripheral (or other SY/MAX RS-422 port).

10

Transparent and Share Modes

Modes 4,5: Transparent, Share

Transparent and Share modes are identical except for the behavior of the RTS pin (see RTS/CTS Handshaking, on page below). These modes are used to interface non-SY/MAX devices to the SY/MAX environment so that their communications can be carried on the SY/NET network or through SY/MAX modems or routers such as the EPE5. Transparent mode communication between ports in the same module can be used for PLC controlled switching of serial data. Transparent communication between ports in different modules can be used to transmit non SY/MAX serial ASCII messages over SY/NET or SY/MAX cabling along with other SY/MAX or non-SY/MAX traffic. Example applications of transparent mode include:

- Connecting serial terminals to non-SY/MAX computers through the SY/NET network.

- Connecting distributed printers to non-SY/MAX computers.

- Sharing a printer between a SY/MAX PLC and a non-SY/MAX computer.

- Programming Micro-1 or Model 50 processors through SY/NET

- Programming Micro-1 or Model 50 processors through SY/MAX modems (Niobrara 2496X)

- Baud rate or word size conversion of non-SY/MAX data

Each transparent port accepts ASCII input and processes it as a series of SY/MAX network print messages. Each packet is transmitted according to the target route of the originating port. The route should consist of the drop number of the originating port, any Net-to-Net drops, and the drop number of the receiving port. For two-way communication, the receiving port should be programmed with the the same drops in reverse order. The target route can be configured using EPE5SW or dynamically by a write messages generated by a PLC or Gateway port.

Packet assembly is performed by accepting characters until either an ASCII carriage return is encountered, the transparent mode packet size limit is exceeded, or the transparent mode time limit is exceeded between characters. Setting the packet size to 1 will cause each character entering the port to be transmitted without delay but will result in slow throughput because of the large overhead of sending each character as a packet. Larger packets are more efficient but will not be transmitted until they are terminated by a carriage return or timeout. For full duplex interactive applications, set the timeout to just slightly longer than the transmission time of a single character at the port's baud rate and word structure. For example, at 9600 baud at time limit of 2 (hundredths of a second) might be used.

TRANSPARENT Mode Example
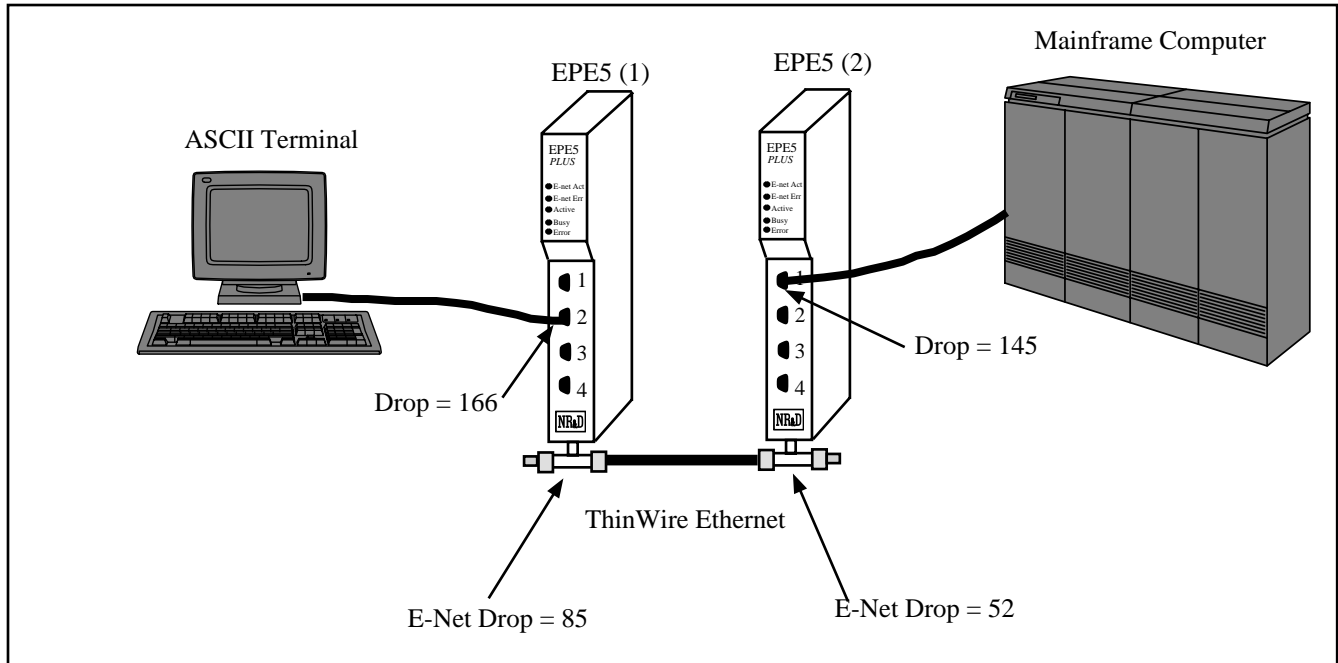
Figure 10-1   Transparent Mode Example

Table 10-1   Transparent Routing Examples

Origin	Target	Route
ASCII Terminal	Mainframe	166, 085, 052, 145
Mainframe	ASCII Terminal	145, 052, 085, 166

Table 10-2   EPE5 (1) Setup for TRANSPARENT Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop
E-Net	85	SY/MAX	NA	NA	NA	NA
1	166	Net-to-Net	19200	N	7	1

Table 10-3   EPE5 (2) Setup for TRANSPARENT Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop
E-Net	52	SY/MAX	NA	NA	NA	NA
2	145	Net-to-Net	19200	N	7	1

The ports connected to the terminal and the Mainframe computer should be set to the appropriate values for those devices. The ports connecting to the NIMs should be in Net-to-Net mode.

If the Devices are RS-232 but the EPE5 ports are RS-422, the SC406 **or SC902** cable may be used to connect the external devices to the EPE5.

Baud rates of 19200, may be used for higher throughput. Set the timeout to just slightly longer than the transmission time of a single character at the port's baud rate and word structure.

Another use for the Transparent mode is the remote programming of other PLCs over SY/NET. The Model 50 or Micro-1 processors may be programmed through transparent ports over Ethernet. Set the Port connected to the Personal Computer running SFW50 or SFW30 for Transparent mode. Set the Port connected to the processor to IDEC mode. The IDEC port will accept network print messages and pass those along to the PLC. The IDEC port will then send the reply back to the Transparent port to complete the message.

Driver Mode

The Driver Mode setting for the Share mode allows the control of the RS-485 transmitter and receiver. For most applications, the PT to PT mode is the proper driver mode. This mode allows full duplex operation with the transmitter enabled at all times. This can be used to drive a 4-wire multidrop network as a master.

The FOUR WIRE mode causes the transmit driver to follow CTS. When CTS is enabled, the driver is enabled. When CTS is not enabled, the driver is allowed to tri-state at a high impedance. This mode is useful when the port is acting as a slave on a 4-wire multidrop network.

The HALF DUPLEX mode has the transmitter enabled at all times, but the receiver is disabled while transmitting. This feature is useful for ignoring an echo from the attached device.

The TWO WIRE mode causes the transmit driver to follow CTS and the receiver to be disabled while transmitting. This mode allows the use of a 2-wire multidrop network.

11
PLogic and PNIM Modes

Mode 6: PowerLogic

The EPE5 can be used to route SY/MAX read and write messages originated by a PLC, computer, or EPE5 Gateway port to a PowerLogic network of one or more PowerLogic modules. The EPE5 handles the difficult task of allowing one communication process to be allowed for only one circuit monitor at a time, permitting multiple accessor to poll the units independently.

The PNIM mode is different from the PLOGIC mode. The PLOGIC mode uses the modified SY/MAX protocol that the PowerLogic Circuit monitors can use. Since the PLOGIC mode conforms to the SY/MAX protocol, other SY/MAX devices may be used to extend the connection from the EPE5 port to the Circuit Monitors, including SY/MAX compatible modems like the 2496X and RM14K. The PNIM mode converts the SY/MAX protocol to the PNIM protocol. This protocol is not the same as SY/MAX and SY/MAX devices such as the 2496X may not be used to extend the connection.

Since the PowerLogic Circuit Monitors will communicate with the PLOGIC and PNIM modes, it is recommended the the PNIM mode be used when connecting to PowerLogic Circuit monitors. The PNIM mode will returen an error 17 if the slave does not respond while the PLOGIC mode simply times out.

The route used should be the route from the accessor to the EPE5 port connected to the PowerLogic bus with an additional drop corresponding to the PowerLogic drop number set in the PowerLogic unit's rotary address switches. The port should be configured for 8 data bits, even parity, 9600 baud, and PLOGIC mode for connecting with units "out of the box". The baud rate may be changed to other values to match the application.

The PowerLogic units operate on a 4-wire RS-485 network and may be connected directly to the RS-422 port of the EPE5. The EPE5 supplies internal biasing for its receive data lines so the PowerLogic RS-485 Multipoint Communications Adapter (MCA-485) is not required for operation with the EPE5. But the network terminator should always be used. See the recommended cabling section at the end of this manual.

PowerLogic Mode Example
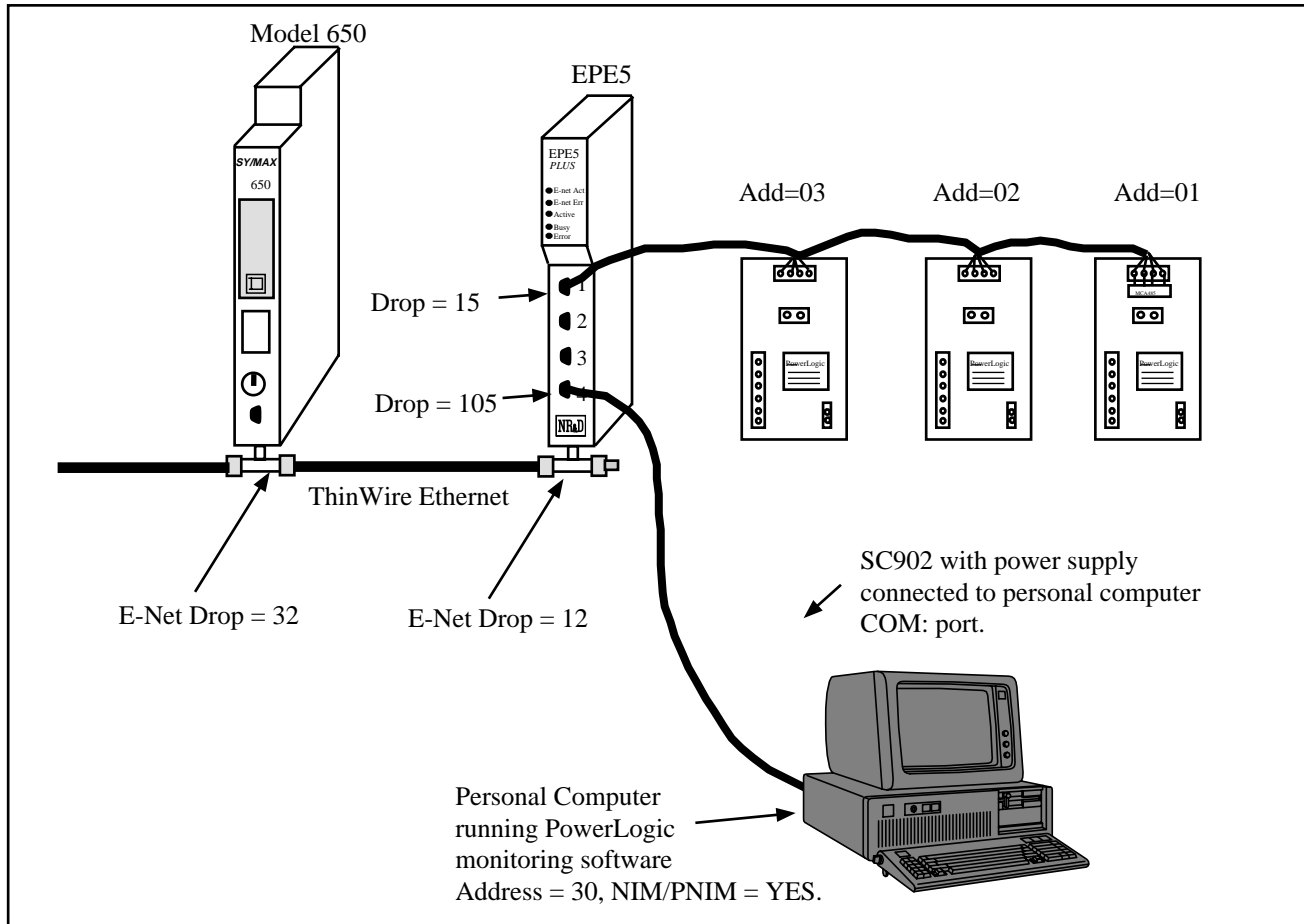
Figure 11-1   PowerLogic Example

Table 11-1   PowerLogic Routing Examples

Origin	Target	Route
Model 650	CM 1	032, 012, 015, 001
Model 650	CM 3	032, 012, 015, 003
Personal Computer	CM 1	30, 105, 015, 001
Personal Computer	CM 2	30, 105, 015, 002

Table 11-2   EPE5 Setup for PowerLogic Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop
E-Net	12	SY/MAX	NA	NA	NA	NA
1	015	PLOGIC	9600	E	8	1
4	105	SY/MAX	9600	E	8	1

The PowerLogic units are set up as 4-wire. The Personal Computer has an address of 30 and NIM/PNIM is set to YES.

Mode 11: PNIM

The EPE5 can be used to route SY/MAX read and write messages originated by a PLC, computer, or EPE5 Gateway port to a network of one or more devices that communicate using the PNIM protocol. This includes PowerLogic Circuit monitors, Altivar motor drives, and other PNIM devices. The EPE5 handles conversion from SY/MAX protocol to PNIM protocol.

The PNIM mode is different from the PLOGIC mode. The PLOGIC mode uses the modified SY/MAX protocol that the PowerLogic Circuit monitors can use. Since the PLOGIC mode conforms to the SY/MAX protocol, other SY/MAX devices may be used to extend the connection from the EPE5 port to the Circuit Monitors, including SY/MAX compatible modems like the 2496X and RM14K. The PNIM mode converts the SY/MAX protocol to the PNIM protocol. This protocol is not the same as SY/MAX and SY/MAX devices such as the 2496X may not be used to extend the connection.

Since the PowerLogic Circuit Monitors will communicate with the PLOGIC and PNIM modes, it is recommended the the PLOGIC mode be used when connecting to PowerLogic Circuit monitors. Since the PLOGIC mode ensures an acknowledgment from the network devices, network security is enhanced over the PNIM mode. The PNIM mode should only be used with ALTIVAR motor drive controllers and other PNIM only devices.

The route used should be the route from the accessor to the EPE5 port connected to the PNIM bus with an additional drop corresponding to the drop number set for the attached PNIM device.. The port should be configured for 8 data bits, even parity, 9600 baud, and PNIM mode for connecting with units "out of the box". The baud rate may be changed to other values to match the application.

The PNIM units operate on a 4-wire RS-485 network and may be connected directly to the RS-422 port of the EPE5. The EPE5 supplies internal biasing for its receive data lines so the PowerLogic RS-485 Multipoint Communications Adapter (MCA-485) is not required for operation with the EPE5. But the network terminator should always be used. See the recommended cabling section at the end of this manual.

PNIM Mode Example
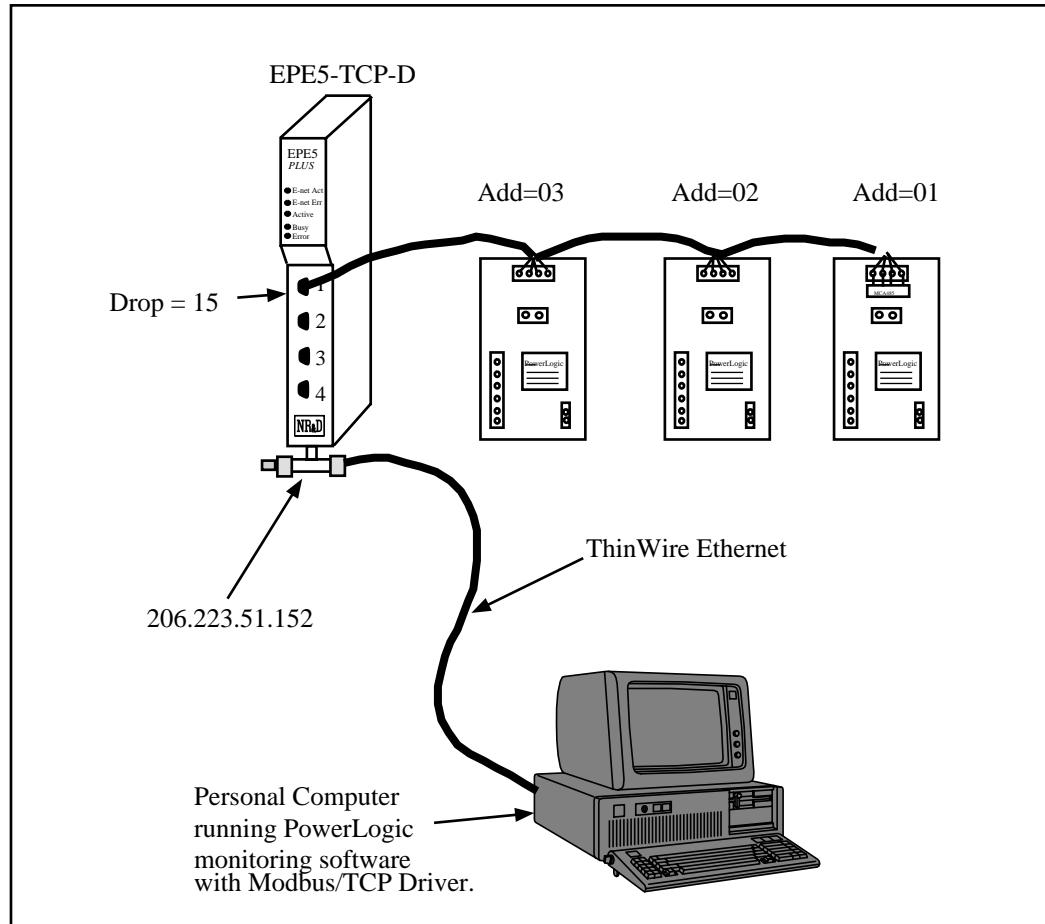
Figure 11-2   PNIM Modbus/TCP Example

Table 11-3   EPE5-TCP Modbus/TCP Server Setup

Index	TYPE	ROUTE
0	OTHER	15,1
1	OTHER	15,2
2	OTHER	15,3

Table 11-4   SMS3000 Device Setup

Device	IP Address	Index
CM 1	206.223.51.152	0
CM 2	206.223.51.152	1
CM 3	206.223.51.152	2

Table 11-5   EPE5 Setup for PNIM Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop
E-Net	206.223.51.152	MODBUS/TCP	NA	NA	NA	NA
1	15	PNIM	9600	E	8	1

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12
IDEC Mode

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Mode 7: IDEC

Micro-1 and Model 50 Interfacing

The EPE5 can translate SY/MAX read and write messages such as those generated by Read and Write rungs in a PLC ladder program to IDEC format read and write rungs compatible with the Micro-1 or Model 50. A network of either of these processors can be connected to a single EPE5 port and then accessed by devices connected to other ports on the module. The route for such messages should include all drops necessary to reach the EPE5 port and one additional drop corresponding to the drop number of the Micro-1 or Model 50 processor within the ring network. The EPE5 is not capable of translating IDEC format requests to SY/MAX requests. This mode is useful when one or more Micro-1 or Model 50 processors are used as remote I/O blocks for a SY/MAX processor. Even if only one IDEC compatible processor is connected to the port, it must be assigned a drop number. A drop setting of zero or none cannot be used. A single Micro-1 or Model 50 processor can be conveniently connected to an EPE5 port with a Niobrara ID422 or MD422 cable respectively. To connect a network ring of multiple units, use the RIU-10 or RIU-20 from Square-D.

When accessing I/O points, internal relays, and shift register bits, the register number in the SY/MAX read or write message is translated to a Micro-1 or Model 50 bit address. Sending a SY/MAX read message will return the state of the eight bits starting at the specified address. Therefore register 256 bit 8 is the same contact as register 257 bit 7. This also means that successive 8 bit registers are addressed at register numbers 8 registers apart. For example, the first internal relay register (8 bits) is found at address 512 but the second 8 bit internal relay register is at address 520, not address 513.

Timer, counter, and the Model 50 data registers are 16 bits wide and are addressed as words. This means the first data register is at address 1792 and the second at address 1793. When interfacing with the Model 50, the most efficient communications will result from reading and writing the data registers and programming the Model 50 to internally address inputs and outputs.

When accessing timer and counter registers, a Read access returns the current value of the timer or counter register. A Write access loads the associated preset register.

Micro-1 register addressing

To communicate with the Micro-1, the EPE5 port should be set to 9600 baud, even parity, 8 data bits, 1 stop bit, IDEC mode. This table shows the SY/MAX register number to use to access various Micro-1 resources.

Table 12-1   Micro-1 Processor Equivalent Register List

Micro-1 Register	SY/MAX Register Equivalent	Notes
Onboard Input	256	
Expansion Input	264	
Onboard Output	384	Bits 1 - 5 only
Expansion Output	392	
Internal Relays	512 - 760	
Shift Registers	768 - 888	
Timers	1024 - 1103	
Counters	1280 - 1326	

Model 50 register addressing

To communicate with the Model 50, the EPE5 port should be set to 9600 baud, no parity, 8 data bits, 2 stop bits, IDEC mode. This table shows the SY/MAX register number to use to access various Model 50 resources.

Table 12-2   Model 50 Processor Equivalent Register List

Model 50 Register	SY/MAX Register Equivalent	Notes
Inputs	256 - 376	
Outputs	384 - 504	
Internal Relays	512 - 744	
Shift Registers	768 - 888	
Timers	1024 - 1103	16 Bits / register
Counters	1280 - 1324	16 Bits / register
Data Register	1792 -1891	16 Bits / register

IDEC Mode Example
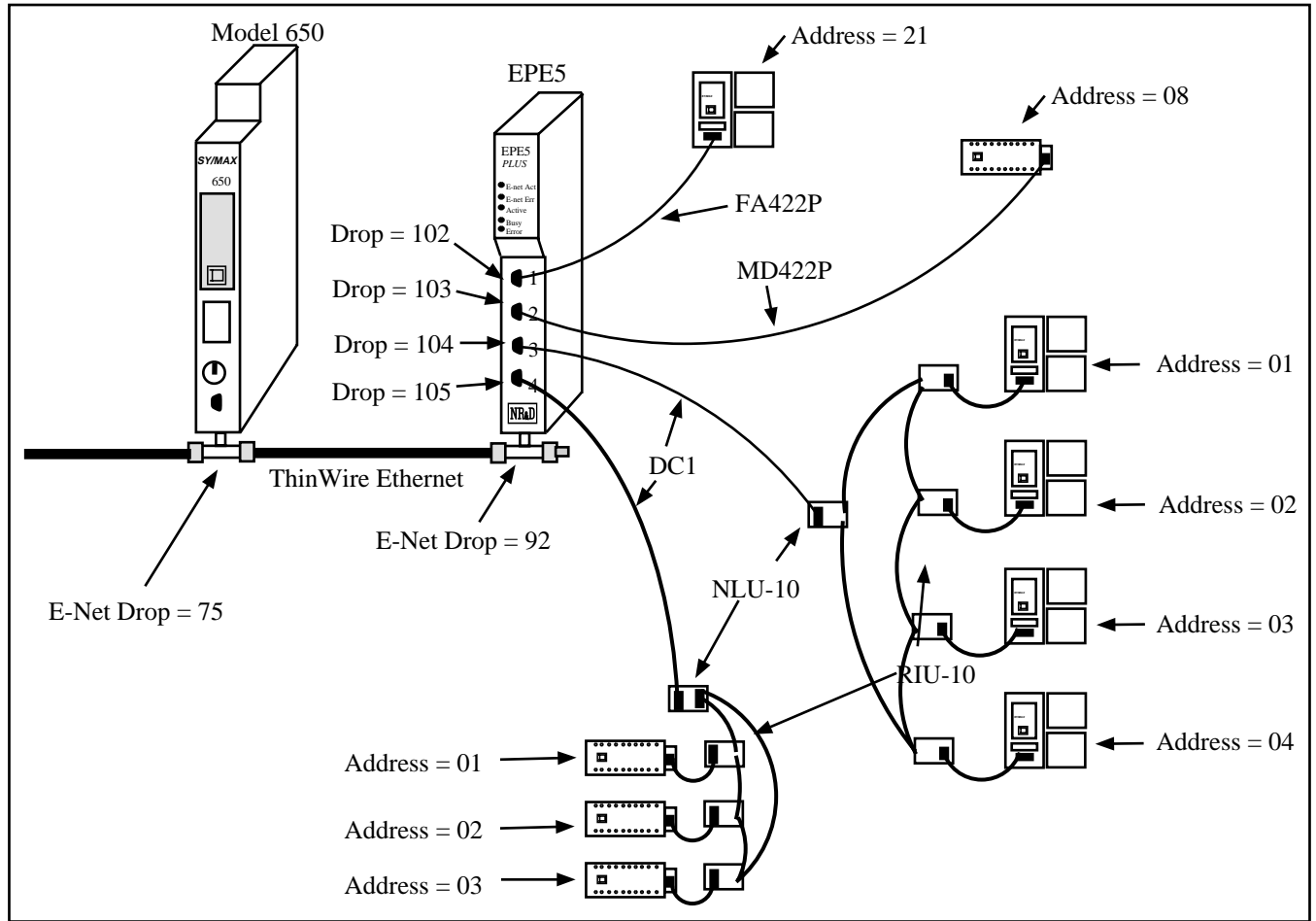
Figure 12-1   IDEC Mode Example

Table 12-3   IDEC Routing Examples

Origin	Target	Route
Model 650	Model 50 on Port 1	075, 092, 102, 021
Model 650	Micro-1 on Port 2	075, 092, 103, 008
Model 650	Model 50 (1) on Port 3	075, 092, 104, 001
Model 650	Model 50 (4) on Port 3	075, 092, 104 004
Model 650	Micro-1 (2) on Port 4	075, 092, 105 002
Model 650	Micro-1 (3) on Port 4	075, 092, 105 003

Table 12-4   EPE5 Setup for IDEC Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop
E-Net	92	SY/MAX	NA	NA	NA	NA
1	102	IDEC	9600	N	8	2
2	103	IDEC	9600	E	8	1
3	104	IDEC	9600	N	8	2
4	105	IDEC	9600	E	8	1

13
Gateway Mode

Mode 8: Gateway

ASCII Command Gateway Functions

To simplify access to SY/MAX devices such as PLCs, Niobrara's various modules, PowerLogic modules, and IDEC mode PLCs, the EPE5 provides a Gateway mode. A port in Gateway mode accepts simple ASCII commands and translates them to properly formatted SY/MAX read, write, and print messages. Using the EPE5 Gateway mode, any device with an ASCII serial port can communicate with the SY/MAX devices. This function facilitates interfacing BASIC or C programs or non-SY/MAX PLCs to SY/MAX devices (or, through an IDEC port, the Micro-1 or Model 50).

The target of all Gateway commands is determined by a route from the Gateway port to the destination device. If the destination is connected to the same module, the route may be the drop of the Gateway port followed by the drop of the destination port. If the target device is connected to another EPE5 or to a NIM connected to the Gateway EPE5 through SY/NET, the second drop will be that of the Net-to-Net port within the Gateway module and additional drops will be added to route the message through the additional network devices. A null route with no drops will direct Gateway accesses to the local processor equivalent mailbox or configuration registers within the EPE5 module. The target route may be set by using EPE5SW (or other means) to modify the Target Route configuration registers or through the Gateway by use of the Gateway ADDRESS command. The target port can also be a PowerLogic or IDEC mode port and accesses made to the registers of those devices. When addressing PowerLogic or IDEC devices, don't forget the final drop should be the drop of the target unit in the IDEC or PowerLogic network. If the target port is an IDEC mode EPE5 port connected to Micro-1 or Model 50 processors, the Set and Clear commands can be applied much more quickly than the Write command to I/O, IR, or SFR registers.

Each Gateway mode command consists of a letter, one or more decimal numeric parameters separated by non-numeric delimiters and either an ASCII carriage return or a time delay. The commands are described individually below. The command termination parameters of packet size limit and packet time limit are the same as for Transparent mode. Unless it is not possible to terminate each command with a carriage return, a packet size limit of 128 and time limit of 100 (1 second) are recommended.

The terminal emulator provided in EPE5SW is useful for testing the gateway features.

Gateway READ command

To read from one or more registers of the addressed SY/MAX device, send the Read command to the Gateway port. The command consists of an 'R' followed by the register number optionally followed by

a register count. The 'R' may be immediately followed by the first digit of the register number or they may be separated by any number of non-numeric characters. The first non-numeric character encountered in the register number likewise delimits it.

The register count, if present is separated from the register by one or more non numeric characters and terminated by any non numeric character or the end of the packet. The reply to a successful read command will be the decimal value of the register followed by a carriage return. If multiple registers are read (i.e. a count field is present and is greater than 1), then the decimal values for the registers will be output separated by ASCII spaces and with a carriage return after the last value. The following are all valid read commands:

- R 100
- r100,10
- READ 100 FOR 10
- Ralph was here 100 years ago.

Gateway WRITE command

The Write command is used to transmit a new value to one or more registers in the target device. The write command is formatted as a letter 'W' followed by zero or more non-numeric characters, followed by the decimal register number, followed by one or more non-numeric characters, followed by the decimal value to be written. Multiple registers can be written by appending additional values to the command delimited by strings of one or more non-numeric characters. The command packet may be terminated by a carriage return or by a time delay. The following are examples of valid Gateway write commands:

- W 100 2
- w100=2,3
- WRITE 100 WITH THE VALUE 2 AND ONE-HUNDRED ONE WITH THE VALUE 3
- We can use anything to separate 100 from 2.

Gateway SET command

The Gateway set command sends a modified write message which will set a single bit in the specified register of the target device to one. The command is an ASCII "S" followed by the register number and bit number. The following are valid bit set commands:

- S 200.3
- s200 16
- SET 200-3

Gateway CLEAR command

The Gateway clear command sends a modified write message which will clear a single bit in the specified register of the target device to zero. The command is an ASCII "C" followed by the register number and bit number. The following are valid bit clear commands:

- C 200.3
- c200 16
- Clear 200-3

Gateway BIT command

The Gateway bit test command sends a read message to the target device and evaluates the returned value to determine the state of the specified bit. The Gateway port will output an ASCII "1" if the bit is

set or a "0" if not. The command is an ASCII "B" followed by the register number and bit number. The following are valid bit set commands:

- B 200.3
- b200 16
- Bit 200-3

Gateway PRINT command

The Gateway print command formats an ASCII message as a SY/MAX network print message and forwards it to the target device. The target should be a NIM port in peripheral mode or an EPE5 port in Peripheral, Transparent, or Share mode, or another Gateway port. The print command is any string starting with an ASCII "P". All characters following the "P" will be emitted by the destination port followed by a carriage return line feed sequence.

Note: A carriage return and line feed will be appended to the message regardless. If a carriage return is sent at the end of the string from the Gateway device, then the string emitted from the peripheral port will have two carriage returns and a line feed. If this presents a problem, use the character limit an inter-character time limits to terminate the message from the Gateway device. If the carriage return and line feed sequence is not desirable, use the Omit print command.

The following are valid Gateway Print commands:

- PHello
- pNow is the time for all good men...

Gateway OMIT Print Command

The Gateway Omit command is a network print command that omits the carriage return and line feed sequence. This allows the printing of exact characters from a peripheral port without the addition of the carriage return and line feed. If no terminator is needed, use the inter-character timeout or character limit settings for the Gateway port to terminate the string. An example of using the Omit command is to send the attention command to a Hayes modem to return it to the command mode. This is accomplished by pausing one second, sending +++, and pausing one second. The three plus signs must not have any other characters with them. The valid command would be: O+++

Gateway ADDRESS command

The target for Gateway commands may be set with the Gateway address command. This command is an ASCII "A" followed by up to eight decimal drops separated by strings of one or more non numeric characters. Remember that the first drop should be the drop number of the Gateway port itself. The following are valid Gateway ADDRESS commands:

- A8,10
- ADDRESS 008 102 104

Gateway Mode Example
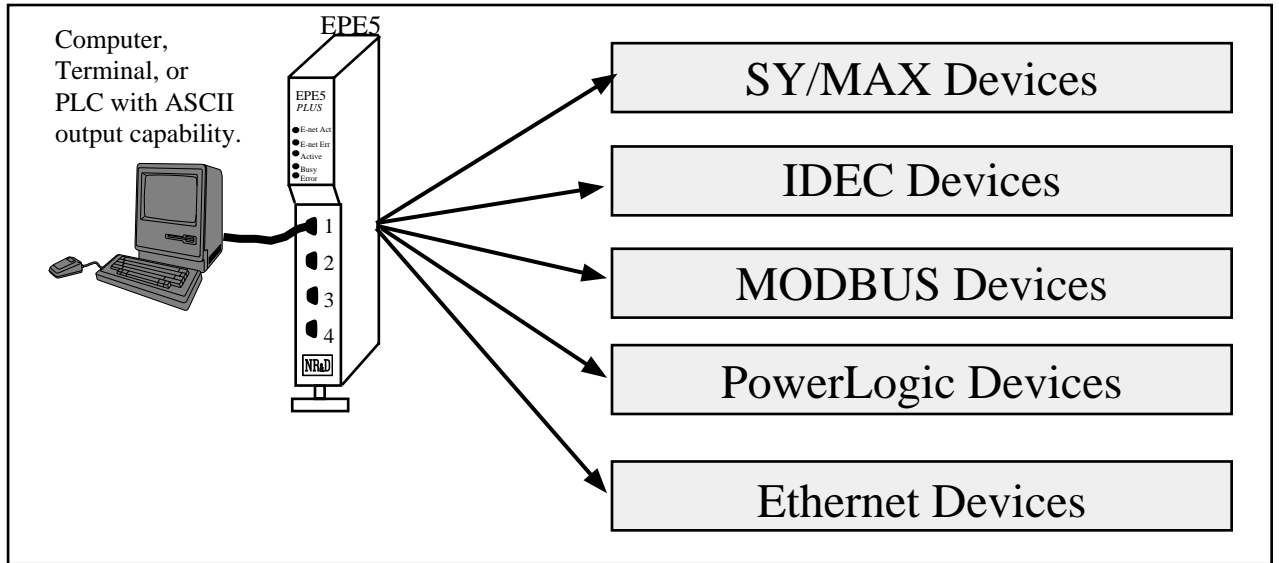
Figure 13-1   GATEWAY Example

The Gateway mode simplifies access to SY/MAX devices, such as PLCs, NR&D's various modules, the EPE5 itself, and any other external mode of the EPE5 (IDEC, PLogic, MODBUS, etc.). A Gateway port accepts simple ASCII commands and translates them to properly formatted SY/MAX read, write, and print messages. Any device with an ASCII serial port may be used to communicate with SY/MAX devices

Figure 13-2 represents a view of the Terminal Emulator from EPE5SW connected to an EPE5 Gateway port.

```
Type contrl-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 13-2   Terminal Emulator connected to Gateway port

Table 13-1   Gateway Command Examples

Command	Description	Example
READ	Reads one or more registers from addressed device.	R 8001.10
WRITE	Writes one or more registers to addressed device.	W 100,2,5
SET	Sends modified write to set a single bit.	S 200-3
CLEAR	Sends modified write to clear a single bit.	C 315,2
BIT	Sends read to determine state of bit.	b375 15
PRINT	Sends ASCII message, adds CR and LF.	PHello
OMIT	Sends ASCII message without CR and LF.	oHello
ADDRESS	Sets the target route for the Gateway port.	A8,10

BASIC Language Example Program

This sample program should run on a PC using most BASIC interpreters. Set the Gateway port to 9600,N,8,1 and connect to COM1 of the PC.

```
10    OPEN "COM1,9600,N,8,1" for RANDOM as 1   'Open the PC's  COM port.
20    PRINT #1, "A 3,4"           'Set the route for the Gateway port.
30    INPUT #1, A$                'Receive the EPE5's  CR reply.
40    PRINT #1, "R 5,10"          'Read registers 5 through 15 in the target.
50    INPUT #1, B$                'Receive the reply data.
60    PRINT B$                    'Print data to screen.  Format:  Reg5 Reg6 Reg7...
70    CLOSE 1                     'Close PC's COM port
80    END
```

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14
Multidrop Mode

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Mode 9: Multidrop

The EPE5 multidrop port mode can be used to route packets between three or more EPE5/SPE4 modules over a single communication medium such as an RS-485 pair or multidrop modems or radios. In multidrop mode, the EPE5 units on the line use a time division scheme to arbitrate access to the line. When an individual EPE5 desires to transmit, it asserts its RTS pair and waits for the modem to respond with CTS. Then it transmits the packet and waits for a response from the receiving unit. All units monitor the line and watch for packets with their individual address.

> **NOTICE:** The MULTIDROP mode is ideally suited for use with a 2-wire RS-485 multidrop network. If a radio or multidrop modem network is to be used, it is recommended that the RNIM mode be used. It is better suited for radio and other multidrop modem applications.

To configure a multidrop network, you must set the Number of Nodes, Time Slice and Node Priority of each node. The Number of Nodes and Time Slice are set the same for all modules. The Node Priority of each module is set to a unique value between 1 and the Number of Nodes. The value of Time Slice is calculated based on the speed of transmission and the RTS to CTS delay of the modem or other network interface. The time slice should be the transmission time for four characters plus the worst case RTS to CTS delay and rounded up to the next highest hundredth of a second. In any case, the time slice should not be less than 5. If you are having trouble with a multidrop configuration, increase the time slice.

The number of nodes in a multidrop configuration is limited only by available drop numbers and by the limits of the transmission medium but the larger the network, the slower will be the throughput for a given packet.

The modem, network controller, or radio type used must be such that all units receive data transmitted by any one unit and that any unit can accept transmit data when its CTS pair is active. It is unimportant whether or not the transmit data is echoed to the transmitting EPE5 port.

Multidrop Mode Example
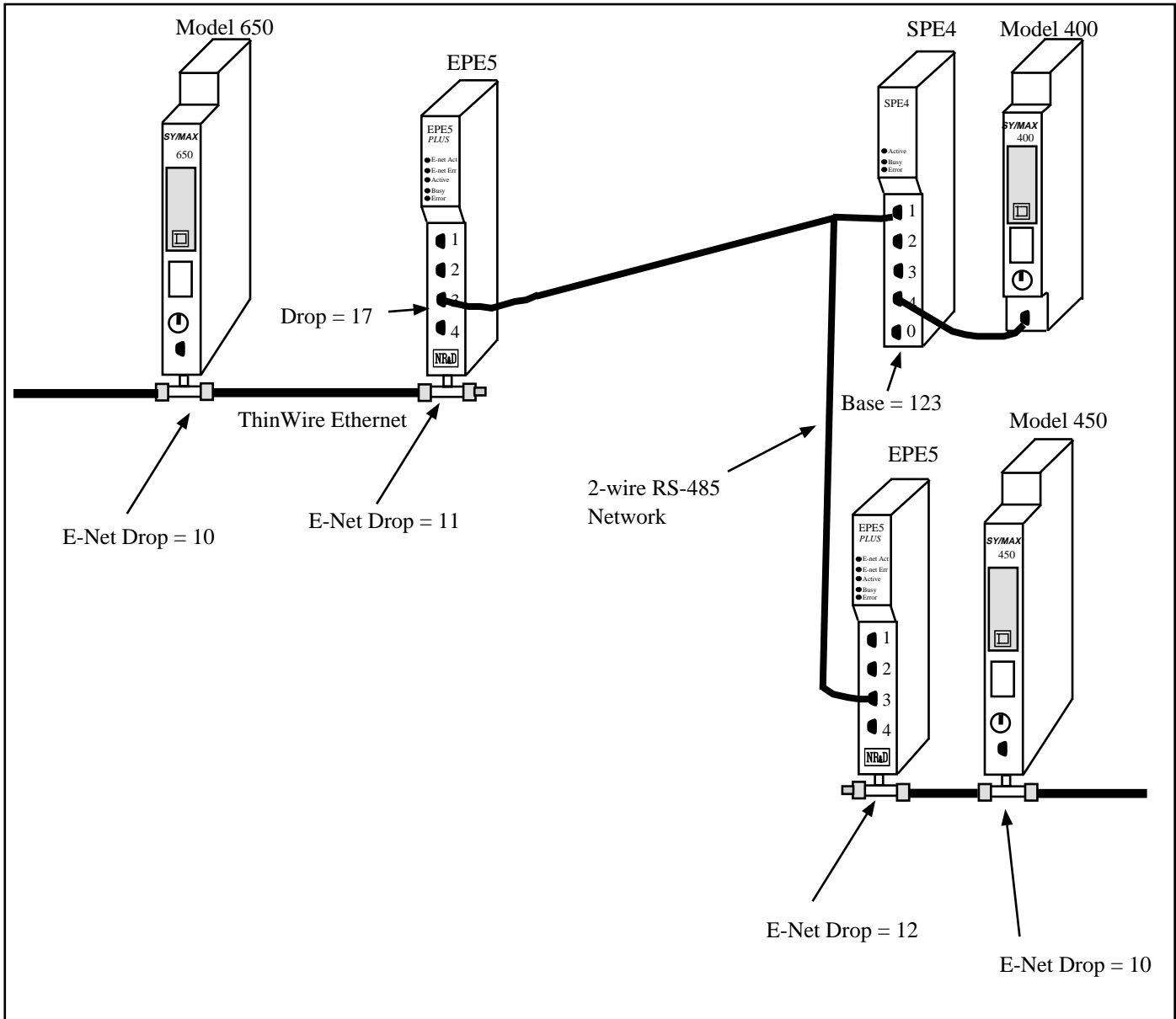
Figure 14-1   Multidrop Example

Multidrop mode is used to allow several EPE5s to communicate over a single medium such as a 2-wire RS-485 network. The EPE5 units use a time division scheme to arbitrate access to the communication system that depends upon the number of nodes and the priority of its node. When ready to broadcast, the EPE5 asserts RTS and waits for CTS from the modem before transmitting its packet. All other EPE5s monitor the incoming packets for their address and then route the packet accordingly.

Table 14-1   MULTIDROP Routing Examples

Origin	Target	Route
Model 650	Model 400	10, 11, 17, 124, 127
Model 650	Model 450	10, 11, 17, 19, 12, 10
Model 400	Model 650	127, 124, 17, 11, 10
Model 400	Model 450	127, 124, 19, 12, 10
Model 450	Model 650	10, 12, 19, 17, 11, 10
Model 450	Model 400	10, 12, 19, 124, 127

Table 14-2   EPE5 (1) Setup for MULTIDROP Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	Error Check	Driver Mode
E-Net	11	SY/MAX	NA	NA	NA	NA	NA	NA
3	17	MULTIDROP	19200	None	8	1	CRC	TWO WIRE

Table 14-3   SPE4 Setup for MULTIDROP Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	Error Check	Driver Mode
1	124	MULTIDROP	19200	None	8	1	CRC	TWO WIRE
4	127	SY/MAX	9600	E	8	1	BCC	NA

Table 14-4   EPE5 (2) Setup for MULTIDROP Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	Error Check	Driver Mode
E-Net	12	SY/MAX	NA	NA	NA	NA	NA	NA
3	19	MULTIDROP	19200	None	8	1	CRC	TWO WIRE

Driver Mode

The Driver Mode setting for the MULTIDROP mode allows the control of the RS-485 transmitter and receiver. For most applications, the PT to PT mode is the proper driver mode. This mode allows full duplex operation with the transmitter enabled at all times. This can be used to drive a 4-wire multidrop network as a master.

The HALF DUPLEX mode has the transmitter enabled at all times, but the receiver is disabled while transmitting. This feature is useful for ignoring an echo from the attached device.

The TWO WIRE mode causes the transmit driver to follow CTS and the receiver to be disabled while transmitting. This mode allows the use of a 2-wire multidrop network.

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15

MODBUS Mode

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The Modbus protocol is implemented in a wide variety of products including Modicon PLCs, temperature controllers, flowmeters, intelligent valve systems, etc. The MEB provides a gateway translation from the SY/MAX protocol to/from Modbus RTU (or ASCII) protocol with the Modbus Gate, Modbus Host, and Modbus ASCII modes. The MEB Modbus Gate and ASCII modes provide reversible translations from SY/MAX messages to Modbus messages and vice versa using a defined series of rules. The Modbus Host mode is used when an explicit opcode and bias is required for a specific master application.

Modbus Overview

The Modicon addressing scheme is somewhat different than SY/MAX. In the SY/MAX PLC there is only one memory address space for data. Input registers, output registers, discrete input bits, and discrete output bits are all treated as registers and bits within these registers. Because of this treatment of memory, the SY/MAX communications protocol requires only one type of message to read, and another to write data to and from external devices.[1]

The Modicon addressing method involves separate memory locations for input bits, output bits, input registers, and output registers. These different areas are denoted by the first character in the number that identifies the bit or register. Output bits (coils) are described by values in the range of 0xxxxx. Input bits (coils) are described by values in the range 1xxxxx. Input registers have values 3xxxxx and Output registers have values of 4xxxxx. Consequently the Modbus protocol requires separate messages to access the data in each of these areas. See Table 15-1.

For example, the first output bit in a Modicon PLC is addressed as 00001. The 150th output bit in the PLC is 00150 and is accessed using Function code 1 and written with Function codes 5 and 15. The seventeenth input bit is 10017 and is read by Function code 2. The 2381st input register is addressed by 32381 and is read with Function code 4. And the 52nd holding register is 40052 and read by Function code 3 and written with Function codes 6 and 16.

---

[1] The SY/MAX protocol includes both Priority and Non-priority READ and WRITE messages, but the different messages still operate on the same memory address space.

Table 15-1   MODBUS Function Code List

Function Code	Description	MODBUS Address Range	Notes
01	Read Coil Status	0XXXXX	
02	Read Input Status	1XXXXX	
03	Read Holding Register	4XXXXX	
04	Read Input Registers	3XXXXX	
05	Force Single Coil	0XXXXX	
06	Write Single Register	4XXXXX	
15	Force Multiple Coils	0XXXXX	
16	Write Multiple Registers	4XXXXX	
22	Masked Write Register	4XXXXX	Not supported by all PLCs.
100	Random Read Holding Registers	4XXXXX	Used by Powerlogic, not supported in any PLCs.

SY/MAX Message Addressing

The SY/MAX protocol supports a variety of operations for transferring data from device to device.

Table 15-2   SY/MAX Messages

Opcode (hex)	Description	Notes
20	Priority Read	May be generated by SY/MAX PLCs.
00	Non-Priority Read	
04	Non-Priority Random Access Read	
1e	Priority Write	May be generated by SY/MAX PLCs.
02	Non-Priority Write	
1e	Priority Alarm	Special version of Priority Write generated by SY/MAX PLCs.
22	Priority Print ASCII	

The SY/MAX PLC processors will only generate the Priority messages for peer-to-peer communication. These are the messages sent when a TWRITE, TALARM, TREAD, or network TPRINT is issued.

The Non-Priority WRITE message has the provision for a bit mask. This means that specific bits may be written to the remote device in a register without modifying other masked bits within that register. The Priority WRITE statement available in the PLC has no provision for a bit mask.

Message Translations

When messages cross from SY/MAX to Modbus media or vice-versa with a Niobrara bridge product (SPE4, EPE5, MEB) they are either reversibly translated or encapsulated and sent transparently. Translatable messages may be sent by one brand of device and operate successfully on another. By means of Niobrara's other translations, Modbus messages translated to SY/MAX operations may also operate on IDEC, PLOGIC, PNIM, and RNIM devices. Untranslateable SY/MAX or Modbus messages should only be directed to a device of the same brand to avoid unpredictable results. SY/MAX, PLOGIC, PNIM, and IDEC serial ports will return an encapsulated error to encapsulated Modbus messages. Modbus Host and Modbus Gate serial ports will return an encapsulated error to encapsulated SY/MAX messages. Net-to-Net, RNIM, MULTIDROP, ETHERNET, SY/NET, and Modbus Plus ports forward all messages transparently.

SY/MAX to Modbus Translations

SY/MAX originated messages which can be reversibly translated are listed in Table <SY/MAX to Modbus Translations>.

Table 15-3 SY/MAX to Modbus Translations

SY/MAX Message	Modbus Message
Priority Read (0x20)	Read Holding Registers (3)
Non-Priority Read (0x00)	Read Holding Registers (3)
Priority Write (0x1E)	Write Multiple Registers (16)
Non-Priority Write (0x02) with mask all ones.	Write Multiple Registers (16)
Non-Priority Write (0x02) with mask containing < 16 contiguous ones, count = 1.	Masked Write Regsiter (22)

All other SY/MAX commands will be encapsulated following Modbus opcode 17 (0x11) with a single parameter 0x01 and sent transparently over the Modbus media. Replies to encapsulated SY/MAX queries are encapsulated with opcode 17 and parameter 0x02. This opcode normally has no parameters, so the presence of parameters allows the router to determine that the message is an encapsulated SY/MAX command and not a valid Modbus opcode 17.

Modbus to SY/MAX Translations

Modbus originated messages which can be reversibly translated are as follows.

Table 15-4 Modbus to SY/MAX Translations with type = "OTHER"

Modbus Message	SY/MAX Message
Read Coil Status (1)	Priority Read (0x20) with status register address 0xMN03 where M is the start bit modulo 16 and N is the bit count modulo 16
Read Input Status (2)	Priority Read (0x20) with status register address 0xMN05 where M is the start bit modulo 16 and N is the bit count modulo 16
Read Holding Registers (3)	Non-Priority Read (0x00) status field with Transnum 0x03
Read Input Registers (4)	Non-Priority Read (0x00) status field with Transnum 0x04
Force Single Coil (5)	Non-Priority Write (0x02) with Transnum 0x05 and single bit set in mask
Preset Single Register (6)	Non-Priority Write (0x02) status field with Transnum 0x06
Force Multiple Coils (15) if all coils lie in one register and count < 16. Force multiple coils with coil count = 1 may be detranslated as force single coil.	Non-Priority Write (0x02) with Transnum 0x0f and appropriate (not 0xfff) mask
Write Multiple Registers (16)	Non-Priority Write (0x02) with Status field with Transnum 0x10
Masked Write Register (22)	Non-Priority Write (0x02) with Transnum 0x10 and appropriate mask.
Random Read (100)	Non-Priority Random Read (0x04)

All other Modbus messages will be encapsulated for transmission of SY/MAX media in a Print command (0x22) with status register address 0xBAD5. This normally illegal status register value enables

downstream translations to distinguish the encapsulated messages from an actual SY/MAX print message (which must be encapsulated to ride Modbus media). Replies to untranslatable Modbus messages are encapsulated as the Print Reply (0x92) with the same, illegal, status register address. Encapsulated Modbus query and response packets include a byte for the Modbus address following the status register address bytes. This byte is unused but is required for compatibility with existing Niobrara Modbus to SY/MAX translations. Niobrara translator conforming to this specification set this unused byte to zero on transmission and ignore it on reception.

If the target device type is set to "MODBUS" then only opcodes 03, 16, 22, and 100 are translated and all other opcodes will be encapsulated as above.

Master Operation

The Modbus Gate, Host, and ASCII modes may be used to connect Modbus slaves and networks of slaves to SY/NET. The Modbus Gate and ASCII modes use the translations in Table <SY/MAX to Modbus Translations> to convert SY/MAX messages to Modbus serial messages. The Modbus Host mode allows the user to select the Modbus opcode and register bias (offset) for the translation. It is recommended that the Modbus Gate mode be used unless the user explicitly needs to alter the normal translation.

Register Bias

Modbus address values may fall outside the valid SY/MAX range of 1..8192. The EPE5 Modbus Host port provides an offset value called the Register Bias. The Register Bias may be set for any 16 bit value from 0 to FFFF hex (-23768 to 32767 dec). The Register Bias is only applied to Modbus Host Master translations and is not applied on Modbus messages incoming to an EPE5 Modbus Host or Gateway Slave port.

Register Calculations

The Modbus commands which are register operations, (3, 4, 6, 16) are related to the SY/MAX REMOTE address specified in the READ or WRITE by the following formula:

MODBUS address = (SY/MAX REMOTE address) + (Register Bias)

NOTE: The Modbus Gate port always has Register Bias = 0. Also, the SY/MAX register address generated in a Modbus Slave translation always uses the Register Bias = 0

> Example: A SY/MAX read is routed to a Modbus Host (Master) port of an EPE5. The Read Opcode is set for 4 because it is desired to read input register 300121 in a Modbus Slave PLC. The Register Bias is set to 0. The Modbus Address to be read is 121. The SY/MAX remote address for the READ is therefore: (121) - 0 = 121.

> Example: A SY/MAX multiple register write is routed to a Modbus Host (Master) port of an EPE5. The Write Opcode is set to 16. The target registers in the Modbus devices start at 49175. The value 9175 is outside the range of the SY/MAX 8192 limit so the Register Bias must be set to a larger number such as 4000. With this value, the SY/MAX remote register number will be: (9175) - 4000 = 5175.

Table 15-5 displays the SY/MAX register to Modicon Register relationship for the EPE5 Modbus Host Master translation.

Table 15-5 SY/MAX Register to Modbus Register Relationship

SY/MAX Register	Modbus Register Bias = 0	Modbus Register Bias = 1	Modbus Register Bias = 500
1	1	2	501
2	2	3	502
3	3	4	503
4	4	5	504
5	5	6	505
6	6	7	506
7	7	8	507

Bit Calculations

Since the SY/MAX family does not differentiate between bit address and register address, the EPE5 MODBUS port must perform a translation to accomplish this task. The SY/MAX READ and WRITE messages support 16 bits per register address, so the translation to MODBUS coil address occurs in sections of 16 coils and occur on 16 bit boundaries. The MODBUS commands which are coil (bit) operations (1, 5, 15) are related to the REMOTE address specified in the READ or WRITE by the following formula:

Coil Start Address = (((SY/MAX REMOTE address) + (Register Bias) - 1) * 16) + 1

The start address refers to the address of bit 1 of the SY/MAX register. Table 15-6 displays the SY/MAX bit relationship to the Modbus coils for the EPE5 Modbus Master.

Table 15-6 SY/MAX Bit to Modbus Coil Relationship

SY/MAX Register	SY/MAX Bits	Modbus Bits Bias = 0	Modbus Bits Bias = 1	Modbus Bits Bias = 500
1	1...16	1...16	17...32	8017...8033
2	1...16	17...32	33...48	8034...8049
3	1...16	33...48	49...64	8050....8065
4	1...16	49...64	65...80	8066...8081
5	1...16	65...80	81...96	8082...8097
6	1...16	81...96	97...112	8098...8113
7	1...16	97...112	113...128	8114...8129

NOTE: Because of the limitation of the Modbus protocol, coil number 65535 is the highest number coil that can be accessed. This means that SY/MAX register 4095 is the highest register that may be accessed.

Modbus Retries

If a Modbus packet is transmitted from the EPE5 port and a valid reply is not received from the Modbus device, the EPE5 will wait for the amount of time specified in the MODBUS RETRY timeout register for that port. The EPE5 will then rebroadcast the message and wait for a valid reply. The EPE5 will retry only twice after the initial message.

Driver Mode

The Driver Mode setting for the Modbus modes allows the control of the RS-485 transmitter and receiver. For most applications, the PT to PT mode is the proper driver mode. This mode allows full

duplex operation with the transmitter enabled at all times. This can be used to drive a 4-wire multidrop network as a master.

The FOUR WIRE mode causes the transmit driver to follow CTS. When CTS is enabled, the driver is enabled. When CTS is not enabled, the driver is allowed to tri-state at a high impedance. This mode is useful when the port is acting as a slave on a 4-wire multidrop network.

The TWO WIRE mode causes the transmit driver to follow CTS and the receiver to be disabled while transmitting. This mode allows the use of a 2-wire multidrop network.

Modbus peripherals are available in a variety of configurations. For most applications, you should set the port to 9600 baud, 8 data bits, EVEN parity (sometimes ODD) and 1 stop bit.

RS-485 MODBUS Host Master Mode Example
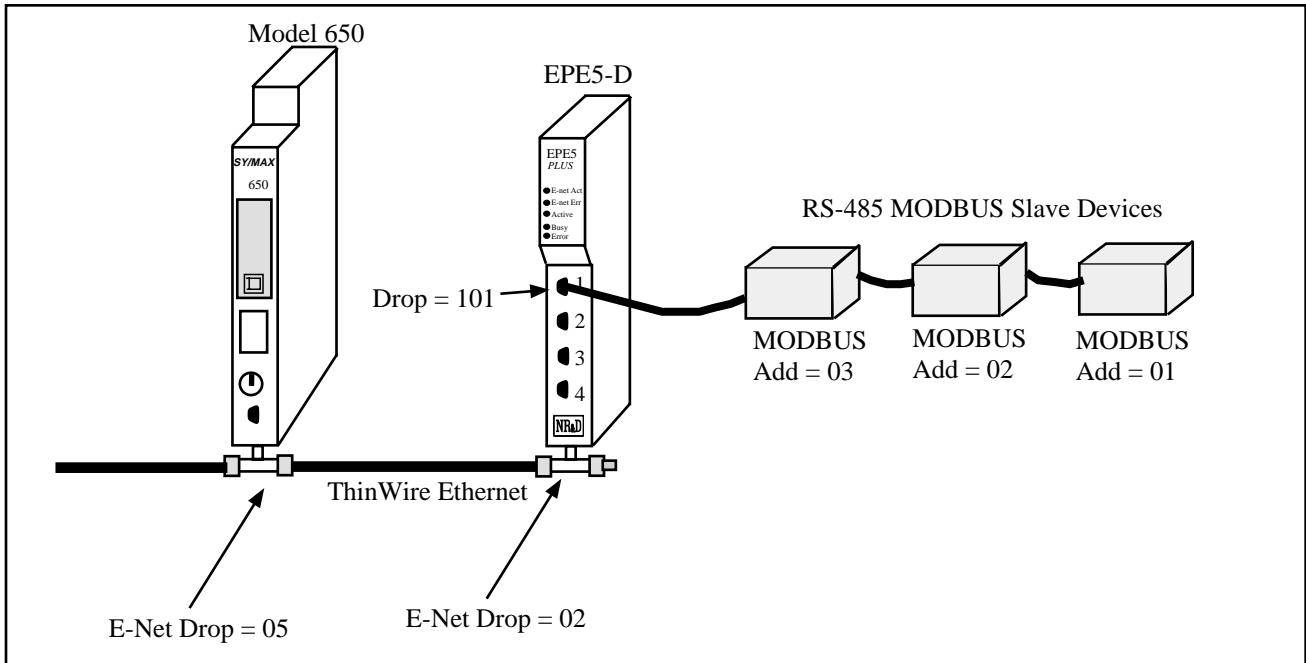
Figure 15-1   MODBUS Master Mode Example

Table 15-7   MULTIDROP Routing Examples

Origin	Target	Route
Model 650	MODBUS Slave 1	005, 002, 101, 001
Model 650	MODBUS Slave 3	005, 002, 101, 003

Table 15-8   EPE5 Setup for MULTIDROP Master Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	Driver Mode
E-Net	02	SY/MAX	NA	NA	NA	NA	NA
1	101	Modbus Host	9600	E	8	1	Pt to PT

If the MODBUS peripherals are equipped for 4-wire RS-485 operation, up to 32 units may be connected to a single EPE5 RS-422 port. Set the Options bits for that Modbus port for Multidrop False and FULL Duplex.

If a 2-wire RS-485 network is required, set the Options bits for that port for Multidrop TRUE and HALF Duplex.

Modbus Slave Operation

The EPE5 Modbus Slave operation allows a Modbus Master to read and write data into SY/MAX devices via SY/NET. The EPE5 Modbus Slave port listens to the Master for messages that have Addresses that match entries in its Modbus Address table. Messages that do not correspond to addresses in the table are ignored. This functionality is similar to the operation of the Modicon BM-85 in Silent Master configuration.

The SY/MAX route generated for the translated message is determined by the setting in the Modbus Address table for that EPE5 port. Each EPE5 RS-422 port has its own table that is capable of holding 128 eight drop SY/MAX routes that correspond to 128 consecutive Modbus Slave addresses. The starting point of these 128 entries is adjustable using the Base Drop for that port. Therefore, two EPE5 ports connected in a multidrop fashion are able to respond to all 255 Modbus addresses.
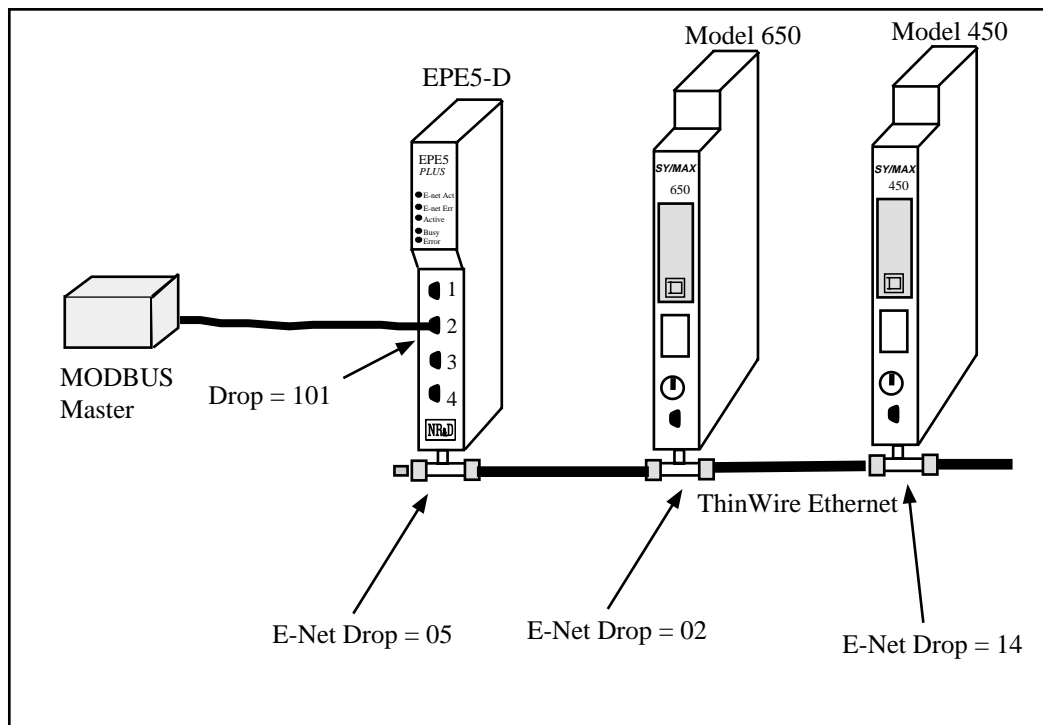
Figure 15-2   OTHER Modbus Slave Example

Table 15-9   Modbus Slave Example Setup

Origin	Target	Modbus Address	SY/MAX Route in the Modbus Address Table
Modbus Master	Model 650	1	101, 005, 002
Modbus Master	Model 450	2	101, 005, 014
Modbus Master	EPE5 Mailbox	3	101, 204

Table 15-10 Modbus Example Configuration

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Driver Mode**
E-Net	05	SY/MAX	NA	NA	NA	NA	NA
2	101	Modbus Gate	9600	E	8	1	Pt to Pt

Since the incoming Modbus message is translated to SY/MAX, it is possible to have any this message routed to any other type of port on the SY/NET for further translation. This includes target devices such as PowerLogic units on PNIM ports, PLOGIC ports, IDEC units, and other speciality NIMs.
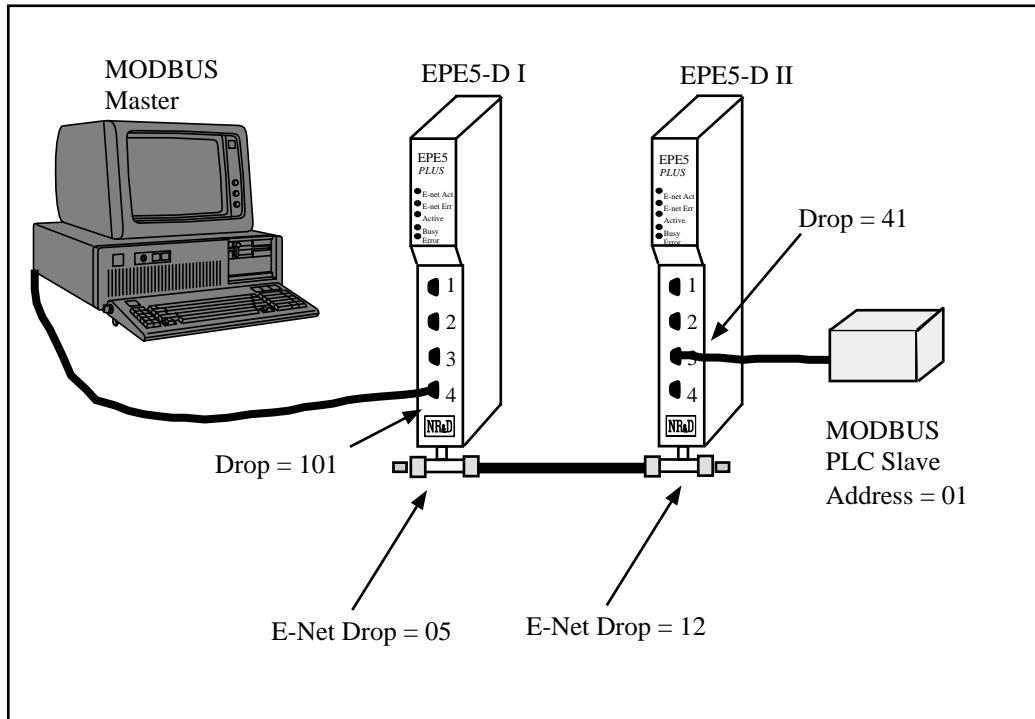
Figure 15-3   Modbus through SY/MAX Example

Table 15-11   Modbus Example Setup

Origin	Target	Modbus Address	SY/MAX Route in the Modbus Address Table
Modbus Master	Modbus PLC Slave	15	101, 005, 012, 041, 001

Table 15-12   EPE5 I configuration

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Driver Mode**
E-Net	05	SY/MAX	NA	NA	NA	NA	NA
4	101	Modbus Gate	9600	E	8	1	Pt to Pt

Table 15-13 EPE5 **II configuration**

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Driver Mode**
E-Net	12	SY/MAX	NA	NA	NA	NA	NA
3	41	Modbus Gate	9600	E	8	1	Pt to Pt

Figure 15-4 displays a Modbus Routing table for the previous application from the Edit Modbus Routing screen of EPE5SW.


```
            E P E 5    E T H E R N E T    P O R T    E X P A N D E R       |
Niobrara R&D                   EPE5 06JUN95 Port 4                   01Jun95
                    CONFIGURATION AND UTILITY SOFTWARE
oNline          oFfline              Utility            Setup            Quit
        MODBUS ROUTING FOR PORT 3, BASE DROP = 1
             DROP  DEVICE   ROUTE
               1   OTHER    101,5,2
               2   OTHER    101,5,14
               3   OTHER    NONE
               4   OTHER    NONE
               5   OTHER    NONE
               6   OTHER    NONE
               7   OTHER    NONE
               8   OTHER    NONE
               9   OTHER    NONE
              10   OTHER    NONE
              11   OTHER    NONE
              12   OTHER    NONE
              13   OTHER    NONE
              14   OTHER    NONE
              15   MODBUS   101,5,2,41,1
              16   OTHER    NONE
                            Use arrows to select field. Home to edit base drop.
                            Use PgUp and PgDown to select port. Escape to exit.
```

Figure 15-4 EPE5**SW Modbus Routing Editing Screen**

PowerLogic Software use with Modbus Devices

The Modbus Host mode acting as a Master may be used to connect Modbus compatible devices to SY/NET for use with operator interfaces such as PowerLogic's System Manager software.

Register 8188

The entire suite of PowerLogic software packages includes the "feature" that they use a Read of register 8188 to determine if a device is online. Unfortunately, not all Modbus devices have registers that extend to 8188 and an error will be returned on the translation. If it is possible, Niobrara recommends that the user assign 8192 registers to the address space to be read in the target device. Otherwise, Bit 9 of the Options register for the port may be set to enable the Modbus port to recognize the single read of register 8188 and translate that read into the Modbus opcode 17 (11hex) to determine the PLC ID of the Modbus Device.

The Modbus PLC ID message returns a one byte ID, a run/halt byte, and a variety of other information about the PLC. The Modbus Host port will return the PLC ID in the LSB of the R[8188] reply. Bit 15 of R[8188] will always be set in this reply. Bit 16 of R[8188] will indicate the run/halt state of the PLC; if set, the PLC is in run and if clear, the PLC is in halt. Table 15-14 displays the currently used PLC IDs from Modicon.

Table 15-14 Modicon PLC ID Values

ID Value	PLC Type
0	Micro 84
1	484
2	184/384
3	584
8	884
9	984/Quantum

For example, if a Modicon 984 is attached to a Modbus Host port with Bit 9 of the Options register set, if the PLC is in run, a read of R[8188] will return the data C009 (hex) and if the PLC is in halt, the data 4009 (hex) will be returned.

Non-Priority Random Access Reads

The PowerLogic softwares all make extensive use of the SY/MAX Non-Priority Random Access Read message. This is a highly efficient use of the SY/MAX protocol and can provide excellent throughput for gathering large amounts of non-contiguous data. Niobrara and Square D have colaborated to develope a random read for the Modbus protocol. At the time of this writing only Niobrara and PowerLogic devices support opcode 100; Modicon PLCs do not. Because of this incompatibility, the Modbus Host mode must be used to connect most Modbus devices with PowerLogic software networks.

The Modbus Host mode translates each element of a random read to the corresponding Modbus read. So, an update of a custom table in System Manager with 60 entries, may very well translate to 60 Modbus RTU messages.

The Modbus Gate and Modbus Plus translations translate SY/MAX Random Access Reads into Modbus Random Reads for shipment across the Modbus media and hence require another Modbus Gate or Niobrara Modbus Plus translation to restore the SY/MAX read. This technique allows the full use of the Random Read with SY/MAX and PowerLogic equipment.

The drawback is that it is not possible to directly access Modbus Plus devices from System Manager. There are two possible solutions to this problem: connect a Modbus Host port to the serial port of the MB+ device, or use the Global Data feature of the MEB to gather important data from several MB+ devices within the MEB and have the System Manager read the data from the MEB's mailbox.

16

RNIM Mode

The RNIM mode provides compatibility with the Square D CRM-560 RNIM. Two modes of RNIM operation are RNIM Master (Mode 12) and RNIM Slave (Mode 13). The RNIM protocol provides remote network access to SY/MAX devices using a half-duplex connection via radio/microwave/fiber optic/telephone links with the addition of a modem device. For a twisted pair RS-485 link, it is recommend that the MULTIDROP Mode be used rather than RNIM. (See page 83.) The RNIM protocol is designed for Master/Slave operation while the Multidrop protocol is intended for Peer-to-Peer communication.

The RNIM mode makes use of the RTS/CTS handshake lines in Push-to-Talk mode. This mode is not available on Port 0 of any SPE4. The RNIM protocol may be used in conjunction with other SPE4s, EPE5s, MEBs, MPE3s, CRM-560s, and other RNIM compatible devices.

The RNIM protocol provides a single Master device to communicate with up to 99 Slave devices. Communication may occur through any of four mechanisms:

- Direct Master originated to Slave (NORMAL operation)

- Slave originated to Master (BID operation)

- Slave to Slave command relaying (STORE/FORWARD operation)

- Master originated broadcasting (BROADCAST operation)

Full SY/MAX message support, including all types of READs, WRITEs, and Programming is provided over the RNIM link.

NORMAL Operation

In general communication occurs by way of devices on the Master's local network sending messages routed to devices on a Slave's local network. The Master is usually located in a base station or control room and the Slaves are at the remote sites.

Under NORMAL operation, messages from the network of the Master are routed to a device on the network of a Slave. The SY/MAX route from the originator determines the exact path to the target device. In Figure 16-1, the Master RNIM is the CRM-560 and the SPE4 and EPE5 units are acting as Slave devices. If a PLC on the "Blue Hose" at NIM address 134 needs to read a register in the Model 400 connected to the SPE4, a route of 134, 36, 24, 27 would be used. To communicate with the Model 450, the route 134, 36, 19, 12, 10 is required.
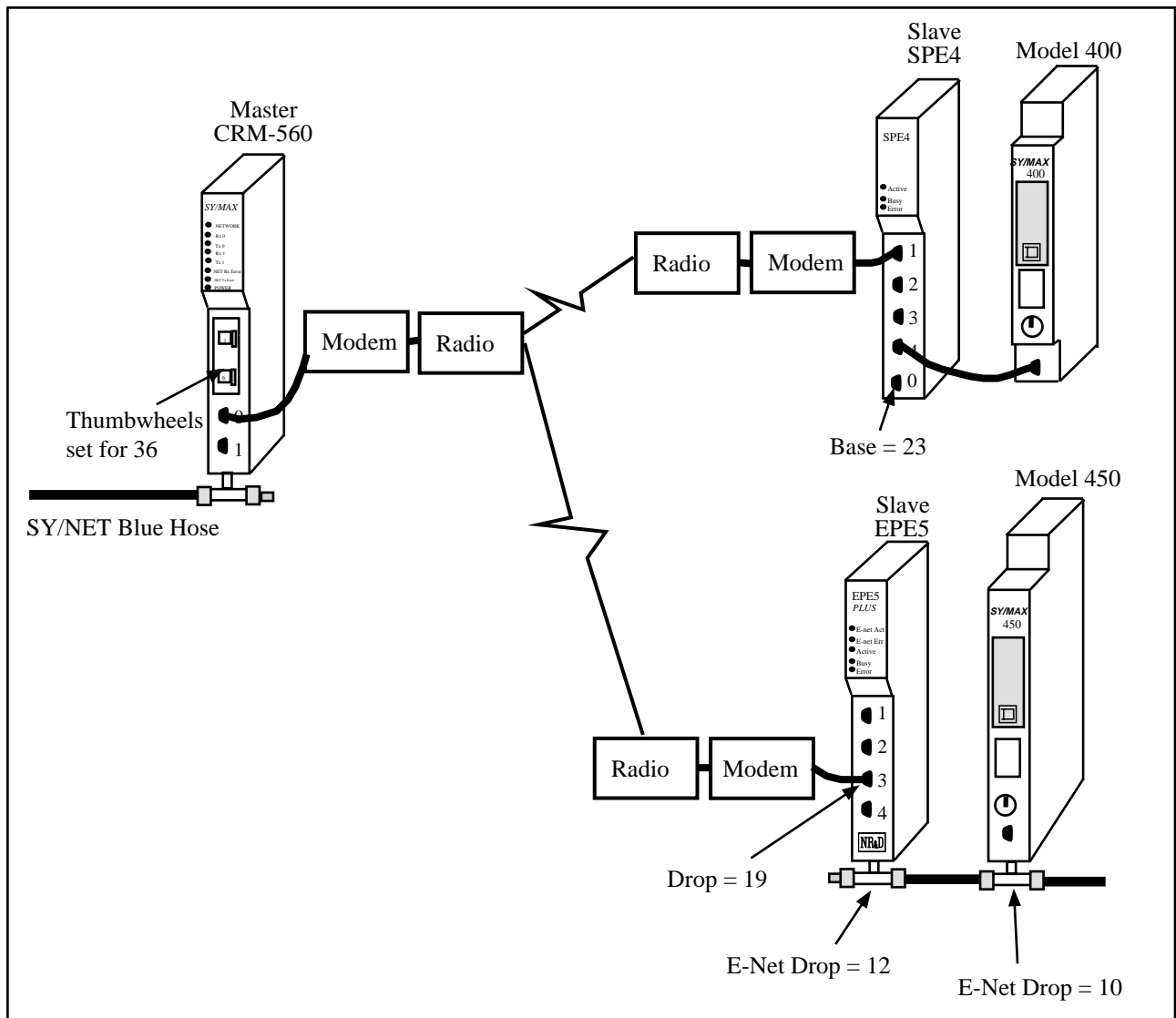
Figure 16-1   NORMAL RNIM Example

The RNIM protocol is a single-threaded half-duplex system. Single-threaded refers to the fact that only one message may be outstanding at any given time. Half-duplex refers to the fact that the transmission media only supports communication in one direction at a time. When a message arrives at the Master, it places that message in a buffer until the current message on the remote network is completed. Once the current message is complete, the new message is sent.

BID Operation

Under NORMAL operation, any device on the Master's network may communicate to any device on either Slave network. If a device on a Slave network attempts to send a message to a device on the Master's or another Slave's network, the Slave will buffer the message until a BID operation from the Master allows it to send the message.

In a BID operation, the Master temporarily releases its control of the remote network and allows individual Slaves the opportunity to transmit a stored message. A BID message is a special message sent from the Master to the Slave. The Slave has a limited amount of time to send its message.

NOTE: In the EPE5 RNIM Slave, this time is set by the Reply timeout setting. This time is fixed at 2 seconds in the CRM-560.

NOTE: A CRM-560 Slave will not respond to consecutive BIDs within 30 seconds of a successful BID. The EPE5 RNIM Slave does not include this restriction. The EPE5 will respond to any BID if it has a message in its Command buffer.

NOTE: The EPE5 Master will allow Slave to Slave automatic BIDs if the Reply timeout is large enough.

Single Slave BID Operation

When a Master BIDs a Slave, it relinquishes its control of the remote network to the slave. On a CRM-560, a BID is sent by writing the Drop number of the Slave to register 21 of the Master RNIM. On the SPE4 or EPE5, the drop number is written to the setup register for the RNIM Master mode port. When the Slave unit receives a BID, if it has one or more messages in its "buffer" it will transmit that message as though it is a Master. If more than one message is in the buffer, the message that has been in the buffer the longest will be transmitted. After the Slave completes its message transaction, control of the network returns to the Master.

The Slave is allowed to send only one message per BID regardless of the number of buffered messages.

If the Slave has no message to send, it simply ignores the BID and the Master will time out after 2 seconds (CRM-560 Master) or Reply timeout (EPE5 Master).

NOTE: To BID Slave address 00, use the BID address 100.

Automatic BID Operation (100 + n)

It is possible to automatically BID consecutive Slaves by writing the highest Slave drop number plus 100 to the BID register in the Master. The Master will BID the Slave and after a complete message cycle (or timeout), the Master will decrement the drop number by 1 and BID the next slave. This will continue for each drop number until 0 is reached. All drop numbers will be BID regardless if a Slave with that number is present on the network.

For example, if the number 134 is placed in the BID register, the Master will bid unit 34, then unit 33, 32, 31, ... 1, 0.

The BID interval setting is used to control the rate of BIDding. The Reply timeout is used to control the time that the Master waits for a BID to be completed. The Masters timing sequence is as follows:

1   A value is written to the Bid address register.

2   A BID is sent to that address - 100.

3   The Master waits for the Reply timeout amount of time.

4   The Master waits for the BID interval amount of time. All queued NORMAL messages will be sent during the BID interval delay.

5   If the BID address is 100 then the automatic BID ends.

6   The BID address is decremented by one and flow returns to step 2.

If the Master receives a NORMAL message(s) while performing an Automatic BID, the process will be interrupted at the end of the current BID (during the BID interval) and the NORMAL message(s) will be sent. After the NORMAL message(s) is complete (or retries exhausted), the Automatic BID will be resumed.

Automatic BID Operation (200 + n)

It is possible to continuously automatically BID a single Slave by writing the Slave drop number plus 200 to the BID register in the Master. The Master will BID the Slave and after a complete message cycle (or timeout), the Master will BID the Slave again.

For example, if the number 207 is placed in the BID register, the Master will bid unit 07, then unit 07, 07, ...

The BID interval setting is used to control the rate of BIDding. The Reply timeout is used to control the time that the Master waits for a BID to be completed. The Masters timing sequence is as follows:

1   A value is written to the Bid address register.

2   A BID is sent to that address - 200.

3   The Master waits for the Reply timeout amount of time.

4   The Master waits for the BID interval amount of time. All queued NORMAL messages will be sent during the BID interval delay.

5   Flow returns to step 2.

If the Master receives a NORMAL message(s) while performing an Automatic BID, the process will be interrupted at the end of the current BID (during the BID interval) and the NORMAL message(s) will be sent. After the NORMAL message(s) is complete (or retries exhausted), the Automatic BID will be resumed.

Automatic BID Operation (300 + n)

It is possible to continuously automatically BID consecutive Slaves by writing the highest Slave drop number plus 300 to the BID register in the Master. The Master will BID the Slave and after a complete message cycle (or timeout), the Master will decrement the drop number by 1 and BID the next slave. This will continue for each drop number until 0 is reached. After the 00 Slave is BID, the BID restarts at the starting address. All drop numbers will be BID regardless if a Slave with that number is present on the network.

For example, if the number 334 is placed in the BID register, the Master will bid unit 34, then unit 33, 32, 31, ... 1, 0, 34, 33, 32, ... 1, 0, 34, 33, 32,...

The BID interval setting is used to control the rate of bidding. The Reply timeout is used to control the time that the Master waits for a BID to be completed. The Masters timing sequence is as follows:

1   A value is written to the Bid address register.

2   A BID is sent to that address - 300.

3   The Master waits for the Reply timeout amount of time.

4   The Master waits for the BID interval amount of time. All queued NORMAL messages will be sent during the BID interval delay.

5   If the BID address is 300 then the BID address is reset to the initial value.

6   The BID address is decremented by one and flow returns to step 2.

If the Master receives a NORMAL message(s) while performing an Automatic BID, the process will be interrupted at the end of the current BID (during the BID interval) and the NORMAL message(s) will be sent. After the NORMAL message(s) is complete (or retries exhausted), the Automatic BID will be resumed.

Data Store and Forward Operation

In addition to the NORMAL and BID operations, all Slave units can function as a repeater. If a Master is located where it cannot reach a Slave unit because of excessive distance or some other barrier, a Slave that is within reach of the Master and the final target Slave may be used as a repeater.

The STORE and FORWARD feature of the RNIM Slave is used by simply including the drop number of the repeater Slave plus 100 in the route.
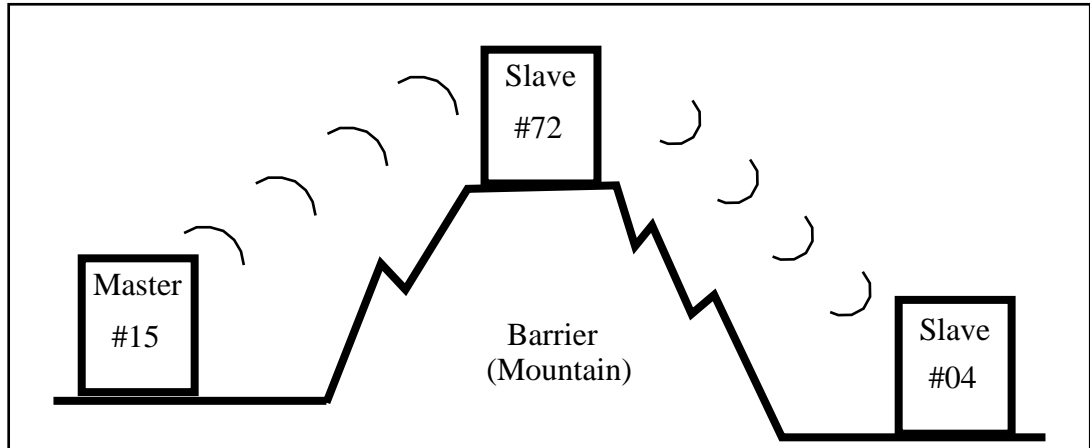
Figure 16-2   RNIM Repeater Example

Figure 16-2 displays an RNIM Master (15) on one side of a mountain, a Slave (04) on the other side of the mountain, and a Slave (72) at the top that can communicate with the other two. If a source on the Master's network (16) wants to send a READ to a PLC (87) on the Slave's network on the other side of the mountain, the route would be: 16, 15, 172, 4, 87.

The repeater unit can still function as a normal Slave if it is the target of the route. For instance, if the same source targets a PLC (21) on the network of the Slave at the top of the mountain, the route would be: 16, 15, 72, 21.

NOTE: It is not possible to perform an indirect BID using the STORE and FORWARD feature of an intermediate Slave.

Broadcast Operation

Due to physical differences between the Square D CRM-560 and EPE5, the Broadcast Operation implementation varies. The EPE5 RNIM Slave will respond equally to either the even or odd Broadcast message that correspond to Table 16-1 and this response will be acting upon the internal registers within the EPE5.

Table 16-1   Broadcast Route Values

	Slave Drop #	CRM-560 Slave Port	EPE5 Response	Broadcast Route Value
General Broadcast	00-99	#1 Twin-ax	Internal Internal	254 253
Partial Broadcast	90-99	#1 Twin-ax	Internal Internal	252 251
	80-89	#1 Twin-ax	Internal Internal	250 249
	70-79	#1 Twin-ax	Internal Internal	248 247
	60-69	#1 Twin-ax	Internal Internal	246 245
	50-59	#1 Twin-ax	Internal Internal	244 243
	40-49	#1 Twin-ax	Internal Internal	242 241
	30-39	#1 Twin-ax	Internal Internal	240 239
	20-29	#1 Twin-ax	Internal Internal	238 237
	10-19	#1 Twin-ax	Internal Internal	236 235
	00-09	#1 Twin-ax	Internal Internal	234 233

If it is desired to route a broadcast message to all EPE5 RNIM Slaves with Drop numbers in the fifties and send a broadcast message our all of the other SY/MAX mode ports on the EPE5, simply use the route number 244 in the position normally held by the Slave address and 254 for the last drop in the route.

Mode 12: RNIM Master

Several operational parameters of the RNIM Master in the EPE5 are adjustable. Table 16-2displays the control registers in the EPE5 and the equivalent registers in the Square D CRM-560. The EPE5 retains the previous setup parameters upon power-up while the CRM-560 always returns to the factory default settings.

It is important that the Master and all Slave units on the same network be set for the same parameter values. If CRM-560s are included in the network, it is important to note that the BID response timeout is fixed at two seconds in the CRM-560 while it is adjustable in the EPE5.

Bit 9 of the Options register for a RNIM Master controls the Enable of the Master. If this bit is set (on), the RNIM Master is disabled. This allows multiple Masters to be connected to the Remote Network for redundancy.

Table 16-2   RNIM Master Register Summary

CRM-560 Register	SPE4/EPE5 Register				Description	Notes
	Port 1	Port 2	Port 3	Port 4		
18	8041	8073	8105	8137	Identification number.	Must be the same for all RNIMs on the same network. CRM-560 defaults to 0 on power-up.
19	8042	8074	8106	8138	Clear to Send (CTS) Delay (10mS units)	CRM-560 defaults to 500mS on power-up.
20	8043	8075	8107	8139	Message Response timeout (10mS units)	CRM-650 defaults to 20 seconds on power-up. The EPE5 also uses this value as the BID timeout.
21	8044	8076	8108	8140	BID address number	00 to 99 Single BID. 100 to 199 Automatic BIDs. 200 to 299 Continuous Single BIDs 300 to 399 Continuous Automatic BIDs.
22	8045	8077	8109	8141	Number of Retries (when no ACK received)	CRM-560 defaults to 3 on power-up.
23	8062	8094	8126	8158	Master Disable	Set bit 9 in the SPE4/EPE5 options register to disable the Master. Set the CRM-560 register to decimal 123 to disable the Master.
25	8058	8090	8123	8155	Pause Time (10mS units)	CRM-560 defaults to 15 seconds on power-up.
26	8059	8091	8124	8156	Message Count (between Pause Time)	CRM-560 defaults to 4 on power-up.
NA	8060	8092	8125	8157	BID Reply Interval	This value determines the amount of time between successive automatic BIDs.
NA	2103	2135	2167	2199	Number of messages in Command Buffer	Read Only Statistic that displays the number of queued messages waiting in the Command buffer.

Mode 13: RNIM Slave

Several operational parameters of the RNIM Master in the EPE5 are adjustable. Table 16-3 displays the control registers in the EPE5 and the equivalent registers in the Square D CRM-560. The EPE5 retains the previous setup parameters upon power-up while the CRM-560 always returns to the factory default settings.

It is important that the Master and all Slave units on the same network be set for the same parameter values. If CRM-560s are included in the network, it is important to note that the BID response timeout is fixed at two seconds in the CRM-560 while it is adjustable in the EPE5.

Bit 9 of the Options Register for a RNIM Slave allows the Command Buffer to be cleared. Set this bit to clear the queued messages. Clear this bit to resume normal operation. The Number of Queued Messages statistic register may be used to determine the number of messages in the Command Buffer.

Table 16-3   RNIM Slave Register Summary

CRM-560 Register	SPE4/EPE5 Register				Description	Notes
	Port 1	Port 2	Port 3	Port 4		
18	8041	8073	8105	8137	Identification number.	Must be the same for all RNIMs on the same network. CRM-560 defaults to 0 on power-up.
19	8042	8074	8106	8138	Clear to Send (CTS) Delay (10mS units)	CRM-560 defaults to 500mS on power-up.
20	8043	8075	8107	8139	Message Response timeout (10mS units)	CRM-650 defaults to 20 seconds on power-up. The EPE5 also uses this value for the BID timeout.
24	8062	8094	8126	8158	Clear Command Buffer	Set bit 9 in the SPE4/EPE5 options register to clear the Command buffer. Set the CRM-560 register to decimal 210 to remove stored commands from the buffer.
NA	2103	2135	2167	2199	Number of messages in Command Buffer	Read Only Statistic that displays the number of queued messages waiting in the Command buffer.

Driver Mode

Pt to Pt

RNIM Master and Slave modes on ports 1-4 of a -1D or -2D modules offer the ability to operate on RS-485 networks in 4-wire and 2-wire modes. When the port is set to Pt to Pt it is in its normal RS-422 mode for point to point operation. This is the default state for the module and it is the only state available on Port 0 and the RS-232 ports. In Pt to Pt mode, the RS-485 transmit drivers are always enabled. Choose Pt to Pt when the Multidrop port is the master on a 4-wire multidrop network.

Half Duplex

RNIM Master and Slave modes on ports 1-4 of a -D module offers the ability to operate on RS-485 networks in 4-wire and 2-wire modes. Half Duplex mode allows the port to ignore any echo that may be returned from the attached device. The Half Duplex mode is the same as the Pt to Pt mode with the exception that the receiver is disabled when the unit is transmitting. The transmit drivers are always enabled.

NOTE: It is recommended that the Half Duplex mode be used with RNIM Multidrop networks such as when the RM14K is being used.

Two Wire

RNIM Master and Slave modes on ports 1-4 of a -D module offers the ability to operate on RS-485 networks in 4-wire and 2-wire modes. Two wire setting allows the port to operate on a 2-wire RS-485 peer-to-peer network. The transmit driver is normally tri-stated and is dependent upon the state of CTS. The receiver is disabled when the transmitter is enabled. The two wire setting sets bits 7 and 8 of the options register for that port.

RTS/CTS Operation

It is important to note that the RTS/CTS operation of the EPE5 RNIM is slightly different than that of the CRM-560. If CTS is not present at the end of the CTS delay, the CRM-560 will post an error message to the originator, while the EPE5 will wait for the attached device to assert CTS. This true handshaking feature of the EPE5 allows the CTS delay setting to be set to the smallest allowable time for the best throughput while allowing a longer than normal handshake response if required. The CRM-560 must be set to the largest delay possible to avoid excessive timeout errors.

The EPE5 handshake sequence is as follows:

1   The EPE5 asserts the Request to Send (RTS) signal when it has data to send.

2   The EPE5 will wait for the CTS delay time and for CTS to be asserted before it will send the data. If the CTS delay time is set for zero, the EPE5 will just wait for CTS to be asserted.

17

Transfer Mode

The Transfer mode is not implemented at this time. This feature will allow re-routing of Ethernet packets to the Primary PLC in a redundant system.

The Transfer mode allows re-routing of SY/MAX messages to the Primary PLC in a redundant system. This feature may be used for re-directing messages through any port but is most useful for Ethernet devices.

> **NOTE:** The Transfer mode is available only on the four serial ports. When a port is in Transfer mode, the actual serial port is disabled and may not be used for external communication.

Incoming command messages routed to the Transfer port have their routes modified by the addition of the Transfer Route to the end of route. The message is then re-routed to the destination directed by the Transfer Route. Reply messages from the destination target have the Transfer Route removed as they are routed through the Transfer port and are then sent back to the original source. The Transfer Route is stored in the Auto-Transfer Route configuration registers for the appropriate serial port.

The "On Ethernet" feature may be used to reduce the number of drops needed in the route.

Transfer Example

Figure 17-1 displays a pair of Model 650 PLCs in a Hot-Backup system, an EPE5, and a computer acting as an operator interface. The Model 650s are controlling a critical system and one is the Primary running the system. The other Model 650 is the Secondary (Standby) unit and upon failure of a component in the Primary, it assumes control and becomes the new Primary.

This oscillation of the Primary usually spells trouble for the Operator Interface (OI). The Model 650's E-net address is fixed by dip switches and it is not able to modify it while running. Therefore, the OI must continuously decide which PLC is the Primary by polling additional registers in the PLC and switch between the two E-net addresses on the transfer of control.

With the Transfer mode in the EPE5, it is possible to set up the OI (and other devices on the network) to poll a single E-net drop and have the EPE5 redirect the messages to the Primary. The OI doesn't care which PLC is the Primary, it always sends its messages to the EPE5.

When the transfer occurs the new Primary sends a TWRITE to the EPE5 to change the "Transfer Route" within the EPE5 to point to its E-net address.
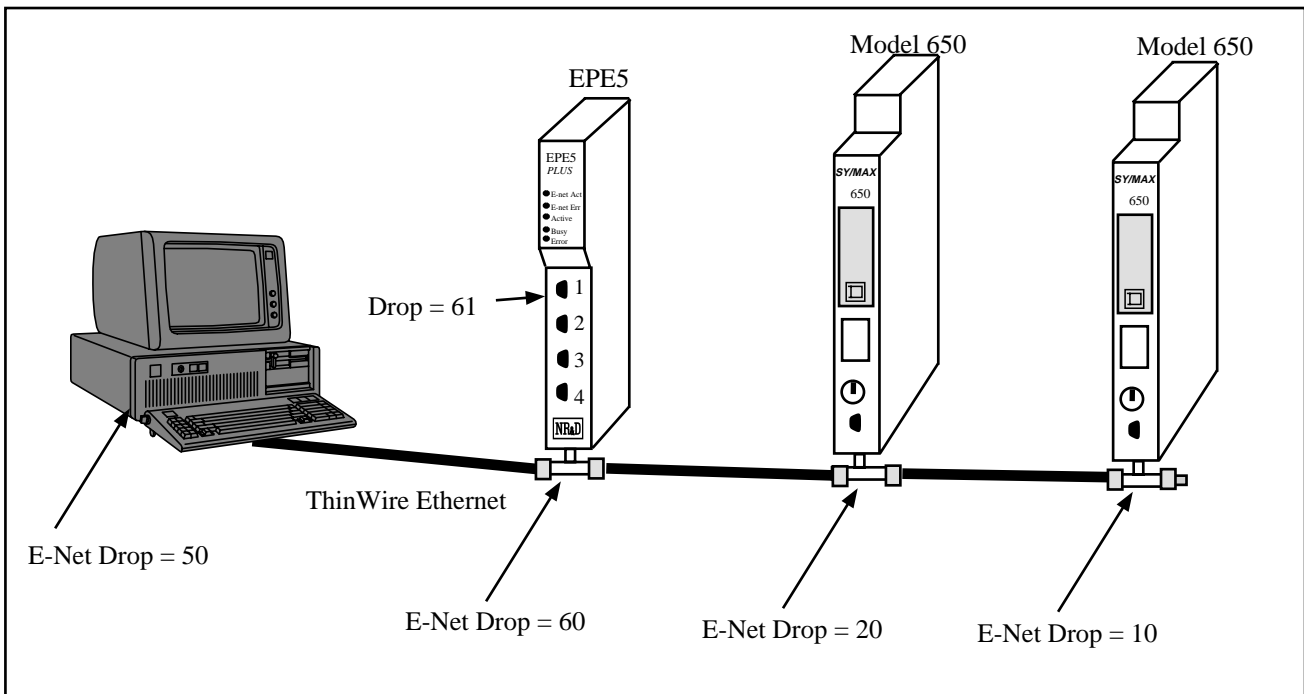
Figure 17-1   Transfer Example 1

The EPE5 Port 1 is set for TRANSFER protocol. The "On Ethernet" feature is set to NO. The Transfer Route will be set to 60, 20 when the left Model 650 is Primary and 60, 10 when the right 650 is Primary. The route from the OI will always be 50, 60, 61 to reach the Primary.

The Transfer Route for Port 1 is stored in registers 8046 through 8054 in the EPE5. Register 8046 contains the number of drops in the route to the Primary from the Transfer port. The registers following contain the 8 drops of the route.

Table 17-1   Transfer Route Registers

MEB Register	Description	Settings for 20 as Primary	Settings for 10 as Primary
8046	# of drops in route	2	2
8047	Drop 1	60	60
8048	Drop 2	20	10
8049	Drop 3	0	0
8050	Drop 4	0	0
8051	Drop 5	0	0
8052	Drop 6	0	0
8053	Drop 7	0	0
8054	Drop 8	0	0

When the hot-backup transfer occurs and the old Secondary becomes the new Primary, the new Primary writes its own Ethernet address to EPE5 register 8048. It is usually important to write the application in a redundant system such that both PLCs run the exact same program. Register 8093 in the Model 650 contains the 650's Ethernet drop number.

NOTE: The value in EPE5 register 8046 sets the number of drops in the Transfer Route for Port 2. Since it is set to 2 in this example, it doesn't matter what the values are in registers 8049 through 8054.

PLC Ladder Rungs

Both Model 650s could have the following ladder rungs in their programs to perform the communications switch.

```
   8161                                                              000x
 ---| |------------------------------------------------------( )---|
   -20                                                              -0x

   000x                        +-------ROUTE-ROUTE-STAT-LOCAL-REMOTE-COUNT-+
 --| |---------------------TWRITE3  201    60   S222 S8093 S8048     1    |
   -0x                         +-----------------------------------------+
```
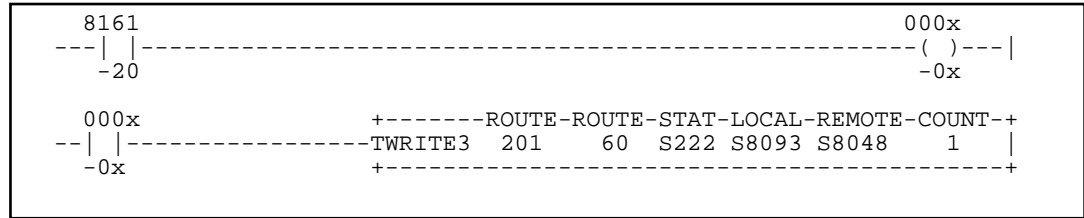
Figure 17-2 Transfer Communication Rungs

As the backup PLC assumes the role of Primary, status bit 8161-20 is set to 1 (ON) by the LTI. This energizes coil 000x-0x. Upon scanning this contact in rung 2, the TWRITE is executed. The first drop in the route is set to the special "don't care" drop number 201. The second drop in the route is set for the EPE5's E-net port of 60. The STAT register is a unique communication status register within the PLC. The LOCAL register contains the Ethernet SY/MAX drop number of the PLC. The REMOTE register is the target in the EPE5 for the write. And finally, the COUNT is set to 1 because only one register needs to be sent.

With the use of the 201 route and registers 8093, the above rungs become generic and may be used in both PLCs.

> # CAUTION
>
> Do not attempt to program the Primary PLC through the Transfer route. A system transfer could occur during the program load and cause the program to load incorrectly. Programming should always be performed directly to the PLC's E-net address.

"On Ethernet" Example

The above example could be changed to use the "On Ethernet" feature of the Transfer port to reduce the number of drops in the routing. The following changes would take place:

- The "On Ethernet" option would be set to YES for Port 1 of the EPE5.

- The value in R[8046] would need to be changed to 1 since there will only be one drop in the Transfer Route.

- The remote register in the ladder logic TWRITE would now need to be 8047 to place the target Model 650 address in the first drop of the Transfer Route.

- The Route from the OI is now simply 50, 61

- Extra care must be used to avoid setting one of the drop numbers of a port in the EPE5 to a potential target of the Transfer Route to avoid routing errors.

18
Chevron Mode

The Chevron mode is a combination of the RNIM Master and Modbus Gate modes to allow the integration of remote SY/MAX and Modbus devices on the same multidrop (RS-485, modem, or radio) network. Incoming messages with the drop number following the Chevron Port's drop number within the range of 0 through 99 are sent out as RNIM packets. Messages with the following drop in the range of 100 through 199 are sent out as Modbus RTU packets where the Modbus slave address is 100 minus the drop number.

All SY/MAX messages are supported through the RNIM messages structure including PLC programming. Also, all Modbus RTU messages are supported including PLC programming. All RNIM Slave devices may be used in a Chevron network including CRM-560 RNIMs, SPE4s, EPE5s, and MEBs. Any Modbus RTU slave device with active RTS/CTS handshaking (or multidrop RS-485 ports) may also be used in a Chevron network as a Slave.

NOTE: The POWERLOGIC PNIM protocol supported by most POWERLOGIC equipment is a subset of the RNIM protocol and thus the CHEVRON mode may be used to integrate POWERLOGIC and MODBUS equipment on the same RS-485 network. Simply set the NETWORK ID to 0 and set the CTS DELAY to 0.

The following restrictions apply to the Chevron mode:

- All devices (RNIM and Modbus) must operate with the serial parameters. Typically this will be 9600 baud, 8 data bits, 1 stop bit, and EVEN parity.

- All Modbus Slave PLCs must not be in "Bridge" mode if they are also on a Modbus Plus network. The Slave devices must not respond to Modbus messages are not targeted to their address. PLCs in Bridge mode pass messages onto the Modbus Plus network which may result in multiple replies from different units and/or error replies from non-existent units.

- Modbus address 16 decimal (10 hex) may not be used. It is possible that unit 16 would try to respond to the RNIM messages.

- RNIM repeater features are not allowed. Drop numbers greater than 100 will be sent as Modbus RTU messages and not RNIM repeater routes.

- The Chevron port operates as a Modbus Gate mode as a master only. The port will not accept messages as a Modbus Slave.

- The values for the CTS timer, Pause Time, and Message Count are used for both Modbus and RNIM messages.

- The Modbus messages do not retry if a response is not received before the Reply Timeout. RNIM messages follow the normal retry mechanism of the standard RNIM Master.

- Like a normal RNIM network, all RNIM devices must use the same Network ID.

- RNIM BIDding and automatic BIDding is permitted and operates like a normal RNIM Master port.
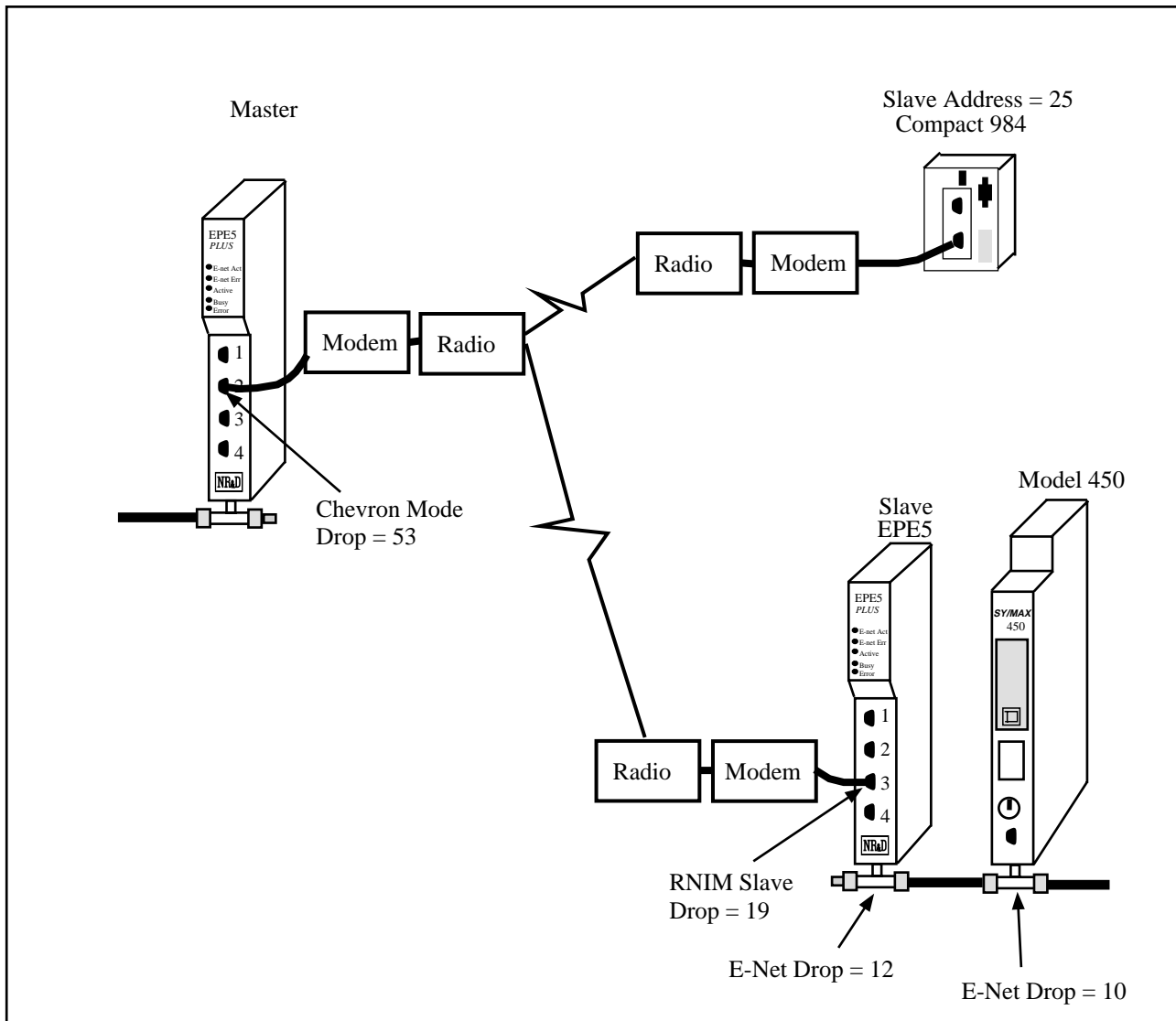
Figure 18-1   Chevron Radio Example

An example application of the Chevron mode is displayed in Figure 18-1. The Master EPE5 on the left has Port 2 in Chevron mode with a drop number of 53. This port is connected via radio modems to another EPE5 and a Compact 984 PLC. The remote EPE5 has its Port 3 set for RNIM Slave with a drop number of 19. The Compact 984 is configured for RTU mode with and address of 25.

To route to the Model 450, the portion of the route from the Master EPE5 would be:

..., 53, 19, 12, 10

while the route to the Compact 984 from the Master EPE5 would be:

..., 53, 125

Notice that the Modbus device was accessed by adding 100 to its slave address.
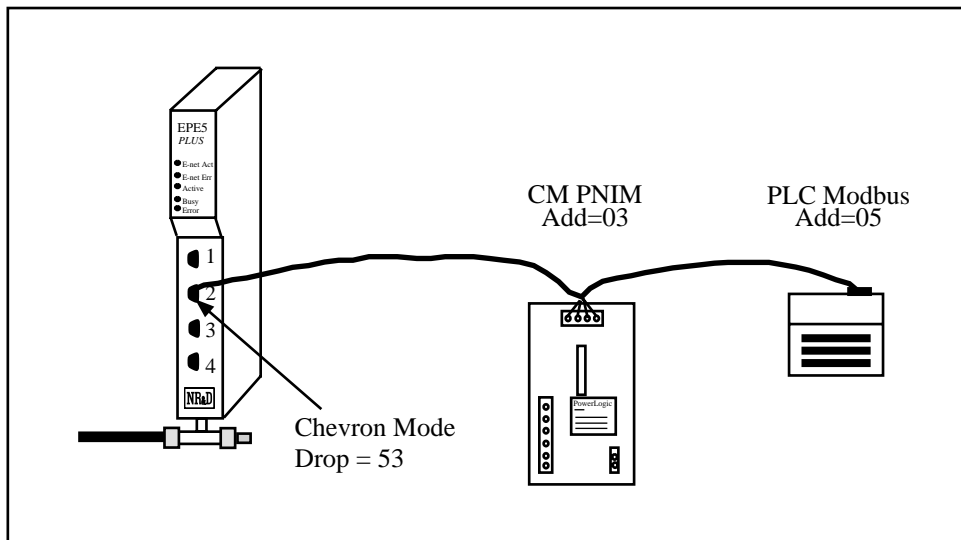
Figure 18-2 Chevron POWERLOGIC Example

An example application of the Chevron mode is displayed in Figure 18-2. The EPE5 has Port 2 in Chevron mode with a drop number of 53. This port is wired with a 4-wire RS-485 cable to a POWERLOGIC Circuit Monitor and a Momentum PLC. The CM is configured for PNIM Address 03 while the PLC is at Modbus RTU Address 05.   All three devices are configured for the same baud rate, paritye, data bits, and stop bits (9600,EVEN,8,1). The PLC has its 9-pin port confgured for RS-485.

The setup for the CHEVRON port is as follows:

Table 18-1   POWERLOGIC CHEVRON Example

Setting	Value
Drop	53
On Ethernet	NO
Protocol	CHEVRON
Baud Rate	9600
Parity	EVEN
Data Bits	8
Stop BIts	1
Buffer Limit	16
Driver Mode	PT TO PT
Network ID	0
CTS Timer	0
Reply Timeout	200
Bid Interval	0
Attempts	1
Pause Time	0
Message Count	0
Bid Address	0

To route to the CM, the portion of the route from the Master EPE5 would be:

                    ..., 53, 03

while the route to the Momentum PLC from the Master EPE5 would be:
..., 53, 105

Notice that the Modbus device was accessed by adding 100 to its slave address.

19
Dual Slave Mode

The Dual Slave mode is a combination of the Modbus Gate and SY/MAX modes to allow a single-threaded master connected to the port to use either Modbus RTU or SY/MAX to route through the port. This mode is most useful with POWERLOGIC's SMS's "SY/MAX to NIM/PNIM" serial driver since it will route messages targeted to both POWERLOGIC and MODBUS devices through a single communications port. This mode is also useful when a single connection from a computer is needed for running both SY/MAX and Modicon PLC programming softwares at different times.

There are a few limitations imposed by the Dual Mode:

- The device attached to the port must be the communication Master; it must initiate the communication.

- The connected Master must only issue one message at a time. SY/MAX messages will eventually return either a data reply or an error reply and the Master should wait for that reply. Modbus messages may or may not receive a reply and the Master should wait an appropriate amount of time before generating the next query.

- SY/MAX messages are routed just like a normal SY/MAX port. The first drop in the route should be either the drop number of Dual Mode port or the special "Don't Care" drop of 201. No route will result in local access of the Module.

- The Modbus Routing table is used for routing the Modbus messages just like in Modbus Gate mode. A drop number of 255 will always result in local access of the Module.

- Modbus Slave address 16 (decimal) and 254 (decimal) are not supported and should not be used in the Modbus Routing Table.

SMS Example

POWERLOGIC System Manager Software supports Modbus RTU devices as well as SY/MAX (POWERLOGIC Compatible) devices. When both Modbus and SY/MAX devices are configured within SMS to use the same serial communications port of the PC, SMS will send both the SY/MAX and Modbus messages out the serial port even if the port is configured only for SY/MAX mode. The Dual Mode now allows the EPE5 to accept both types of messages on a single serial connection.

NOTE: The "Communications Wiring" setting within SMS must be set for "SyMax to NIM/PNIM" Do not choose "PowerLogic/Modbus/Jbus (4-Wire)" because the SY/MAX routing will not work.

NOTE: This example is to demonstrate the operation of the Dual Slave mode. See page ??? for this example using the Modbus/TCP features of the EPE5 and SMS.
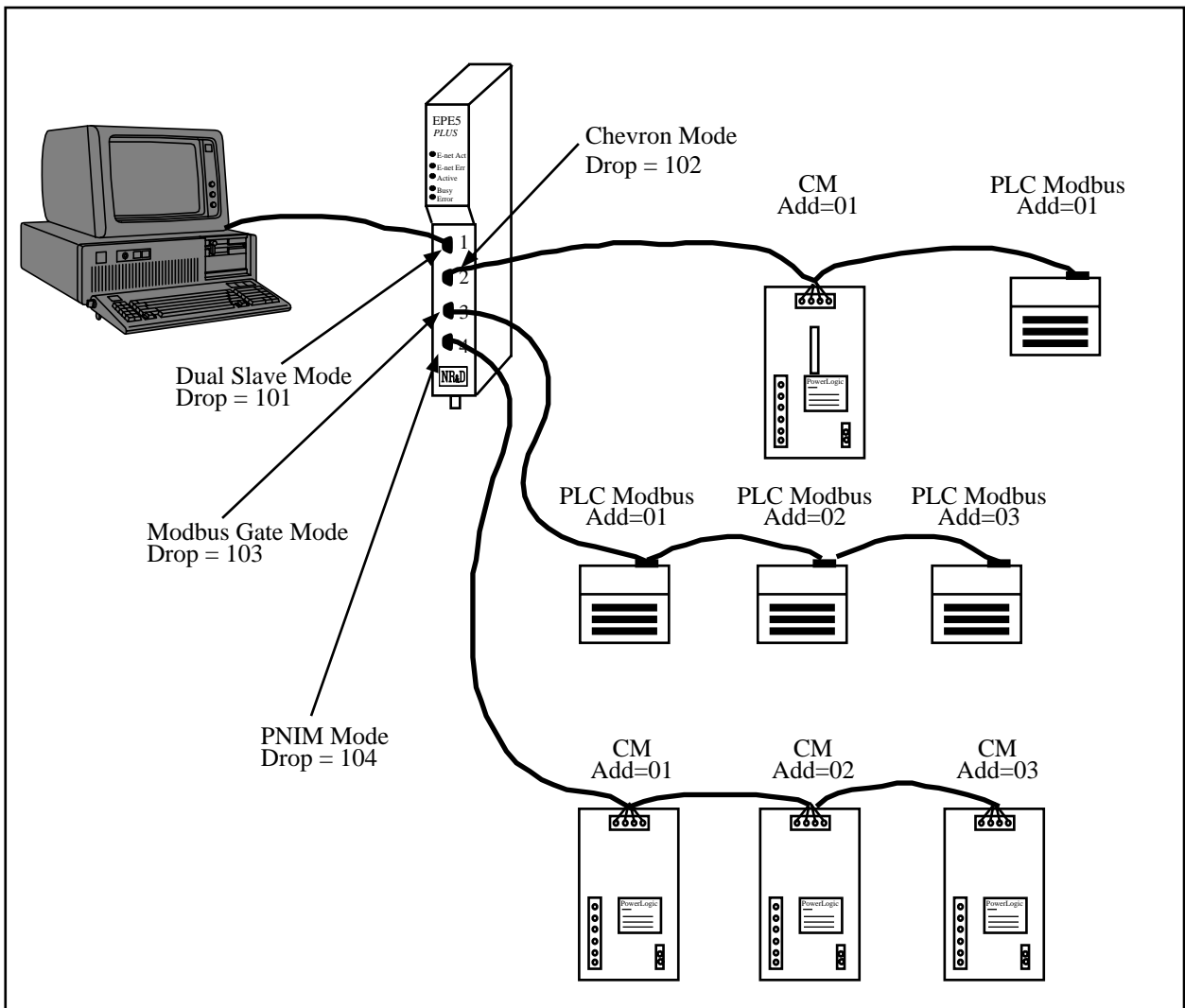
Figure 19-1   Dual Slave SMS Example

An example application of the Dual Slave mode is displayed in Figure 19-1. The EPE5 has Port 1 in Dual Slave Mode with the SMS computer connected through an NR&D SC902 cable. Port 2 is in Chevron mode with a Circuit Monitor and a Momentum PLC. Port 3 is in Modbus Gate Mode with three Momentum PLCs. Port 4 is in PNIM mode with three Circuit Monitors.

Table 19-1   POWERLOGIC Example DUAL SLAVE Port

Setting	Value
Drop	101
On Ethernet	NO
Protocol	DUAL SLAVE
Baud Rate	9600
Parity	EVEN
Data Bits	8
Stop BIts	1
Buffer Limit	16

Table 19-2   POWERLOGIC Example DUAL SLAVE Port Modbus Routing

ADDR	DEVICE	ROUTE
1	MODBUS	101,102,101
2	MODBUS	101,103,1
3	MODBUS	101,103,2
4	MODBUS	101,103,3

Table 19-3   POWERLOGIC Example CHEVRON Port

Setting	Value
Drop	102
On Ethernet	NO
Protocol	CHEVRON
Baud Rate	9600
Parity	EVEN
Data Bits	8
Stop BIts	1
Buffer Limit	16
Driver Mode	PT TO PT
Network ID	0
CTS Timer	0
Reply Timeout	200
Bid Interval	0
Attempts	1
Pause Time	0
Message Count	0
Bid Address	0

Table 19-4   POWERLOGIC Example Modbus Gate and PNIM Ports

Setting	Port 3 Value	Port 4 Value
Drop	103	104
On Ethernet	NO	NO
Protocol	MODBUS GATE	PNIM
Baud Rate	9600	9600
Parity	EVEN	EVEN
Data Bits	8	8
Stop BIts	1	1
Buffer Limit	16	16
Driver Mode	PT TO PT	PT TO PT
Reply Timeout	200	200
Transfer Interval	0	0
Transfer Route	NONE	NONE
Read Count	0	0
Read From	0	0
Read To	0	0
Write Count	0	0
Write From	0	0
Write To	0	0

Table 19-5   POWERLOGIC Example SMS Communications Connection - Serial

Setting	Value
Connection Name	Com1
Communications WIring	SyMax to NIM/PNIM
Parity	Even
Using Modem	NO (Not Checked)
Serial Port	COM1
Baud Rate	9600
Attempts	2
Timeout	5000mS
Network Address	30

Table 19-6   POWERLOGIC Example SMS Setup Devices/Routing

Setting	CM 1 on Port 2	PLC 1on Port 2	PLC 1 on Port 3	PLC 2 on Port 3	PLC 3 on Port 3	CM 1 on Port 4	CM 2 on Port 4	CM 3 on Port 4
Device	CM_1	MOM_1	MOM_2	MOM_3	MOM_4	CM_2	CM_3	CM_4
Connection Name	Com1	Com1	Com1	Com1	Com1	Com1	Com1	Com1
Protocol	PowerLogic	Modbus	Modbus	Modbus	Modbus	PowerLogic	PowerLogic	PowerLogic
Phone Number								
RT 1	30	30	30	30	30	30	30	30
RT 2t	101	1	2	3	4	101	101	101
RT 3	102					104	104	104
RT 4	1					1	2	3
RT 5								
Rt 6								
RT 7								
RT 8								

PLC Programming Example

Model 400

SY/MAX Mode
Drop = 102

Dual Slave Mode
Drop = 101

Modbus Gate Mode
Drop = 103

PLC Modbus
Add=01

PLC Modbus
Add=02

PLC Modbus
Add=03
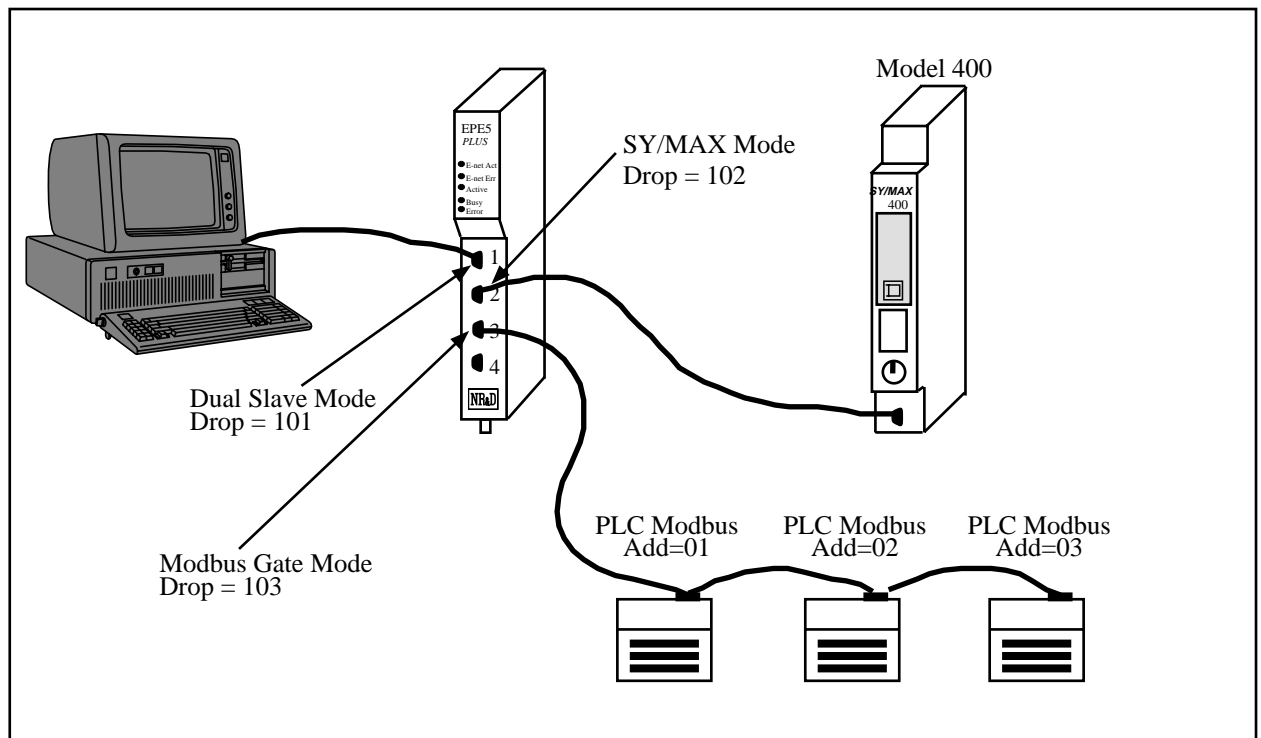
Figure 19-2   Dual Slave PLC Programming Example

Another example application of the Dual Slave mode is displayed in Figure 19-2. The EPE5 has Port 1 in Dual Slave Mode with the PLC Programming computer connected through an NR&D SC902 cable. Port 2 is in SY/MAX mode with a Model 400 PLC. Port 3 is in Modbus Gate Mode with three Momentum PLCs. This setup allows the computer to run either the SY/MATE programming software or a Modicon programming software (Modsoft, ProWorks, Concept) without changing the cabling or EPE5 port setup.

Table 19-7   PLC Programming Example DUAL SLAVE Port

Setting	Value
Drop	101
On Ethernet	NO
Protocol	DUAL SLAVE
Baud Rate	9600
Parity	EVEN
Data Bits	8
Stop BIts	1
Buffer Limit	16

Table 19-8   PLC Programming Example DUAL SLAVE Port Modbus Routing

ADDR	DEVICE	ROUTE
1	MODBUS	101,103,1
2	MODBUS	101,103,2
3	MODBUS	101,103,3

Table 19-9   PLC Programming Example SY/MAX and Modbus Gate Ports

Setting	Port 2 Value	Port 3 Value
Drop	102	103
On Ethernet	NO	NO
Protocol	SY/MAX	MODBUS GATE
Baud Rate	9600	9600
Parity	EVEN	EVEN
Data Bits	8	8
Stop BIts	1	1
Buffer Limit	16	16
Error Check	BCC	N/A
Route Appendix	NONE	N/A
Route Replacement	OFF	N/A
Driver Mode	N/A	PT TO PT
Reply Timeout	N/A	200
Transfer Interval	0	0
Transfer Route	NONE	NONE
Read Count	0	0
Read From	0	0
Read To	0	0
Write Count	0	0
Write From	0	0
Write To	0	0

Table 19-10 PLC Programming Example SY/MATE Settings

Setting	Value
Comm. Device	COM1
Resp. Time (sec)	003
Retries	03
Route	101 102
ASCII ID	
Baud Rate	9600
Parity	EVEN
Error Checking	BCC

Table 19-11 PLC Programming Example Modsoft Settings

Setting	PLC 1	PLC 2	PLC 3
Address	1	2	3
Protocol	Modbus I	Modbus I	Modbus I
Mode	RTU	RTU	RTU
Data Bits	8	8	8
Parity	EVEN	EVEN	EVEN
Stop Bits	1	1	1
Baud	9600	9600	9600
Device	COM1	COM1	COM1

20

Auto-transfer and Auto-Scan

The EPE5 has the ability to originate READ and WRITE messages on a timed interval using the Auto-transfer and Auto-Scan features. The READ messages move information from an external device to the EPE5's internal mailbox registers. The WRITE messages move information from the EPE5's mailbox registers to an external device.

Auto-Transfer

The Auto-transfer is available on the serial ports in the following protocol modes: SY/MAX, NET-to-NET, IDEC, Modbus Host, Modbus Gate, PLOGIC, and PNIM. The use of Auto-transfer in Modbus modes implies that the EPE5 port is the Master. The Auto-transfer feature is available on the Ethernet port as long as the E-PEER feature is disabled.

The Auto-transfer has the ability to perform a single READ and/or WRITE with a single fixed route to the target device on a timed interval. Adjustable parameters include:

- Transfer Interval - This value sets the amount of time between successive messages in 10mS units. If only READs or only WRITEs are enabled, this interval determines the amount of time between the sending of each messages. If both READs and WRITEs are enabled, the READs and WRITEs are alternated. For example if both READs and WRITEs are enabled and the Transfer Interval is set to 100, then a READ will be sent, one second later a WRITE will be sent, one second later a READ will be sent...etc.

  The Transfer Interval should be set to a large enough number to allow a message to be sent and the response to be received before the next message is sent. If the Transfer Interval time has expired and the reply from a previous poll has not been received, that EPE5 port will insert a delay of two seconds before the next transfer. It is good practice to allow for at least three times the actual transmission time of the command and reply message for retries and additional network traffic. A Transfer Interval of zero (0) will disable the Auto-transfer.

- Transfer Route - The Transfer Route determines the path to the target device. The first drop in the route is usually the drop number of the Auto-transfer port. Additional drops are used to point to the specific target. For example, if a PNIM port has a drop number of 125 and the target of the Auto-transfer is Circuit Monitor 4 then the route would be 125,004.

- READ Count - The READ Count determines the number of registers returned by the READ. The maximum Count is 128 for SY/MAX messages. A setting of zero (0) disables the Auto-transfer READ.

- READ From - The READ From value is the starting register for the read in the remote device.

- READ To - The READ To value is the starting register for where the data from the external device is placed in the EPE5's mailbox registers. This value must be within the range of 1 through 2048.

- WRITE Count - The WRITE Count value is the number of registers transferred from the EPE5's Mailbox registers to the external device. The valid range is 0 through 128 where 0 disables the WRITE transfer.

- WRITE From - The WRITE From value is the starting register in the EPE5's Mailbox from which the data is sent to the external device.

- WRITE To - This value is the starting point in the external device where the data is written.

Auto-Scan

The Auto-Scan is an enhancement of the Auto-transfer feature to allow up to 48 independent READs or WRITES to be operated on external devices. Each serial port on the EPE5 includes its own Auto-Scan table. The Auto-Scan feature is not available on the Ethernet port. Each entry in the Auto-Scan table is configured for its own local, remote, count, read or write type, and route parameters.

- TRANSFER INTERVAL - This value sets the amount of time between successive non-empty messages in 10mS units. The Transfer Interval should be set to a large enough number to allow a message to be sent and the response to be received before the next message is sent. If the Transfer Interval time has expired and the reply from a previous poll has not been received, that EPE5 port will insert a delay of two seconds before the next transfer. It is good practice to allow for at least three times the actual transmission time of the command and reply message for retries and additional network traffic. A Transfer Interval of zero (0) will disable the entire Auto-Scan table.

- LOCAL - The local value is a pointer to a register in the EPE5's mailbox. On READ operations, this register is the starting register where the data from the external device is placed upon completion of the read. On WRITE operations, this is the starting point of the data from the EPE5 to the external device. The valid range of this parameter is 1 through 2048. A setting of zero will disable an individual Auto-Scan entry.

- REMOTE - The remote value is a pointer to a register in the external device. On READ operations, this is the starting register in the remote device. On WRITE operations, this is the starting register for the data from the EPE5. The valid range of this parameter is 1 through 8192. A setting of zero will disable an individual Auto-Scan entry.

- COUNT - The count value determines the number of registers to be included in the READ or WRITE. The valid range is normally 1 through 128. A setting of zero will disable an individual Auto-Scan entry.

- DIRECTION - The direction determines whether the operation will be a READ (from the external device to the Mailbox) or a WRITE (from the Mailbox to the external device).

- ROUTE - The Route determines the path to the target device. The first drop in the route is usually the drop number of the Auto-Scan port. Additional drops are used to point to the specific target. For example, if a PNIM port has a drop number of 125 and the target of the Auto-Scan is Circuit Monitor 4 then the route would be 125,004.

Notice: The Auto-Scan feature uses the Timer Interval from the Auto-transfer feature so therefore the Auto-transfer feature is disabled if a valid entry in the Auto-Scan is found by the EPE5. In order to be classified as a valid entry, the local, remote, count and route entries must be non-zero and fall within their respective valid ranges.

Notice: The Auto-Scan feature uses the route table from the Modbus Slave Table for a given serial port. If the Auto-Scan feature is enabled on a Modbus mode port, that port will be a Master and Slave operation will not be allowed.

Auto-Scan Status

The Auto-Scan feature includes the option of having a group of three mailbox registers to display the status of each Auto-Scan entry. Each Auto-Scan entry has a status bit which is set if the scanned message has a successful reply and cleared if the scan entry is disabled or an error occurs in the reply. The

first Status register is for Scan entries 1 through 16, the second register is for entries 17 through 32 , and the third Status register is for entries 33 through 48.

Auto-Scan Watchdog

The Auto-Scan feature includes a watchdog option that can turn off autoscan entries in specific ports when a user-specified timer expires. This option is only available in firmware revision 19JUN01, or later. Two registers control this option: 8189 and 8190. Register 8190 is the bitmask register. The first (least significant) five bits control each of the ports. Bit one (LSB) controls port 0, bit two controls port 1, etc. When any of these bits is set high, the corresponding port is affected by the watchdog timer. The timer register, 8189, can be set by any outside device. The decimal value written will indicate the time in 10 ms increments. The time will immediately begin to count down to 0, unless a new number is rewritten to the timer register. If the timer reaches 0, all autoscans on the specified ports will be discontinued, and the status bits, if any, will be set to zero. Since this option is designed to take effect in the event of a communications loss, the affected ports will also be shut down in the event of a power cycle. When the EPE5 reboots, register 8189 will be reset to 0.

Auto-Scan Watchdog Example
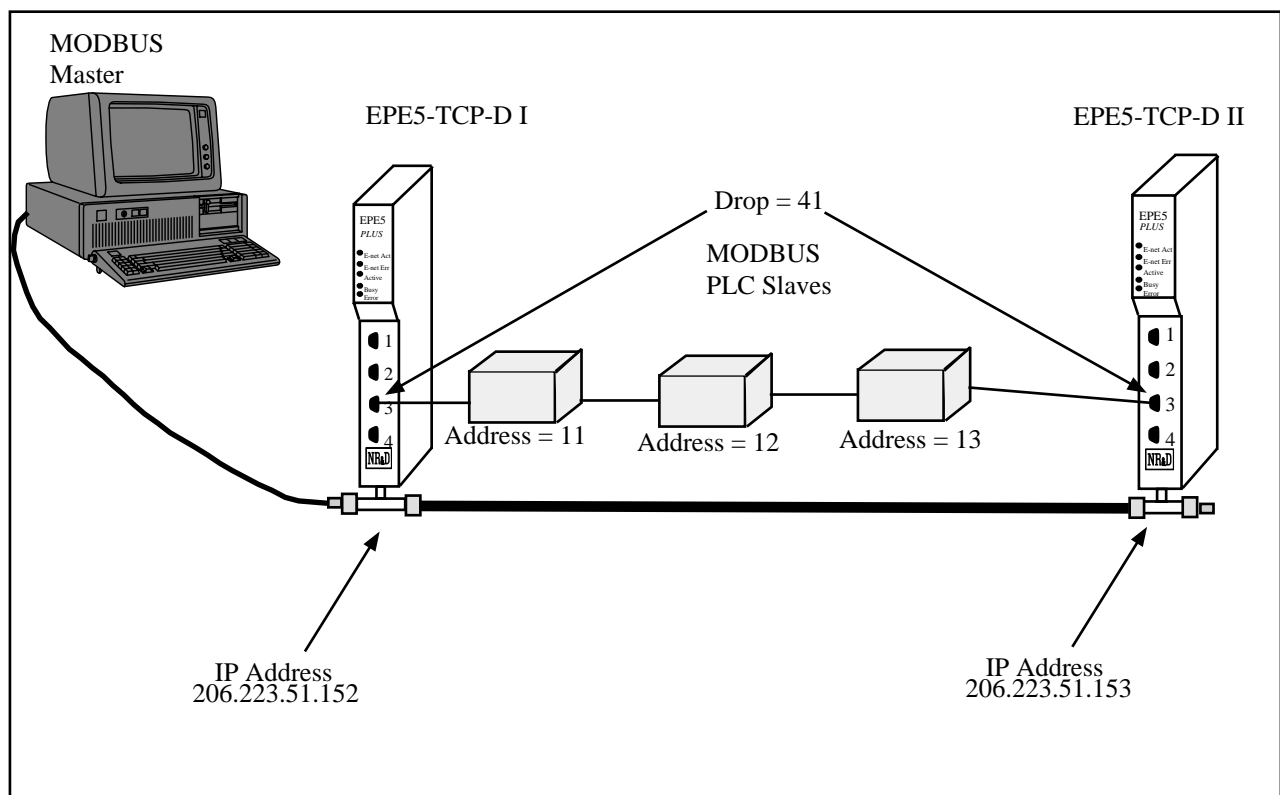
Figure 20-1   Auto-Scan Watchdog Example

In this example, an HMI package is monitoring registers that have been Auto-Scanned by EPE5 I. The HMI is constantly writing a decimal value of 500 to register 8189. The HMI is also monitoring the status register for the Auto-Scans. If the value of the status register is ever zero, or if the HMI loses communication to EPE5 I, the HMI must wait five seconds, then begin continuously writing decimal 500 to EPE5 II. Waiting five seconds will allow the timer in EPE5 I to run out, and there will be no conflicting queries on the serial line. As can be seen in the tables below, the Auto-Scan tables for both EPE5's are exactly the same, so only one should be Auto-Scanning at any given time.

Note: Since the Auto-Scan table uses the same routing registers as the Modbus Routing table, the programmer must be careful to select slave ID's that will be higher than the last entry in the Auto-scan table. Otherwise, the EPE5 not Auto-Scanning would reply to the master's queries.

Table 20-1   Auto-Scan Entries for both EPE5'

Entry	Local	Remote	Count	Direction	Route
1	4	1	10	Read	41,11
2	14	1	10	Read	41,12
3	24	1	10	Read	41,13

21

E-PEER Mode

Niobrara EPE5 (and MEB) Ethernet port expanders with firmware revision 21Apr95 or later are equipped with a peer-to-peer feature that allows a number of EPE5 units to distribute a range of rack-addressed registers among themselves. This feature is similar to the Sy/Peer feature of the Square-D model 600. In comparison, Sy/Peer is higher in performance and can synchronize the scan of the linked PLCs but the EPE5 is more flexible and uses standard Ethernet protocols so can be mixed with a small amount of ordinary traffic. For instance, PLCs can be programmed over the same cabling that carries the EPE5 peer-to-peer traffic. The EPE5 peer mode is faster than ordinary Sy/Net 802 operations because all nodes in the network are updated by a single multicast Ethernet packet instead of individual write transactions.

To design an EPE5 peer network, determine how many registers each node will provide (broadcast) to the other nodes, the number of nodes, the total number of registers involved and the required update interval. Unlike Sy/Peer, the EPE5 network is not restricted to broadcasting the same number of registers from each node, nor does the number of registers broadcast need to be a power of two. Any number of registers from 1 to 128 can be broadcast by any node. For an example, let us assume a network of eight EPE5 equipped nodes each transmitting 50 registers. This is a total of 400 registers that would be rack-addressed to each EPE5 unit.

Each node is assigned a node number, in this case 1 through 8. This node number is not related to the Sy/Net 802.3 drop number of the EPE5. For our example, let us imagine that the register map of each EPE5 looks like this:

Table 21-1   E-PEER Register List Example

EPE5 Registers	Supplying Node
1..50	1
51..100	2
101..150	3
151..200	4
201..250	5
251..300	6
301..350	7
351..400	8

Write the following values to the setup registers in each EPE5:

Table 21-2   E-PEER Example Setup

EPE5 Register	Function	Example Value
8026	Number of peer nodes	8
8012	Number of this node	1 through 8
8013	Start of register range to transmit	(R[8012] - 1) * 50 + 1
8027	Number of registers to transmit	50
8028	Destination register (in other peers)	same as R[8013]
8011	Update interval in milliseconds	24 (3mS per node)
8030	Bit 6 enables E-PEER operation	32

Rack address 400 registers to the EPE5 in each PLC rack.

The bits of read-only register 3303 correspond to those of the first sixteen nodes in an EPE5 peer network which are active. If unit x is active on the network, bit x is set. If node x is powered off, disconnected from the cable, or otherwise disabled, bit x will be cleared. Loss of one node has no effect on the timing of the other nodes. They will detect the absence of the node and clear the corresponding bit in their register 3303. If the peer network has more than sixteen nodes, node numbers 17 and beyond have no associated active bit.

The update interval should be selected depending on system requirements and PLC scan time. As a rule of thumb, don't attempt to update faster than 1 or 2 milliseconds per node. There is no point in updating the peer-to-peer network much faster than the PLC can scan, but bear in mind that there is no synchronization between PLC scanning and peer-to-peer updating. Attempting to update too many registers too fast will result in Ethernet collisions that will reduce the throughput of the network and render it non-deterministic. Check the collision statistics (register 2066 and 2067) to determine if your update rates are too ambitious or consult Niobrara for maximum update rates for a given system design. Use the Ethernet packet counters (registers 2064 and 2065) and a stopwatch to verify that throughput is what you expect. Note that no acknowledge packet is sent for EPE5 peer operations and it is your responsibility to avoid overloading the available throughput.

With no other traffic on the cable, the network will operate deterministically. Each node will time its register broadcast to occur in its time slot. Depending on the amount of network bandwidth and processing resources used up by the peer-to-peer transmissions, non-peer traffic (i.e. Sy/Max programming or reads and writes) can cause a temporary loss of deterministic behavior. This is not usually a problem when the network is being used to program the PLCs. Peer operations have priority over other EPE5 transactions.

As of 5 June, 1995 it is possible to set up an EPE5 to receive E-Peer broadcasts without transmitting any. Any number (up to Ethernet limits) of EPE5 units may listen to one or more broadcasting units. To configure a listen-only E-Peer node, set bit 6 of register 8030 to 1 and set register 8012 (number of this node) to 0. An EPE5 with 8030.6 clear will ignore E-Peer broadcasts but, like any IEEE 802 compliant device, can coexist on the Ethernet with E-Peer configured units. A receive-only or non E-Peer unit is not counted in the number of nodes programmed into register 8026 of the E-Peer units.

The E-Peer parameters may be easily configured within EPE5SW. See page 138 for more information.

Figure 21-1 displays the timing relationship for an E-peer network with three nodes, A, B, and C. Notice that the Update Interval is based upon the time between broadcasts of the same unit.
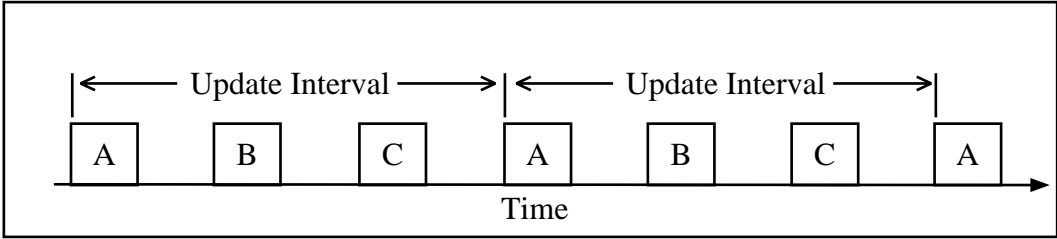
Figure 21-1 E-PEER Update Interval Timing

22

On Ethernet Option

NOTE: The "On Ethernet" option only works in SY/MAX 802.3 mode. It is ignored in the TCP/IP protocol modes.

Each of the serial ports have the option of being mapped to the Ethernet as a "Virtual E-Net Node". This feature is called "On Ethernet". By placing the drop numbers of the serial ports or Modbus Plus ports on the Ethernet, the number of drops in the Route may be reduced. This may be especially helpful in cases of Net-to-Net, Modbus, and PowerLogic protocol modes.

The EPE5 treats ports with the "On Ethernet" option set with the following rules:

- Messages arriving at serial ports have their routes inspected to determine if the next drop in the route is one of the other ports in the EPE5. If the next drop number matches another port in the module then the message is routed to that port.

- Messages arriving at serial ports with the next drop number not in the Module are routed out of the Ethernet port as the next drop is assumed to be on the E-Net.

- Ethernet Messages routed to the standard E-Net port are routed as normal.

- Ethernet Messages targeted to an "On Ethernet" port are immediately sent out the appropriate port.

- The SY/MAX Ethernet addresses are limited to the range 00 through 99. "On Ethernet" drop numbers in the range 100 through 199 will appear on the E-Net as the drop number - 100.   For example, if drop 154 is placed "On Ethernet" then the EPE5 will place the drop number 54 on the Ethernet. Thus messages routed to the E-Net address 54 and 154 will both be processed by the same EPE5. This feature may be used to reduce the number of E-Net drop numbers consumed by "On Ethernet" ports.
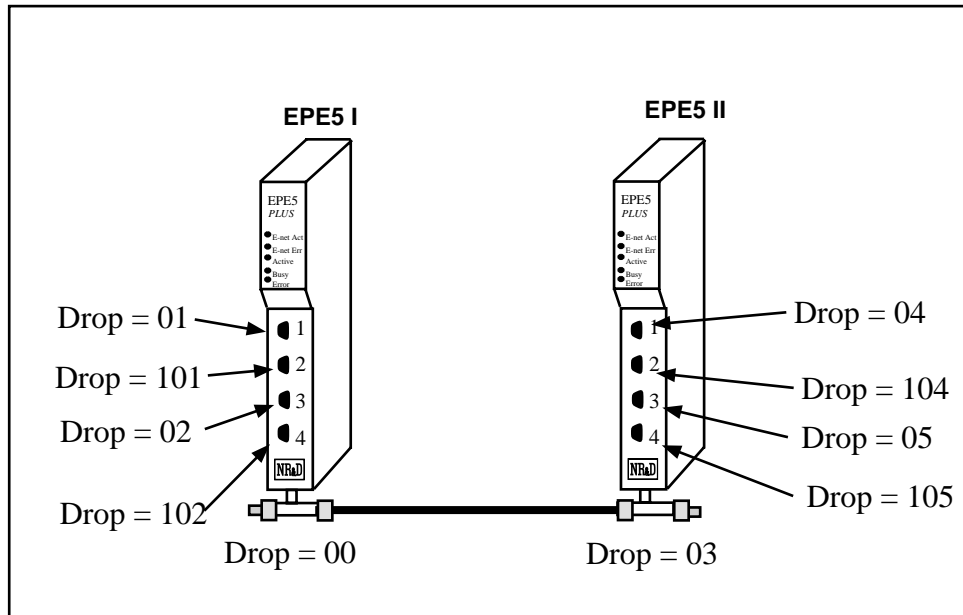
Figure 22-1 On Ethernet Example

In Figure 22-1 if all of the ports are placed on the Ethernet then the EPE5s would respond to E-Net messages with target drop numbers of 00, 01, 02, 03, 04, 05, 102, 103, 104, and 105. Therefore none of the other devices on the SY/MAX Ethernet may have these drop numbers or a duplicate drop number error condition will occur.

Consider that all of the serial ports are in SY/MAX mode. Table 22-1 shows several possible routes for communication.

Table 22-1   On Ethernet Routing Examples

Source	Target	Route
EPE5 I Port 1	EPE5 II Port 1	1, 0, 3, 4
EPE5 I Port 1	EPE5 II Port 1	1, 0, 4
EPE5 I Port 1	EPE5 II Port 1	1, 3, 4
EPE5 I Port 1	EPE5 II Port 1	1, 4
EPE5 II Port 2	EPE5 1 Port 2	104, 3, 0, 101
EPE5 II Port 2	EPE5 1 Port 2	104, 0, 101
EPE5 II Port 2	EPE5 1 Port 2	104, 3, 101
EPE5 II Port 2	EPE5 1 Port 2	104, 101
EPE5 I Port 1	EPE5 I Port 2	1, 2
EPE5 II Port 3	EPE5 II Port 4	5, 105

<div align="right">

23

Configuration Software EPE5SW

</div>

EPE5SW

The EPE5SW and EPE5SW32 software programs are provided free of charge to EPE5 and EPE5-TCP users. EPE5SW is a 16-bit DOS application and may be run under MS-DOS or WIN3.x/95/98/NT while EPE5SW32 is a Windows 32-bit console application and may be run under WIN95/98/NT only. They both look and act alike and may operate on the same EPE5 setup files. The main difference between the two softares are the support for connection type to the EPE5. These softwares are used to configure the operational parameters of the EPE5. They may be operated in either online or offline modes.

> NOTE: EPE5SW supports all versions of the EPE5 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 EPE5.

EPE5SW may use the SY/MAX, Net-to-Net, Gateway, Modbus RTU, or Modbus ASCII serial protocols for the configuration of the EPE5; thus allowing remote service of the EPE5 through SY/NET, and other SY/MAX devices such as Niobrara's 2496X or RM14K modems. Full support for the SY/LINK SFI-510 Network Interface Card and SFI-610 Ethernet Card is also provided when used under DOS or WIN95/98. SFI-510 and SFI-610 use is not supported under WIN/NT. Modbus and SY/MAX serial operation under WIN/NT may not be optimum and may result in timeouts and retries because of NT's control of the serial port for DOS applications.

EPE5SW32 may also use the SY/MAX, Net-to-Net, Gateway, Modbus RTU, or Modbus ASCII serial protocols for the configuration of the EPE5. These serial drivers are written for Windows support and provide much improved operation in Win/NT over EPE5SW. EPE5SW32 may also use the TCP/IP stack native to WIN95/98/NT for direct MODBUS/TCP connection to the EPE5-TCP. Support for the SY/LINK SFI-510 Network Interface Card and SFI-610 Ethernet Card is not provided.

In online mode, EPE5SW 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 EPE5 module and are effective immediately.

In offline mode, EPE5SW allows a copy of the configuration to be uploaded from the EPE5 to an image in offline memory. The offline copy can be edited without affecting the EPE5 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 EPE5 need not be connected to perform most offline operations. The offline copy of the configuration parameters may be downloaded to an EPE5 module at any time.

Because the EPE5 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 EPE5SW is shown in Figure 23-1 on page 134. 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.

```
    E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                                                        01Jun95
                   CONFIGURATION AND UTILITY SOFTWARE
oNline            oFfline           Utility            Setup           Quit




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


       Copyright (c) 1994 Niobrara R&D Corporation.  All rights reserved.
```

Figure 23-1 EPE5SW Startup Screen

If offline mode is selected, a second menu appears as shown in Figure 23-2 on page 135. 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 EPE5 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 EPE5. 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 EPE5, not the offline copy. Likewise, changes made in offline mode have no effect on a connected EPE5 until they are explicitly sent to it using the "Send memory to EPE5" function.

EPE5SW 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.
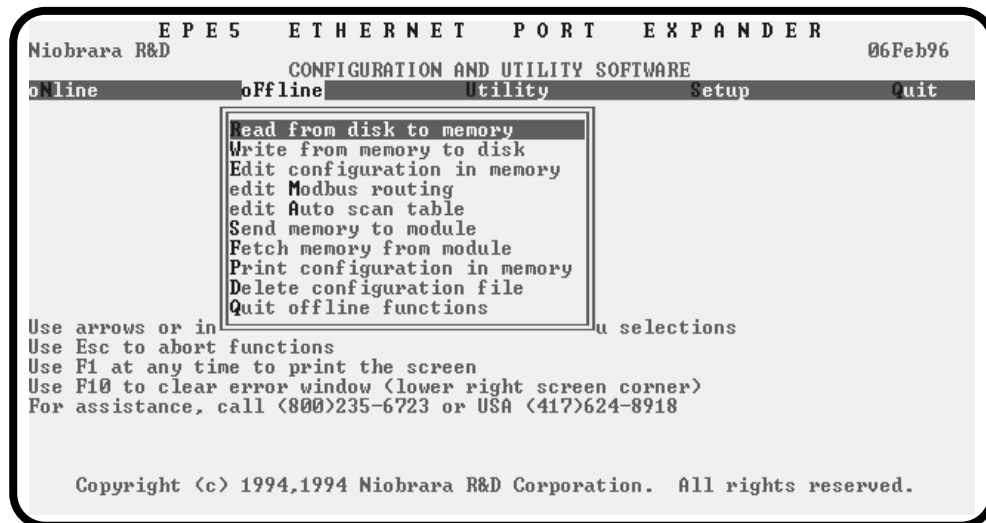
Figure 23-2   EPE5SW oFfline Menu

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 EPE5SW 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.

The oNline Edit (and oFfline Edit) screen is presented as a matrix of parameters, see Figure 23-3. Each column represents one of the ports of the EPE5. The lower half of the screen will change to present the available parameters for each protocol mode. The parameters are described below.

```
          E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                                                      29Oct96
                      CONFIGURATION AND UTILITY SOFTWARE   Press F2 for help.
                     ETHERNET     PORT 1      PORT 2      PORT 3      PORT 4
Drop                 0            100         101         2           102
On Ethernet          YES          NO          NO          NO          NO
Protocol             NRD/TCP      PNIM        SY/MAX      SY/MAX      SY/MAX
Baud Rate            199.186.195.27  9600     9600        9600        9600
Parity               255.255.255.0   EVEN     EVEN        EVEN        EVEN
Data Bits            199.186.195.1   8        8           8           8
Stop Bits                         1           1           1           1
Buffer Limit         16           16          16          16          16

Error Check                                   BCC
Route Appendix                                NONE
Route Replacement                             OFF

Transfer Interval                             100
Transfer Route                                NONE
Read Count                                    0
Read From                                     128
Read To                                       0
Write Count                                   0
Write To                                      0
Write From                                    10
```

Figure 23-3   EPE5SW oNline Edit Screen

Drop Number

(Ports 1..4, E-NET) This value determines the route drop number of the port. All ports must have unique drop numbers within the module. The drop number of the Ethernet port must be unique for the entire Ethernet network (SY/MAX 802.3 mode). The Ethernet drop number must fall within the range of 00 through 99. The drop numbers for Ports 1 through 4 must fall within the range 000 through 199. The default drop number for the Ethernet port is 0. The default drop numbers for Ports 1 through 4 are: 1, 101, 2, 102.

In Modbus/TCP mode, the Ethernet drop number is not required to be unique on the Ethernet.; instead, the IP Address must be unique for the entire IP network.

Protocol

(Ports 1..4) This value determines the mode of the individual communication port. Possible values are SY/MAX, Net-to-Net, Peripheral, Transparent, Share, PLogic, Idec, Gateway, Multidrop, MODBUS Host, PNIM, RNIM Master, RNIM Slave, Modbus Gate, Transfer, CHEVRON, Modbus ASCII, and Dual Slave. The default mode is SY/MAX.

(E-net Port) The Ethernet port supports SY/MAX 802.3 mode and Modbus/TCP modes. The SY/MAX mode allows connection to standard Model 650s, Model 450s, SFI-610 cards, EPE5s, MEBs, and PENs. Modbus/TCP is a widely used TCP/IP protocol and is the recommended protocol for the Ethernet port.. The default mode is Modbus/TCP.

Baud Rate

(Ports 1..4) Controls the baud rate of the individual port. This value should be set to match the baud rate of the device attached to the port. The default value is 9600.

Parity

(Ports 1..4) Controls the parity of the individual port and should be set to match the attached device. Available choices are EVEN, ODD, and NONE. The default value is EVEN.

Data Bits

(Ports 1..4) Set to 7 or 8 to match the data bits transmitted by the connected device. The default value is 8.

Stop Bits

(Ports 1..4) Set to 1 or 2 to match the stop bits used by the connected device. The default value is 1.

Buffer Limit

(Ports 1..4, E-NET) The buffer limit sets the maximum amount of available buffers for each port. The default value is 16 with a minimum value of 2 and a maximum value of 16. Then E-Net port has a maximum value of 32. It is not recommended to alter the number of buffers available unless the equipment requires a small number of buffers.

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

(Modbus/TCP) This value sets the 32 bit IP address for the EPE5-TCP's Ethernet port. The value is entered in dotted-decimal notation. This value must be unique for a given IP network.

Subnet Mask

(Modbus/TCP) The Subnet Mask is a 32 bit mask applied to outgoing Ethernet messages to determine the network ID portion of the outbound IP address. Set the network portion of the mask to ones and the host portion to zeros. The default masks for Class A address should be 255.0.0.0, Class B should be 255.255.0.0, and Class C default is 255.255.255.0.

Default Gate

(Modbus/TCP) This 32 bit IP address is used to point to the gateway router on the local IP network segment. If there is no gateway, enter the value 0.0.0.0 for the default gate.

IP Framing

(Modbus/TCP) The options are ETHERNET II and 802.3. ETHERNET II is also known as DIX and is normally used for IP. 802.3 is also known as SNAP and is seldom used. ETHERNET II is the default value.

BOOTP/DHCP

(Modbus/TCP) When theis option is ON then the module attempts to get its IP settings from a BOOTP or DHCP Server on the Ethernet network every time it powers up. The default value is ON.

MAC Address

This read-only value displays the 12 digit hexadecimal value of the MAC address of the EPE5. This value is used by the BOOTP or DHCP Server to assign a specific IP address to a unit.

Driver Mode

(Peripheral, Share, Multidrop, Modbus) These settings control the action of the transmit driver and receiver action of the RS-485 port. Possible settings include **Pt to Pt** for Point to Point (RS-422 operation), **FOUR WIRE** for 4-wire RS-485 slave operation, **HALF DUPLEX** for 4-wire Pt to Pt half duplex operation, and **TWO WIRE** for 2-wire half duplex operation.

E-Peer

(E-Net Port only) The E-Peer item allows the enabling of the EPE5's Peer-to-Peer mode. If set to OFF the E-Peer is disabled on this EPE5 and the Auto-Transfer settings for the E-Net port are displayed. If set to ENABLE, the Auto-Transfer settings for the E-Net port change to show the settings for the E-Peer. The E-Peer is only active in SY/MAX 802.3 mode.

Error Check

(SY/MAX, Net-to-Net, PLOGIC, Multidrop, PNIM) The Error Check item allows the selection of the standard BCC error check or the CRC error check. Normal SY/MAX operation requires the BCC error check. The SY/MATE PLUS software provides the CRC checksum as an option for use with no parity, thus allowing 10 bit modem programming. The CRM-512 NIM also uses the CRC checksum.

Route Appendix

(SY/MAX) The Route Appendix allows SY/MAX devices with limited network capabilities, such as the EATON PanelMate operator interface, to increase the number of drops available. SY/MAX packets arriving at the port with the last drop in the route being 205 will have the Route Appendix attached to the incoming route in place of the 205 drop number. To disable the Route Appendix feature, set the Route Appendix to NONE by deleting all drops in the route field.

Route Replacement

(SY/MAX) The Route Replacement is an extension of the Route Appendix feature. If the Route Replacement is ON, any incoming SY/MAX packet on the port will have its route ignored and the route described in the Route Appendix will be used instead. The replies from sent messages will have their original route reversed and replaced as they leave the port. The default value is OFF.

The Route Replacement/Appendix may be enhanced to include up to 128 eight-drop routes by using Options bit 2. When this Options bit is set for the SY/MAX mode port, incoming route of the form 205,X will have the route located in the Modbus Slave Address Table entry X used for the replacement. The reply will be returned to the sender with the reversed route X,205. This feature may only be used on single-threaded SY/MAX ports and is primarily intended to be used with the PanelMate operator interface.

Packet size limit

(Transparent, Share, Gateway) This value determines the number of characters which will accumulate without receiving an ASCII carriage return or exceeding the Packet time limit, and result in the formation of a SY/MAX packet being formed. Setting the packet size to 1 will cause each character entering the port to be transmitted without delay but will result in slow throughput because of the large overhead of sending each character as a packet. The default value is 128 characters.

Packet time limit

(Transparent, Share, Gateway) This integer value determines the number of hundredths of a second which will pass between characters before a packet is formed of the characters already received. The default value is 100.

Target Route

(Transparent, Share, Gateway) The route should consist of the drop number of the originating port, any Net-to-Net drops, and the drop number of the receiving port. For two-way communication, the receiving port should be programmed with the same drops in reverse order. In Gateway mode, the route may be easily modified by using the Address command. The default value is NONE.

Control Character

(Transparent, Share, Gateway) The Control Character field determines whether control characters (carriage return, line feed, etc.) will be used to terminate the message before the packet time limit or packet size limit is met. The default value is ON.

Echo

(Transparent, Share, Gateway) The Echo field determines whether the port will echo all characters received back to the sending device. This may be useful in applications involving terminals. The default value is OFF.

Highlight

(Gateway) The Highlight field determines whether the Gateway port provides the ANSI highlight control characters before and after each message returned from the Gateway port. The default value is OFF.

Node Priority

(Multidrop) This value determines the priority for the port within the multidrop scheme. Each port on the multidrop circuit should have its own unique priority value and should fall within the range of 1 to the number of nodes.

Number of Nodes

(Multidrop) This value should be set to equal the number of multidrop EPE5 or SPE4 ports included within the network. This value must be at least equal to 2.

Time Slice

(Multidrop) The time slice value determines the amount of time that each unit will wait from the receipt of the last character on the network before transmitting a new request. This value is expressed in units of n/100 seconds

READ command

(MODBUS Host) This value is required in the MODBUS Host mode. SY/MAX read requests are translated to the MODBUS function code defined in the MODBUS READ register for that port. Possible values are 1, 2, 3, or 4. The default value is 4.

WRITE command

(MODBUS Host) This value is required in the MODBUS Host mode. SY/MAX write requests are translated to the MODBUS function code defined in the MODBUS WRITE register for that port. Possible values are 5, 6, 15, or 16. The default value is 16.

Retry timeout

(MODBUS Host and Gate) This value expressed in units of n/100 seconds determines the delay time between retries for failed transmissions from a MODBUS mode port acting as a Master. The default value is 100. When a Modbus Host or Gate port is acting as a slave, the reply timeout value is ignored and the connected Master is responsible for determining the timeout.

Register Bias

(MODBUS Host) Since it is not possible to read or write MODBUS registers outside of the legal SY/MAX range of 1 through 8192., an offset value has been added. This offset value allows the translation from the SY/MAX range to another valid range in MODBUS. The MODBUS register addressed will the result of the following formula:

MODBUS value = SY/MAX register + Offset value - 1

 If the offset value equals 0 then reading the SY/MAX register 1 will translate to reading the MODBUS register 0. If the offset value equals 20001 then reading the SY/MAX register 10 will translate to reading the MODBUS register 20010. The default value for the offset is 1.

Transfer Interval

(Auto-transfer, Auto-Scan) This value determines the periodic interval between Auto-transfer and Auto-Scan READS/WRITES. The value is expressed in units of n/100 seconds (i.e. 100 = 1 sec).

Some consideration must be taken in selecting the interval. Too small of a value will result in the filling of the buffers and possible rejection of reads/writes. If the application is time critical, this value should be set to a value slightly longer than the transmission + reception time of the largest expected packets. If both read and write are selected, the transmission time must be calculated for each worst case and added together for the final interval.

Transfer Route

(Auto-transfer) The route describes the path that any Auto-transfer reads and/or writes will require to reach the desired peripheral device. If the device is directly attached to the EPE5 port a route may not be necessary. If this is the case simply press the DEL key and the route will be set to NONE.

If the attached device requires a unit number (MODBUS, IDEC, PLOGIC) then two drops are required. The first must be the drop number of the EPE5 port, the second must be the unit number of the attached device.

READ Count

(Auto-transfer) This value determines whether the Auto-transfer read will operate. A value of zero will disable the Auto-transfer read. A value of one will cause a read to occur at the time interval. A value greater than one will cause a multiple register read to occur starting at the READ From register.

READ From

(Auto-transfer) This is the register number located within the peripheral device that is of interest. On multiple register reads, READ Count > 1, this is the starting register of the multiple register read.

READ To

(Auto-transfer) This is the register number in the mailbox where the data from the peripheral device will be stored. On multiple register reads, this is the first register of the multiple registers.

WRITE Count

(Auto-transfer) This value determines whether the Auto-transfer WRITE will operate. A value of zero will disable the Auto-transfer write. A value of one will cause a write to occur at the time interval. A value greater than one will cause a multiple register write to occur starting at the WRITE From register.

WRITE To

(Auto-transfer) This is the register number located within the peripheral device that is of interest. On multiple register writes, this is the starting register of the multiple register write.

WRITE From

(Auto-transfer) This is the register number in the mailbox where the data for the peripheral device is stored. On multiple register writes, this is the first register of the multiple registers.

Total E-Peer Nodes

(E-Peer) This value determines the total number of EPE5 modules on the E-Peer. This value must be in the range of 2..100 and must be the same for all EPE5 modules using the E-Peer.

E-PEER devices with This Node's Number set to zero are not included in the total E-PEER nodes count.

This Node's Number

(E-Peer) This value sets this EPE5's E-Peer number. This number must be unique among the E-Peer members and must also fall within the range of the Total E-Peer Nodes.

A special case of This Node's Number is when it is set for zero. When This Node's Number is set to zero and the E-PEER is enabled, this EPE5 will accept E-PEER messages, but will not transmit any data. This allows E-Peer devices to listen to all of the data on the network but not consume any of the

available bandwidth because they have nothing to transmit. E-PEER devices with This Node's Number set to zero are not included in the total E-PEER nodes count.

Start Register

(E-Peer) This is the register number in the mailbox where the data for the other E-Peer members is stored. On multiple register writes, this is the first register of the multiple registers.

Register Count

(E-Peer) This value determines the number of registers broadcasted from this EPE5 to the other members of the peer. The register count is not required to be the same among the members of the peer.

Destination Reg

(E-Peer) This is the register number in the other members of the peer where the data from this EPE5 will be transferred. This value is commonly the same as the Start Register.

Update Interval

(E-Peer) The amount of time in milliseconds allotted for a complete cycle of the peer. It is recommended that the Update Interval be an integer multiple of the total number of units where the multiple has a minimum value of 2. For example, if there are 8 nodes in the peer and 3mS is allowed for each node, set the Update Interval to 24.

Network Id

(RNIM Master and Slave) This number must be the same for all RNIM devices on the same Remote Network. The Network Id allows multiple Remote Networks to operate within close range on the same frequency. RNIM devices only respond to messages that match their own Network Id. The Valid data range is 0 through 255.

NOTE: The Square D CRM-560 always defaults to a Network Id of 0 upon power-up.

CTS Timer

(RNIM Master and Slave) The CTS timer provides a minimum amount of time to wait for the Clear to Send hardware handshake line to become active after the Request to Send (RTS) line has been asserted. The unit of time is 10mS. A value of 50 provides a 500mS delay. The valid data range is 0 through 65535 (655.35 seconds max).

NOTE: The Square D CRM-560 CTS timer has units of 50mS and defaults to a value of 10 (for a delay of 500mS) upon power-up.

Packet response

(RNIM Master and Slave) This value sets the message response timeout in 10mS units. This value determines the amount of time that the RNIM port will wait for a response before a message is retransmitted. (The number of retries is governed by the Retries setting.) This value also covers the response time allotted to a BID. The valid data range is 0 through 65535 (0 sec to 655.35 sec).

NOTE: The Square D CRM-560 Message response timeout is in 1 second units and defaults to 20 seconds upon power-up. Also the CRM-560 has the BID response fixed at 2 seconds.

Bid interval

(RNIM Master) This value sets the interval between successive automatic BIDs in 10mS units. This value determines the amount of time that the RNIM Master port will wait between sending one BID and sending the next after the Message response timeout has elapsed. During this interval any queued NORMAL messages are sent. The valid data range is 0 through 65535 (0 sec to 655.35 sec).

NOTE: The Square D CRM-560 does not allow this parameter to be adjusted. It is fixed at 2 seconds.

Retries

(RNIM Master) This value sets the number of retries by the Master (without a valid reply from the Slave) before an error message is returned to the originating device. The valid range is 0 through 65535 for Masters and 0 for Slaves.

NOTE: The Square D CRM-560 Number of Retries has a valid range of 0 through 3 for Masters and 0 for Slaves and defaults to 3 upon power-up.

Pause time

(RNIM Master) This value determines the amount of time that will be inserted after a specific number of messages or BIDs have been sent to rest the transmitter. Valid data range is 0 through 65535.

NOTE: The Square D CRM-560 Pause time is in 1 second units and defaults to 15 upon power-up.

Message Count

(RNIM Master) The Message Count is the number of messages and/or BIDs that will be transmitted by the Master before the Pause Time will be inserted to give the transmitter a chance to rest. Valid range is 0 through 65535.

NOTE: Most modern transmitters will operate at 100% duty so set this value to 0 if your transmitter can handle it.

NOTE: The Square D CRM-560 defaults this value to 4 upon power-up.

Bid Address

(RNIM Master) This number determines the type of BID operation.

1 to 99 - If the value falls within the range of 1 through 99, the RNIM Master will issue a single BID to that Slave address. The Slave has the amount of time set by the Message response setting to respond to the BID.

NOTE: To send a single BID to Slave 00, use the value 100.

100 to 199 - If the value falls within the range of 100 through 199, the RNIM Master will issue a BID to the Slave address that corresponds to the number minus 100. The Slave has the amount of time set by the Message response setting to respond to the BID. After the Message response timeout has occurred (regardless if a response was sent), the Master will wait for the BID Interval delay. After the BID Interval delay, the Master will subtract 1 from the address and issue a BID to that new Slave address minus 100. This new address will be displayed in the BID Address register in the Master. The address will be automatically decremented at the end of the Bid response timeout (or reply) until the address 00 BID has been issued. All addresses between the starting address and 00 will be BID. It is not possible to skip any addresses. NORMAL messages received while performing an automatic BID take precedent over the automatic BID and will be inserted during the next BID Interval delay.

200 to 299 - If the value falls within the range of 200 through 299, the RNIM Master will issue continuous BIDs to that address minus 200. After sending the BID, the Master will wait for the Message response timeout before processing any other messages. After the Message response timeout, the Master will wait for the BID Interval time before sending the next BID. During the BID Interval delay, all queued NORMAL messages will be sent over the remote network.

300 to 399 - If the value falls within the range of 300 through 399, the RNIM Master will issue continuously decrementing automatic BIDs from that address minus 300 to address 00. After the BID for address 00 is sent, the BID resumes at the starting address. This works just like the 100 to 199 that automatically resets itself when it gets to zero.

NOTE: Unlike the 100 to 199 operation, the value displayed in the BID address register always stays at the 300 range value. This is to allow the automatic BID to resume upon power loss.

HOTKEYS

F1 Print Screen hotkey

Pressing the F1 key at any time will allow for printing of the screen information to a printer or text file. Pressing the F1 key will produce a window similar to Figure 23-4.

```
         E P E 5     E T H E R N E T    P O R T    E X P A N D E R            ─
Niobrara R&D              EPE5 06JUN95 Port 4                      01Jun95
                      CONFIGURATION AND UTILITY SOFTWARE      Press F2 for help.
oNline         oFfline            Utility              Setup              Quit
               ETHERNET    PORT 1      PORT 2      PORT 3      PORT 4
Drop           0           i           101         2           102
Protocol                   SY/MAX      PERIPHERAL  GATEWAY     SY/MAX
Baud Rate                  9600        9600        9600        9600
Parity                     EVEN        EVEN        EVEN        EVEN
Data Bits             ═════PRINT SCREEN═════                   8
Stop Bits         ║ Output file:              ║                1
Buffer Limit      ║ PRN_____ ║              16
                  ╚════════════════════════════╝
Error Check                BCC
Route Appendix             NONE
Route Replacement          OFF

Transfer Interval          0
Transfer Route             NONE
Read Count                 0
Read From                  128
Read To                    0
Write Count                0
Write To                   0
Write From                 10
```

Figure 23-4   F1 Print Screen 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, EPE5SW will print the information to that file-name as an ASCII text file.

F2 Help Window

Pressing the F2 key will present the help window shown in Figure 23-5. Pressing any key will return to the previous location

```
         E P E 5     E T H E R N E T    P O R T    E X P A N D E R            ─
Niobrara R&D              EPE5 06JUN95 Port 4                      01Jun95
                      CONFIGURATION AND UTILITY SOFTWARE      Press F2 for help.
oNline         oFfline            Utility              Setup              Quit
               ETHERNET    PORT 1      PORT 2      PORT 3      PORT 4
Drop           0
Protocol                       ═════PARAMETER EDITOR HELP═════
Baud Rate              ║ Beware of changing the port you are connected ║
Parity                 ║ to which is displayed at top center of screen. ║
Data Bits              ║ Use Up and Down arrows, Page Up, and Page Down ║
Stop Bits              ║ to select a field.                            ║
Buffer Limit    16     ║ Use Left and Right arrows, Home, and End to    ║
                       ║ select a port.                                ║
Error Check            ║                                               ║
Route Appendix         ║ In multiple choice fields, + key increases, -  ║
Route Replacement      ║ decreases, and spacebar increases to the last  ║
                       ║ choice and then wraps to the first choice.     ║
Transfer Interval      ║ In numeric fields, type new value and ENTER.   ║
Transfer Route         ║                                               ║
Read Count             ║ Type ESC to exit online parameter editor.      ║
Read From              ║ Type F10 to clear error window.                ║
Read To                ║ Type F3 for real time statistics.              ║
Write Count            ║ Type F9 to change Sy/Max communication setup.  ║
Write To               ║                                               ║
Write From             ║ Press any key to close help window.            ║
                       ╚═══════════════════════════════════════════════╝
```

Figure 23-5   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 23-6 and 23-7.

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.

```
         E P E 5   E T H E R N E T   P O R T   E X P A N D E R
Niobrara R&D                EPE5 06JUN95 Port 4                    01Jun95
                            ═Statistics═                           for help.
oNl┌───────────ETHERNET PORT DROP 0──────────┬──Count─┬─Register─┐  Quit
   │ Valid Command/Reply packets received    │  758   │   2049   │RT 4
Dro│ Incoming packet lost because no buffer   │   0    │   2050   │2
Pro│ Retry packets received                   │   0    │   2051   │/MAX
Bau│ Packets generated internally             │  608   │   2052   │00
Par│ Internal generations failed (No Buffer)  │   0    │   2053   │EN
Dat│ Packets sent and ACK received            │  758   │   2054   │
Sto│ Transmit not ACKed, packet lost          │   0    │   2055   │
Buf│ Transmit retries                         │   0    │   2056   │
   │ Packets lost because unrouteable         │   0    │   2057   │
E-P│ Illegal operation requests               │   0    │   2058   │
   │ Priority reads performed locally         │   0    │   2059   │
   │ Priority writes performed locally        │   0    │   2060   │
   │ Non-priority reads performed             │  150   │   2061   │
Tra│ Non-priority writes performed            │   0    │   2062   │
Tra│ Non-Sy/Max Ethernet frames received      │   0    │   2063   │
Rea│ Ethernet frames transmitted              │ 1516   │   2064   │
Rea│ Ethernet frames received                 │ 1516   │   2065   │
Rea│                                          │        │          │
Wri│ Type + or - to change port.  Z to zero.  │        │          │
Wri│ Page Down for more data.  ESC to exit.   │        │          │
Wri└──────────────────────────────────────────┴────────┴──────────┘
```

Figure 23-6   Ethernet Port Statistical Screen (Page 1)

```
         E P E 5   E T H E R N E T   P O R T   E X P A N D E R
Niobrara R&D                EPE5 06JUN95 Port 4                    01Jun95
                            ═Statistics═                           for help.
oNl┌───────────ETHERNET PORT DROP 0──────────┬──Count─┬─Register─┐  Quit
   │                                          │        │          │RT 4
Dro│                                          │        │          │2
Pro│ Last route received                      │   17   │   2076   │/MAX
Bau│                                          │   20   │   2076   │00
Par│                                          │   99   │   2077   │EN
Dat│                                          │   0    │   2077   │
Sto│                                          │  ---   │   2078   │
Buf│                                          │  ---   │   2078   │
   │                                          │  ---   │   2079   │
E-P│                                          │  ---   │   2079   │
   │                                          │        │          │
   │ Ethernet collisions                      │   0    │   2066   │
   │ Packets lost because excess collisions   │   0    │   2067   │
Tra│ Receive packets lost for CRC error       │   0    │   2068   │
Tra│ Receive packets lost for framing error   │   0    │   2069   │
Rea│ Sequence error, NAK TRANS                │   0    │   2070   │
Rea│ Buffers currently in use                 │   0    │   2080   │
Rea│                                          │        │          │
Wri│ Type + or - to change port.  Z to zero.  │        │          │
Wri│ Page Up for more data.  ESC to exit. .   │        │          │
Wri└──────────────────────────────────────────┴────────┴──────────┘
```

Figure 23-7   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 164. 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 EPE5 in TCP/IP mode. (Not implemented yet.)

- **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 EPE5 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 EPE5 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 EPE5 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 EPE5 keeps a table of the SY/NET Ethernet Sequence numbers from every active SY/NET Ethernet unit on the network. If the EPE5 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.

Ports 1 through 4 have the same types of statistics which are shown in Figures 23-8 and 23-9.

```
          E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                    EPE5 06JUN95 Port 4                      01Jun95
                              ═Statistics═                              for help.
oN1│         PORT 4 DROP 102                  │ Count │ Register │       Quit
   │ Valid packets received, ACK sent         │ 1837  │  2177    │RT 4
Dro│ Incoming packet lost because no buffer   │   0   │  2178    │2
Pro│ Invalid packets received, NAK sent       │   0   │  2179    │/MAX
Bau│ Packets generated internally             │   0   │  2180    │00
Par│ Internal generations failed (No buffer)  │   0   │  2181    │EN
Dat│ Packets sent and ACK received            │ 1836  │  2182    │
Sto│ Transmit not ACKed, packet lost          │   0   │  2183    │
Buf│ Transmit retries                         │   1   │  2184    │
   │ Packets lost because unrouteable         │   0   │  2185    │
Err│ Illegal operation requests               │   0   │  2186    │
Rou│ Priority reads performed locally         │   0   │  2187    │
Rou│ Priority writes performed locally        │   0   │  2188    │
   │ Non-priority reads performed             │ 1833  │  2189    │
Tra│ Non-priority writes performed            │   4   │  2190    │
Tra│ Receiver parity or framing               │   0   │  2191    │
Rea│ Characters transmitted                   │ 18661 │  2192    │
Rea│ Characters received                      │ 36966 │  2193    │
Rea│
Wri│ Type + or - to change port.  Z to zero.
Wri│ Page Down for more data.  ESC to exit.
Wri│
```

Figure 23-8   Port 1..4 Statistical Screen (Page 1)

```
          E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                    EPE5 06JUN95 Port 4                      01Jun95
                              ═Statistics═                              for help.
oN1│         PORT 4 DROP 102                  │ Count │ Register │       Quit
   │ Transmit percent of capacity             │  47   │  2192    │RT 4
Dro│ Receive percent of capacity              │  11   │  2193    │2
Pro│ Last route received                      │ ---   │  2204    │/MAX
Bau│                                          │ ---   │  2204    │00
Par│                                          │ ---   │  2205    │EN
Dat│                                          │ ---   │  2205    │
Sto│                                          │ ---   │  2206    │
Buf│                                          │ ---   │  2206    │
   │                                          │ ---   │  2207    │
Err│                                          │ ---   │  2207    │
Rou│
Rou│
   │
Tra│
Tra│
Rea│
Rea│ Buffers currently in use                 │   1   │  2208    │
Rea│
Wri│ Type + or - to change port.  Z to zero.
Wri│ Page Up for more data.  ESC to exit. .
Wri│
```
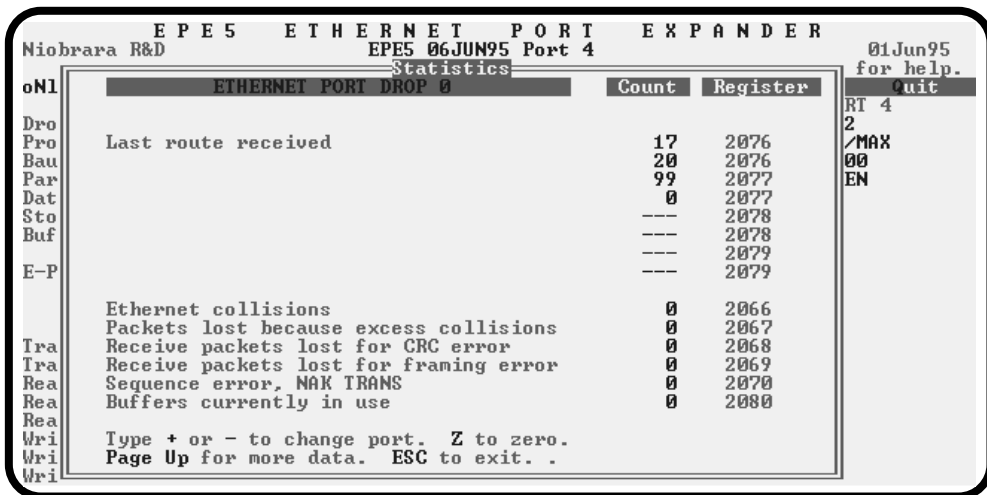
Figure 23-9 Port 1..4 Statistical Screen (Page 2)

Below is a list of the currently active registers for Ports 1 through 4 and the conditions which cause them to be incremented.

For a complete table of these registers see page 166. 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 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.

- **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 EPE5 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.

- **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.

MODBUS Routing

EPE5 ports in MODBUS modes (Modbus/TCP, Modbus Host, Modbus Gate, Modbus ASCII, and Dual Slave) are capable of operating as a MODBUS Slave. As a Slave, the EPE5 port will respond to Modbus messages based upon a look-up table. If the entry in the look-up table is non-empty, the EPE5 will translate the Modbus message into a SY/MAX message with the SY/NET route from the entry in the table. If the entry is empty, the EPE5 port will ignore the message (serial ports only). Each EPE5 port has a Modbus address look-up table with 128 possible entries. These entries consist of a SY/MAX route that may have up to 8 drops and a special entry that signals the Slave port that the target port is another Modbus mode port.

```
                E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                    EPE5 06JUN95 Port 4                        01Jun95
                          CONFIGURATION AND UTILITY SOFTWARE
oNline              oFfline              Utility              Setup              Quit
        MODBUS ROUTING FOR PORT 3, BASE DROP = 1
           DROP   DEVICE   ROUTE
             1    OTHER    101,5,2
             2    OTHER    101,5,14
             3    OTHER    NONE
             4    OTHER    NONE
             5    OTHER    NONE
             6    OTHER    NONE
             7    OTHER    NONE
             8    OTHER    NONE
             9    OTHER    NONE
            10    OTHER    NONE
            11    OTHER    NONE
            12    OTHER    NONE
            13    OTHER    NONE
            14    OTHER    NONE
            15    MODBUS   101,5,2,41,1
            16    OTHER    NONE
                            Use arrows to select field. Home to edit base drop.
                            Use PgUp and PgDown to select port. Escape to exit.
```

Figure 23-10 Edit Modbus Slave Routing

When the oNline, edit Modbus routing screen or the oFfline, edit Modbus routing screen is selected, the Modbus Slave look-up table may be easily edited. Figure 23-10 displays an example of this screen. This screen allows the editing of the table for each EPE5 port, the range of Modbus address that the table covers, and the entries for each of the covered addresses.

Port Number

Each EPE5 serial port has its own Modbus Slave look-up table. The Page Up and Page Down keys are used to select the EPE5 port table for editing.

Base Drop

The EPE5 Modbus port look-up table covers a range of 128 consecutive addresses. The starting point of this range may be adjusted with the Base Drop value. The Home key is used to edit the base drop. The lowest setting allowed is 0 and the highest setting should be 128. Normally this value will be set for 1 or 128.

DROP

The Drop column displays the Modbus Address for which the entry corresponds. The starting and ending point of this column is governed by the Base Drop setting.

DEVICE

The Device column is used to set the type of device that is the target of the SY/MAX route. If the device is Modbus Slave port of an EPE5 or SPE4, set this value to MODBUS. Otherwise set this value to OTHER.

ROUTE

The Route column determines the SY/NET route to the target device. The entries are separated by commas. The first entry should be the SY/NET drop number of this Slave port.

NOTE: The Ethernet port's Modbus Routing table keeps its drop number internally so the first drop in the route will be the drop number of a given serial port that the message needs to be routed out through.

Auto-Scan Table

The EPE5 serial port modes which may be used with Auto-Scan may also be configured for Auto-Scan. The Auto-Scan entries include pointers to the Local (EPE5 mailbox register), Remote (peripheral de-

vice register), Count, type of operation (READ or WRITE), and the Route to the peripheral. Up to 48 entries may be include per port. Figure 23-11 displays an example of the Auto-Scan edit screen.

```
          E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                                                      06Feb96
                     CONFIGURATION AND UTILITY SOFTWARE
oNline              oFfline              Utility         Setup          Quit
Port 1   Drop 1                  SCANNING AUTO TRANSFER        Status 100..102
 ENTRY  LOCAL REMOTE COUNT DIRECTION   ROUTE (from Modbus Slave table)
    1      1     1     10    READ      1,5
    2     11     1     10    READ      1,13
    3      0     0      0    READ      NONE
    4     50  3001      1    WRITE     1,6
    5             0      0    READ      NONE
    6      0     0      0    READ      NONE
    7      0     0      0    READ      NONE
    8      0     0      0    READ      NONE
    9      0     0      0    READ      NONE
   10      0     0      0    READ      NONE
   11      0     0      0    READ      NONE
   12      0     0      0    READ      NONE
   13      0     0      0    READ      NONE
   14      0     0      0    READ      NONE
   15      0     0      0    READ      NONE
   16      0     0      0    READ      NONE

Use + and - to select the port.  Type F4 to edit status pointer
```

Figure 23-11 Edit Auto-Scan Table

Local

This value determines the mailbox register in the EPE5 that is the starting register for the operation. The valid range is 1 through 2048. A value of 0 disables the Auto-Scan entry.

Remote

This value determines the register in the Peripheral device that is the starting register for the operation. The valid range is 1 through 8192. A value of 0 disables the Auto-Scan entry.

Count

The Count field determines the number of consecutive registers moved in the operation. The valid range is 0 through 128. A value of 0 disables the Auto-Scan entry.

Operation

This setting is set to READ or WRITE depending on the operation desired. READ operations copy data from the peripheral device to the EPE5's mailbox. WRITE operations copy data from the EPE5's mailbox to the peripheral device.

ROUTE

The Route column determines the SY/NET route to the target device. The entries are separated by commas. The first entry should be the SY/NET drop number of this Slave port.

TCP Routing

The EPE5-TCP is capable of operating as a TCP/IP Client as well as a Server. As a Client, the EPE5 routes messages out the Ethernet port to IP addresses determined by entries in the TCP routing table. There are 200 possible IP address entries available in the TCP routing table and each entry includes an optional downstream route of up to 4 additional drops. When a SY/MAX packet is routed to the E-net drop number, the EPE5 looks at the next drop in the route as the index to the TCP table. If there is a valid entry in the TCP table, the EPE5 will translate the message into Modbus/TCP and send it to the IP address determined by the table entry.

NOTE: The downstream route feature is not used for Modbus/TCP.

```
          E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                                                            29Oct96
                      CONFIGURATION AND UTILITY SOFTWARE
oNline              oFfline              Utility              Setup              Quit
        Edit Drop to TCP/IP Routing Table
        DROP   IP ADDRESS          DOWNSTREAM ROUTE
         0    199.186.195.21      NONE
         1    0.0.0.0             NONE
         2    0.0.0.0             NONE
         3    199.186.195.200     101,7,1
         4    199.186.195.200     101,7,2
         5    199.186.195.200     101,7,3
         6    199.186.195.44      1
         7    199.186.195.44      2
         8    199.186.195.44      3
         9    199.186.195.44      4
        10    199.186.195.44      5
        11    199.186.195.44      6
        12    199.186.195.44      7
        13    199.186.195.44      8
        14    0.0.0.0             NONE
        15    0.0.0.0             NONE
```

Figure 23-12 Edit TCP Routing Table

When the oNline, edit TCP routing screen or the oFfline, edit TCP routing screen is selected, the TCP/IP Client look-up table may be easily edited. Figure 23-12 displays an example of this screen.

DROP

The EPE5 TCP look-up table covers a range of 200 consecutive addresses. This drop number is the index to the IP address in the table. Possible entries are 0 through 199 inclusive.

IP ADDRESS

The target IP Address is entered in dotted-decimal notation.

DOWNSTREAM ROUTE

This featue should be left at NONE for Modbus/TCP. The Downstream Route column provides an optional supplementary SY/NET route once the target IP device is reached. The entries are separated by commas.

Offline Functions

"Read from disk to memory"

This function reads an EPE5 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 .EPE 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 .EPE 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 .EPE 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.
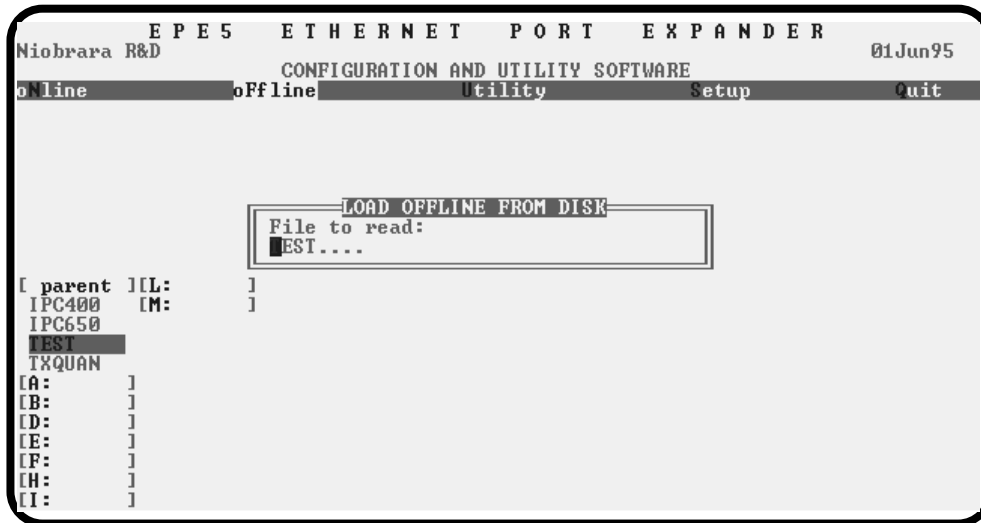
Figure 23-13 oFfline Read from Disk to Memory

"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 .EPE 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 EPE5.

"Send memory to module"

This function will send the configuration in memory to the EPE5 module by way of the SY/MAX setup parameters. In order to send the configuration to the EPE5 it is necessary for the personal computer to communicate with the EPE5. 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 EPE5 module to the offline memory for editing, printout, or saving on disk. "Send memory to the EPE5"

This function transfers all five ports' configuration parameters from offline memory to the EPE5. This function can be used to load configuration back into the EPE5 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 EPE5 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 EPE5SW 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.

```
          E P E 5    E T H E R N E T    P O R T   E X P A N D E R
Niobrara R&D                  EPE5 06JUN95 Port 4                    01Jun95
                       CONFIGURATION AND UTILITY SOFTWARE
REGSTR   HEX   UNSIGN   SIGNED         BINARY            STAT
    1   0000        0        0   0000 0000 0000 0000     A000
    2   0000        0        0   0000 0000 0000 0000     A000        NR&D Sy/Max
    3   8000    32768   -32768   1000 0000 0000 0000     E000       Register Viewer
    4   0000        0        0   0000 0000 0000 0000     E000
    5   0000        0        0   0000 0000 0000 0000     E000      Press F2 for Help
    6   0000        0        0   0000 0000 0000 0000     E000
    7   0000        0        0   0000 0000 0000 0000     E000
    8   1234     4660     4660   0001 0010 0011 0100     E000
    9   FEFE    65278     -258   1111 1110 1111 1110     E000
   10   04D2     1234     1234   0000 0100 1101 0010     E000
   11   0000        0        0   0000 0000 0000 0000     A000
   12   0000        0        0   0000 0000 0000 0000     A000
   13   0000        0        0   0000 0000 0000 0000     A000
   14   0000        0        0   0000 0000 0000 0000     A000
   15   0000        0        0   0000 0000 0000 0000     A000
   16   0000        0        0   0000 0000 0000 0000     A000
   17   0000        0        0   0000 0000 0000 0000     A000
   18   0000        0        0   0000 0000 0000 0000     A000
   19   0000        0        0   0000 0000 0000 0000     A000
   20   0000        0        0   0000 0000 0000 0000     A000
```

Figure 23-14 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 en-

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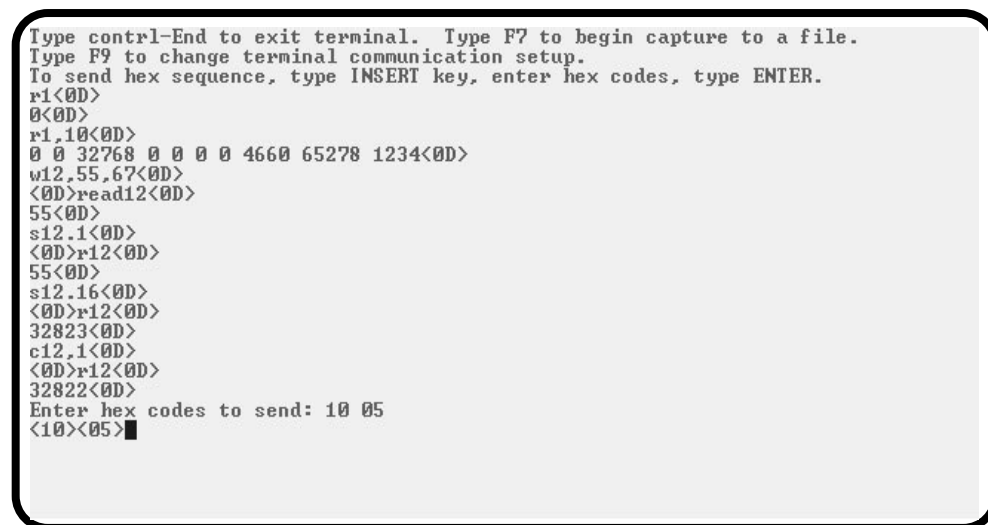
Pressing Esc will exit from the Register viewer and return to the main menu. Pressing Esc while editing a data field will result in canceling the edit and the modified data will not be written to the register.

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 used by the EPE5 as inputs and used by the PLC as outputs.

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 23-15.

```
Type contrl-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 23-15   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.

Download New Firmware to Module

The Download new firmware to EPE5 utility allows the field installation of upgrades provided by Niobrara via the Port 1 RS-422 serial port.   To load new firmware into the EPE5-TCP, perform the following steps:

1   Remove power from the register rack.

2   Remove the EPE5 from the register rack.

3   Locate the CONFIG slide switch on the top of the EPE5. This is a small yellow handled slide switch either mounted on the top edge of the circuit board and is accessable through the vent slot in the top of the module enclosure (See Figure 23-16) or mounted just under the silver clip near the top of the edge connector. Move this switch to the CONFIG position (towards the front of the module where the lights are if the switch is on the top or towards the metal clip if the switch is on the back).
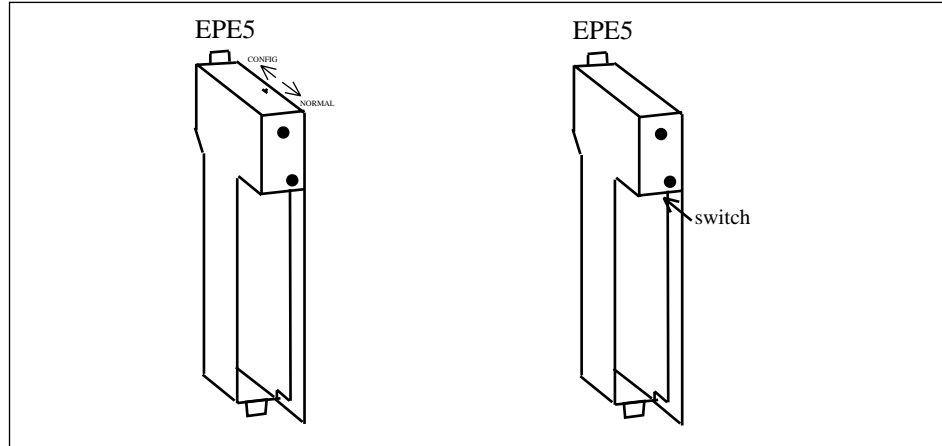
Figure 23-16EPE5 Firmware Load Switch

4   Install the EPE5 back into the register rack.

5   Apply power to the rack. The EPE5 should perform its startup sequence flash the lights at the top of the module leaving the green Power and yellow Ethernet Act lights on. The green ACTIVE light will not be on.

6   Connect the personal computer to the Port 1 of the EPE5. An SC902 cable provides a convenient method for the RS-232<>RS-422 conversion. (See Figure 23-17)

     NOTE: It is important to directly connect the MEB to the personal computer. The Firmware Download utility uses the same personal computer COM port as the normal SY/MAX settings, but the baud rate, parity, and protocol is different. The Firmware Download uses 19200 baud, NONE parity and a custom protocol that is not SY/MAX compatible. It is not possible to download new firmware over normal SY/NET networks.
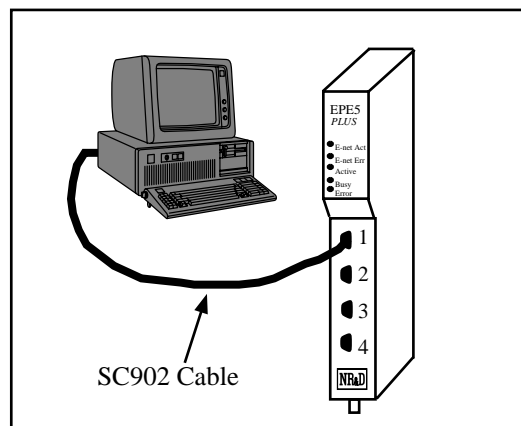
Figure 23-17EPE5 Firmware Download

7   From MEBSW's main menu, select Utility, Download New Firmware to EPE5. A window prompting for the file to download will appear. Select the new revision for the firmware and press Enter.

8   Wait for the firmware download to be completed. A message indicating completion will be displayed on the personal computer.

9   After the completion of the download, remove power from the register rack.

10   Remove the EPE5 from the rack.

11   Change the CONFIG switch back to NORMAL (towards the rack interface).

12   Install the EPE5 back into the register rack.

13   Connect power back to the register rack. The EPE5 should go back through its startup checks and now function normally.

SETUP

The setup menu accesses the setup parameters for the personal computer to enable it to communicate with the EPE5 and the terminal emulator. The parameters chosen will depend on the exact equipment involved in making the connections.

SERIAL SETUP

The connection type is mainly determined by the method of connection to outside world and may be broken into two groups: the personal computer's COM: port 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:, or 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 SPE4s with appropriate routing. This mode is to be used when a direct connection from the personal computer COM: port is made to the EPE5. 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 EPE5.

Net-to-Net COM: is used when connecting to a NIM, SY/LINK, 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 port that is in Gateway mode. For more information about Gateway mode see on page ???.

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 EPE5.

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. An EPE5 has a default baud rate of 9600 and if a direct connection is made to the EPE5 this is the setting that should be

made on the personal computer. If the baud rate of the port of the EPE5 has been changed this value may need to be adjusted.

```
       E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                                                      01Jun95
                     CONFIGURATION AND UTILITY SOFTWARE
oNline            oFfline              Utility          Setup         Quit


                        ═CONFIGURE THIS COMPUTER═
                    Connection type Sy/Max COM:
                              Port COM1:
                         Baud rate 9600
                         Data bits 8
                         Stop bits 1
                            Parity EVEN
                       Error Check BCC
                             Route NONE
Use arrows or initi
Use Esc to abort fu
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



       Copyright (c) 1994 Niobrara R&D Corporation.  All rights reserved.
```

Figure 23-18 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 EPE5 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 EPE5. Other choices are ODD and NONE.

Route - The route is used to determine the path from the personal computer to the EPE5. If a direct connection is made from the personal computer to the EPE5, i.e. without going through a SY/NET network, an Ethernet network, another EPE5, 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 EPE5, they must be included in order of occurrence from the personal computer to the EPE5. The last drop number listed will be that of the NIM or SPE4 SY/MAX mode port that is connected to the EPE5. 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 like above.

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

SY/LINK Connection

EPE5SW 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.

```
        E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                                                        01Jun95
                    CONFIGURATION AND UTILITY SOFTWARE
 oNline             oFfline              Utility          Setup        Quit


                        ═══CONFIGURE THIS COMPUTER═══
                        Connection type Sy/Link Direct
                           Base address CA000
                        RS422 Baud rate 9600
                        RS422 Data bits 8
                        RS422 Stop bits 1
                           RS422 Parity EVEN
                           Sy/Net speed 62.5 KB
                            Sy/Net size 31
                                  Route 10,110,15

Use arrows or initi│
Use Esc to abort fu└
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
        ═══CONFIRM═══
      │ Write setup to startup file? │       R&D Corporation.  All rights reserved.
```

Figure 23-19 SY/LINK Setup Screen

Connection type - The RS-422 port may be set to SY/MAX or Net-to-Net modes. For a direct connection to the EPE5 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 make 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 EPE5, or another Net-to-Net port. If Sy/Link Direct was selected and the EPE5 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

EPE5SW provide 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 EPE5SW. 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.

Modbus/TCP Connection

EPE5W32 provides support of Modbus/TCP via Ethernet directly using the TCP/IP stack of the Windows 95/98/NT operating system.

Figure 23-20 MODBUS/TCP Setup Screen

HOST - Enter the dotted-decimal IP address such as 206.223.51.154. If the EPE5-TCP has been assigned a name by a DNS server then the name may be entered such as epe51.niobrara.com.

PORT - Enter the TCP/IP Port number used by the server. Normally this is 502.

TIMEOUT - Enter the timeout value that EPE5SW32 waits for a reply in 1/10 second intervals. 500 means 5 seconds.

TRAP ERRORS - When set to yes EPE5SW32 will stop on all errors and wait for the user to press F10 before continuing.

DROP/INDEX - Enter the Destination Index value to determine the target device. Use 255 when attempting to communicate with the EPE5-TCP itself.

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 EPE5 SY/MAX connection and COM2 to be used for a terminal emulator connection.


```
        E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                                                      01Jun95
                    CONFIGURATION AND UTILITY SOFTWARE
oNline          oFfline          Utility          Setup          Quit
                    CONFIGURE TERMINAL EMULATOR
                              Port COM1:
                         Baud rate 9600
                         Data bits 8
                         Stop bits 1
                            Parity EVEN


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 23-21 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.

Command Line Parameters

EPE5SW 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 changes the Route to 102,055; loads the setup file TEST.EPE into an EPE5, then quits. It is assumed that the EPE5 is connected to the computer and the rest of EPE5SW setup is correct.

>EPE5SW SS/R/R/R/R/R/D102,055/RNFRTEST/RFSAQ

The S selects Setup, the second S selects Sy/Max, five Return keys to get to the Route field, /D for Delete to remove any previous route, 102,055 Return, for the new route, Y for Yes save the setup to disk, F for oFfline, R for Read from disk, TEST Return for the filename, F for oFfline, S for Send to module, A for all, and finally Q for Quit.

Another way of changing the Setup is to copy the setup file to another name in DOS, then copy it back to EPE5SW.STP in the batch file before calling EPE5SW.

24

Local Registers

The EPE5 configuration is controlled by writing to a set of processor equivalent registers local to the EPE5 module. These registers may be read or written by sending SY/MAX read and write messages to the module itself. These messages may be generated by ladder program read and write rungs in a processor, by a SY/LINK card, a D-LOG module, or a computer program such as the EPE5SW 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 another port, the route should be empty, should end with the drop number of the EPE5 port it enters, or should be terminated with either the null drop 204 or a drop number not found in the module. The Register Viewer located in the Utility section of the EPE5SW program is a convenient interface to the module's registers.

Module Register Overview

Table represents an overview of the local registers present within the EPE5. Notice that only registers 1..2048 may be rack addressed by the PLC. All other registers must be read or written through the data or E-Net ports.

Table 24-1   Module Register Overview

Register	Function
1..2048	Rack Addressable Mailbox registers for user applications
2049..2208	Statistics Registers (See Tables 24-4 and 24-6)
2009..2999	IP Router Configuration Table
3000..3302	Ethernet Addresses (See Table 24-8)
3303	E-Peer Active Nodes Register
3410..3999	Auto-Scan Tables
4000..4639	Modbus/TCP Slave Address Look-up
4640..7199	Modbus Slave Address Look-up Tables (See Table 24-4)
7200..7999	TCP/IP Routing Table.
8001..8162	Setup and Configuration (See Tables 24-12, 24-13, 24-14)
8176..8188	Module identification (See Table 24-27)

Mailbox Registers

The EPE5 contains 2048 Mailbox registers numbered 1..2048. Each of these registers may be written or read from any of the 5 ports on the module. In addition, these registers may be rack addressed by the PLC; therefore each of the 5 ports may read and write values directly to the PLC without using the PLC's COMM port.

The mailbox registers correspond to to the registers in the PLC by the following formula:

PLC Register = Rack Start Address + Mailbox Register

The direction of data flow is determined by the EPE5. Upon power-up all Mailbox registers are considered PLC outputs. This means that the PLC may write data to the Mailbox registers. When a register is a PLC output, its Status register will have a value of A000 in hexadecimal. By using PLC output registers, the processor may write data to the EPE5 Mailbox registers that are rack addressed and external devices may then read that data from the Mailbox.

When it is desired to have the external device write data to the PLC, the EPE5 handles the change in direction of data flow automatically. When an external WRITE is received onto the Mailbox, the Status of the effected register is changed from A000 to E000 and the PLC now recognizes that register as a PLC Input. Once a register has been changed to an Input it will remain an Input until the EPE5 is reset. Once a register is an Input, the PLC may now only read the data in the register. The external devices may both read and write the data.

NOTICE

The scan time of the processor is directly related to the number of externally addressed registers. Allocating more registers than needed can have an adverse impact on the speed of the system. Only Rack Address those registers needed for the particular application. See the processor's manual for more information on optimizing scan speed.

It should be noted that any Mailbox registers that are not rack addressed are still available to the external devices for Mailbox use, they just are not scanned by the PLC.

Mailbox Example

Consider the PLC setup in Figure 24-1. The Model 400 is in slot 1 and has registers 19..4000 assigned to it. A 64 point output module is in Slot 2 and has been rack addressed for registers 1 through 4. The EPE5 has been rack addressed for registers 5 through 14. A 64 point Input module is in slot 4 and has been rack address for registers 15 through 18.
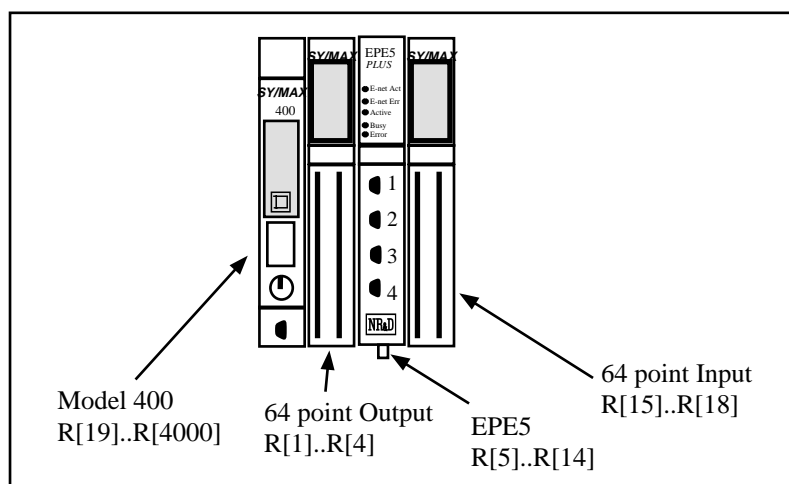
Figure 24-1   Mailbox Setup Example

The rack addressed registers within the EPE5 mailbox will correspond to the PLC registers in the Model 400 as follows:

Table 24-2   Mailbox Example Register List

PLC Register #	EPE5 Register #	Status Register Value (Hex)
5	1	A000
6	2	A000
7	3	A000
8	4	A000
9	5	A000
10	6	A000
11	7	A000
12	8	A000
13	9	A000
14	10	A000

For the external device to READ the PLC register 13, it needs to perform its READ on the Mailbox register 9. If the PLC copies data to its register 11, it will appear in the EPE5 register 7.

Notice that the Status Register of each register has the hexadecimal value A000. This value means that the register is a PLC output. All EPE5 mailbox registers default to PLC outputs upon power-up and consequently have a status of A000. As soon as an external device writes to the mailbox register, (from data ports 1..4, the Ethernet port, Auto-transfer, etc.) the register changes from a PLC Output to a PLC Input. The status register will change from A000 to E000. The register will remain as a PLC Input until the power is cycled on the EPE5. When a register is a PLC Output, the PLC may write data to that register. When a register is a PLC Input, the PLC can only read that data and may not overwrite it. For this reason it is important to plan in advance which registers are to be used as PLC Inputs and which are to be used as Outputs.

It is recommended that the Inputs and Outputs be placed together in blocks of like registers. This allows multiple register WRITEs to be used by the external devices, thus increasing efficiency.

If in the above example, registers 5 through 9 are used as PLC Outputs (data output by the PLC) and 10 through 14 are used as PLC Inputs (data written by external devices), then the status of each register would look like Table 24-3 after each register has been written at least once.

Table 24-3   Mailbox Example Register List after External Writes

PLC Register #	EPE5 Register #	Status Register Value (Hex)	Who Writes
5	1	A000	PLC
6	2	A000	PLC
7	3	A000	PLC
8	4	A000	PLC
9	5	A000	PLC
10	6	E000	EPE5
11	7	E000	EPE5
12	8	E000	EPE5
13	9	E000	EPE5
14	10	E000	EPE5

Statistics Registers

Each port has 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 EPE5. The group of registers is shown in Table 24-4.

Table 24-4   Ethernet Port Statistics Registers (SY/MAX 802.3 Mode)

Register	Incremented when the following occurs:
2049	SY/MAX Ethernet commands/replies received.
2050	Incoming E-Net SY/MAX packet lost because no available buffer.
2051	Retry packets received.
2052	Packets generated locally. (Auto-transfer)
2053	Packet generation failed because no available buffer.
2054	Packet transmitted successfully.
2055	Transmission failed.
2056	Transmission retry.
2057	Packet lost because of unrecognized or illegal drop or bad route.
2058	Illegal SY/MAX operation request on local registers.
2059	Priority read received and performed upon local registers.
2060	Priority write received and performed upon local registers.
2061	Non-Priority read received and performed upon local registers.
2062	Non-Priority write received and performed upon local registers.
2063	Non-SY/MAX Ethernet packet received.
2064	Ethernet packets transmitted.
2065	Ethernet packets received.
2066	Ethernet collisions.
2067	Ethernet transmit packets lost to excess collisions.
2068	Ethernet receive packets with CRC error.
2069	Ethernet receive packets with framing error.
2070	Ethernet NAK TRANS sent (Sequence error).
2071	Number of queued messages.
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 24-5　Ethernet Port Statistics Registers (TCP/IP Mode)

Register	Incremented when the following occurs:
2049	TCP/IP RESET received.
2050	SNIC ran out of Ring Buffer, incomming packet lost.
2051	Not used in TCP/IP mode.
2052	Buffer pulled from Free Queue.
2053	Packet generation failed because no available buffer (Free Queue empty).
2054	Packet transmitted successfully (ACKed by peer).
2055	TCP connection abandoned.
2056	Transmission retry of un-acked TCP packet.
2057	Packet lost because of unrecognized or illegal drop or bad route.
2058	Illegal operation request on local registers.
2059	Modbus read received and performed upon local registers.
2060	Modbus write received and performed upon local registers.
2061	Total number of TCP connections open (Server+Client).
2062	Total number of Client TCP connections open.
2063	Non-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	Not used in TCP/IP modes..
2071	Number of queued messages.
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

Each of the four data ports has its own group of statistics registers. These are displayed in Table 24-6.

Table 24-6   Ports 1 through 4 Statistics Registers

Port 1	Port 2	Port 3	Port 4	Incremented when the following occurs:
2081	2113	2145	2177	Receipt of a packet on the port. In SY/MAX mode, packet was valid.
2082	2114	2146	2178	Incoming packet rejected (SY/MAX) or lost (other) because no available buffer.
2083	2115	2147	2179	Invalid SY/MAX packet received and negative acknowledge sent.
2084	2116	2148	2180	Message generated internally. (translation, Auto-transfer)
2085	2117	2149	2181	Internal message generation failed because no available buffer.
2086	2118	2150	2182	Packet transmitted (SY/MAX packet acknowledged by recipient.)
2087	2119	2151	2183	Transmission failed (SY/MAX retries exhausted).
2088	2120	2152	2184	Transmission retry.
2089	2121	2153	2185	Message lost because of unrecognized or illegal drop or bad route.
2090	2122	2154	2186	Illegal operation request for local command or translation.
2091	2123	2155	2187	Priority read received and performed upon this port.
2092	2124	2156	2188	Priority write received and performed upon this port.
2093	2125	2157	2189	Non-Priority read received and performed upon this port.
2094	2126	2158	2190	Non-Priority write received and performed upon this port.
2095	2127	2159	2191	Character receive error (parity, framing, etc.)
2096	2128	2160	2192	Characters transmitted
2097	2129	2161	2193	Characters received.
2098	2130	2162	2194	Reserved for future use.
2099	2131	2163	2195	Reserved for future use.
2100	2132	2164	2196	Reserved for future use.
2101	2133	2165	2197	Reserved for future use.
2102	2134	2166	2198	Reserved for future use.
2103	2135	2167	2199	Number of queued messages.
2104	2136	2168	2200	Number of bytes transmitted between SY/MAX checksum and ack returned.
2105	2137	2169	2201	Reserved for future use.
2106	2138	2170	2202	Reserved for future use.
2107	2139	2171	2203	Reserved for future use.
2108	2140	2172	2204	Last route received (drops 1,2).
2109	2141	2173	2205	Last route received (drops 3,4).
2110	2142	2174	2206	Last route received (drops 5,6).
2111	2143	2175	2207	Last route received (drops 7,8).
2112	2144	2176	2208	Buffers in use. Number indicates the buffers in use by this port.

IP Routing Table

The EPE5-TCP includes an internal IP router which is configured by a table with sixteen 12 byte entries including the IP addresses, subnet masks, and gateways. This table is held in registers 2900 through 2995.

The first two registers of each entry contain the IP address.   For local IP address, an explicit address is set here and the Flag entry is set to 1 for KEEP. For subnet gateways, the masked IP address of the subnet should appear here.

The next two registers provide the Subnet Mask (or Default Gateway IP address.)

A subnet reoute has a Subnet Address in the first two registers and the full IP address fo a gateway in the next two registers. Failing an exact match, the destination of the packet is ANDed with the local subnet mask and the resulting subnet address is searched for in the table.

A network route is treated the same as a subnet route, except that the subnet maks can be tetermined by whteher the destination is a Class A, B, or C address.

A default route is a network route with a network address of all 0's. This will also ser to mark the end of the table.

The Port Number entry only allows the value 0 for the Ehternet port at this time. When serial IP protocol modes are added to the EPE5-TCP, other port numbers will be allowed.

The Flag entry tells the router what to do with the incoming/outgoing IP packets. If set to 0, the router discards the packet. If set to 1, the router keeps the message and hands it up the protocol stack. If set to 2, the router forwards the IP packet to the port determined by the Port Number entry.

Table 24-7 below shows an example of the IP router table with the IP Address of the Ethernet port set to 199.186.195.20 and a Subnet Mask of 255.255.255.0 and a Default Gateway of 199.186.195.1.

Table 24-7   IP Router Table

Register	Description	Example (hex)	Notes	Entry
2900	IP Address MSW	C7BA	199.186	**IP Table Entry 1** This entry sets the IP address of the Ethernet port to 199.186.195.20 and the Subnet Mask to 255.255.255.0
2901	IP Address LSW	C314	195.20	
2902	Subnet Mask MSW	FFFF	255.255	
2903	Subnet Mask LSW	FF00	255.0	
2904	Port Number	0	Ethernet Port	
2905	Flag	1	Keep	
2906	IP Address MSW	0000	0.0	**IP Table Entry 2** This entry sets the Default Gateway to 199.186.195.1 so other packets not matching the subnet mask are sent to the gateway.
2907	IP Address LSW	0000	0.0	
2908	Subnet Mask MSW	C7BA	199.186	
2909	Subnet Mask LSW	C301	195.1	
2910	Port Number	0	Ethernet Port	
2911	Flag	2	Forward	
...	...	...	...	...
2990	IP Address MSW	0		**IP Table Entry 16**
...	...	...	...	
2995	Flag	0		

TCP/IP Step Size for Incremental Backoff

Register 2997 contains the decimal value in 100ths of a second, the setp size for the TCP incremental backoff timer. If a TCP packet is transmitted on an open connection, it will expect an acknowledgement from the other device within this time value. If an ACK is not received, the message will be retransmitted and the incremental timer value is doubled. This will continue until an ACK is received or the downstream timer expires. The default value is 100 decimal (1 second) which will result in the following retransmit times: 1 sec, 2 sec, 4 sec, 8 sec, 16 sec...

TCP/IP Downstream Timeout

Register 2998 contains the setpoint for the amount of time a client waits for a response from a server (or fruther downstream device). This value is expressed in 100ths of a second and the default is 500 (5 seconds). When this timer expires, a SY/MAX error 29 is returned.

TCP/IP Quiet Timeout

Register 2999 contains the setpoint for the amount of time a socket will remain open with no traffic. The units are seconds with the default equal 600 (10 minutes).

Ethernet Addresses of Known SY/MAX 802.3 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 EPE5 provides a listing of the physical Ethernet 802.3 address of each known active SY/MAX device on the network (See Table 24-8). These values are placed in Registers 3000..3302 with three registers allocated for each address. The Ethernet address requires six bytes of data and this data is split into two bytes per register. The following formulas will provide the registers containing the Ethernet address of each of the 100 possible devices on the SY/MAX network:

$$3000 + Drop * 3 = \text{First two bytes of Ethernet Address}$$
$$3001 + Drop * 3 = \text{Middle two bytes of Ethernet Address}$$
$$3002 + Drop * 3 = \text{Last two bytes of Ethernet Address}$$

Registers 3300..3302 give the Ethernet address of the EPE5.

When another device on the Ethernet has the same SY/MAX drop number (or IP Address), the EPE5 will enter a duplicate drop state. This is characterized by the red Ethernet Error light blinking 2 times a second, continiously. When the EPE5 is in this state, it places the MAC of the offending Ethernet device in the SY/MAX drop number location corresponding with the SY/MAX drop number of the Ethernet port of the EPE5.

Table 24-8   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 EPE5
3301	Middle	
3302	Last	

E-Peer Active Register

The bits of read-only register 3303 correspond to those of the first sixteen nodes on an EPE5 peer net-work which are active. If unit x is active on the network, bit x is set. If node x is powered off, discon-nected from the cable, or otherwise disabled, bit x will be cleared. Loss of the node has no effect on the timing of the other nodes. They will detect the absence of the node and clear the corresponding bit in their register 3303. If the peer network has more than sixteen nodes, node numbers 17 and beyond have no associated active bits.

SY/MAX 802.3 Active Node Search

The Ethernet Active node table may be quickly updated by writing a decimal 100 to register 3304. The EPE5 will send multicast connect messages to all 100 devices on the local E-net and will update its Active table on receipt of the replies. This is how the Utility, show Ethernet Nodes feature works in EPE5SW.

Notice: An entry in the Active nodes table only indicates that the device has been active since the EPE5 has been booted. It does not guarentee that the device is still active. The entries in the Active table are updated only as a result of good communication to that particular SY/MAX address.

Auto-Scan Table Registers

Each serial port has registers reserved for up to 48 entries in the Auto-Scan table. Registers 3410 through 3999 along with the Modbus Slave Address Tables are used to define the Auto-Scan table.

Table 24-9   Auto-Scan Configuration Registers

Port 1 Register	Port 2 Register	Port 3 Register	Port 4 Register	Data Bytes MSB	Data Bytes LSB	Description
3410	3555	3700	3845			Status Pointer
3411	5281	5921	6561	Flag	Count	Drop 1 Flags/Count
3412	5282	5922	6562			Drop 1 Local Pointer
3413	5283	5923	6563			Drop 1 Remote Pointer
3414	5284	5924	6564	Flag	Count	Drop 2 Flags/Count
3415	5285	5925	6565			Drop 2 Local Pointer
3416	5286	5926	6566			Drop 2 Remote Pointer
...	...	...	...	...	...	...
3554	5915	6555	7195			Drop 48 Remote Pointer

Modbus Slave Address Tables

The is a table of translations for each async port in the module. These tables are 640 registers long and comprise 128 entries with 5 registers each. The LSB of the first register en each entry is the number of drops in the entry or zero to indicate the entry is unassigned. Each of the remaining four registers of the entry contains two drops, one in each byte in MSB and LSB order. Up to eight drops may be included in the route. The table entries correspond to Modbus addresses in the range of N through N+127 where N is the Modbus address base value for that port and is programmed in another register. The default is 1 making the table applicable to Modbus addresses 1 through 128.

The MSB of the drop count register contains flags about the target device. Bit 9 of the drop count register is set if the target device is a NR&D Modbus master port.

The table registers occupy addresses in the 4640 through 7199 range in the EPE5.

Table 24-10   Modbus Slave Address Table

Port 1 Register	Port 2 Register	Port 3 Register	Port 4 Register	Data Bytes		Modbus Drop Numbers
				MSB	LSB	
4640	5280	5920	6560	Modbus Bit 9	Number of Drops	Address Base + 1
4641	5281	5921	6561	Drop 1	Drop 2	
4642	5282	5922	6562	Drop 3	Drop 4	
4643	5283	5923	6563	Drop 5	Drop 6	
4644	5284	5924	6564	Drop 7	Drop 8	
4645	5285	5925	6565	Modbus Bit 9	Number of Drops	Address Base + 2
4646	5286	5926	6566	Drop 1	Drop 2	
4647	5287	5927	6567	Drop 3	Drop 4	
4648	5288	5928	6568	Drop 5	Drop 6	
4649	5289	5929	6569	Drop 7	Drop 8	
...	...	...	...	...	...	...
5275	5915	6555	7195	Modbus Bit 9	Number of Drops	Address Base + 128
5276	5916	6556	7196	Drop 1	Drop 2	
5277	5917	6557	7197	Drop 3	Drop 4	
5278	5918	6558	7198	Drop 5	Drop 6	
5279	5919	6559	7199	Drop 7	Drop 8	

Note: The Modbus Bit 9 is not used on Firmware 22Nov95 or later.

The Modbus address base register is in the normal setup register area. (Table 24-11)

Table 24-11   Modbus Address Base Register

EPE5 Port	Modbus Address Base Register
1	8063
2	8095
3	8127
4	8159

When a message is received from a Modbus master, the module checks the table entry associated with the address byte in the message. If the entry is unused (the drop count register is zero), the message is ignored. (It may be intended for another slave multidropped on the Modbus with this port.) If a valid route is found, the Modbus message is translated to SY/MAX and processed locally or forwarded according to the route from the table.

By setting the Modbus address base of two ports to 1 and 128 respectively, all 255 valid Modbus addresses may be recognized and routed by the module. Note that the module must be a -D type EPE5 or SPE4 to connect two ports in this way or to multidrop the Niobrara port with other slave devices on either a two or four wire bus.

The Modbus slave port retains the original Modbus address from the received slave command and uses it to format the reply to the attached Modbus master. Modbus is a single-threaded protocol and only one request at a time may be outstanding from the port through the router.

Translation of commands received on the slave port depends on the settings of the same configuration registers that select the opcodes associated with Modbus Master operations. If the incoming packet has

an opcode of 1, 2, 3, or 4 then the Modbus message is translated into a SY/MAX priority READ. If the incoming packet has an opcode of 5, 6, 15, or 16 then the message is translated into a SY/MAX priority WRITE. The register offset is applied to the incoming packet in reverse fashion.

If the target device is marked as a NR&D Modbus master, then all incoming messages are encoded as a SY/MAX network PRINT and sent to the target device. The target port decodes the network print as a Modbus master and the Modbus reply is returned as a SY/MAX Network Print reply to be emitted at the slave port as the Modbus reply.

TCP/IP Routing Table

Outbound Ethernet TCP/IP messages are routed to the appropriate IP addresses by means of a 200 entry table that maps SY/MAX drop numbers 0 through 199 to IP addresses. Additionally, up to four downstream route drops may be added to the IP address to extend the functionality of the IP routing. This table starts at register 7900 and includes 8 bytes (4 registers) per entry. The first four bytes (2 registers) hold the destination IP address. The last four bytes (2 registers) hold the downstream route. The route is held in 1 drop per byte and is terminated by a hex FF value.

Register	Description	Example (hex)	Notes	Entry
7900	IP Address MSW	C7BA	199.186	**Entry 0** Routes to IP address 199.186.195.21 with no additional route.
7901	IP Address LSW	C315	195.21	
7902	Downstream Rt	FF00	NONE	
7903	Downstream Rt	0000		
7904	IP Address MSW	C7BA	199.186	**Entry 1** Routes to IP address 199.186.195.22 with the additional drop of 10
7905	IP Address LSW	C316	195.22	
7906	Downstream Rt	0AFF	10	
7907	Downstream Rt	0000		
7908	IP Address MSW	C7BA	199.186	**Entry 2** Routes to IP address 199.186.195.23 with the downstream route of 154,17,1
7909	IP Address LSW	C317	195.23	
7910	Downstream Rt	9A11	154,17	
7911	Downstream Rt	01FF	1	
7912	IP Address MSW	C7BA	199.186	**Entry 3** Routes to IP address 199.186.195.23 with the downstream route of 154,17,2
7913	IP Address LSW	C317	195.23	
7914	Downstream Rt	9A11	154,17	
7915	Downstream Rt	02FF	2	
...	...	...	...	**Entries 4 ... 198**
7996	IP Address MSW	B670	182.112	**Entry 199** Routes to IP address 182.112.204.7 with no additional route
7997	IP Address LSW	CC07	204.7	
7998	Downstream Rt	FFFF	NONE	
7999	Downstream Rt	FFFF		

Setup and Configuration Registers

Registers 8001..8162 are provided for the setup and configuration for the ports of the EPE5. Each Port of the EPE5 uses 32 registers to control its operational parameters. The first two registers concern the entire module and are shown in Table 24-12.

Table 24-12 Module Setup Identification Registers

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

Ethernet Port Control Registers

Registers 8003 through 8034 control the parameters of the Ethernet port on the EPE5. Table 24-13 provides a list of these registers.

Table 24-13 Ethernet Port Control Registers

Port 0	Legal Values	Function
8003	0..99	Ethernet SY/MAX drop number.
8004		Reserved
8005		Reserved
8006		Reserved
8007		Reserved
8008	2,104h	Protocol Mode 2 = SY/MAX 802.3, hex 104 = Modbus/TCP
8009	1..8192	Auto-transfer Read Source Register (Peripheral)
8010	0...65535	TCP/IP port number (Defaults to 6000 decimal)
8011	0..32767	Auto-transfer Interval in 10mS units
		E-Peer Update Interval in 1mS units
8012	1..2048	Auto-transfer Read Destination Register (Mailbox)
	0..100	Number of this E-Peer Node
8013	1..2048	Auto-transfer Write Source Register (Mailbox)
		Start of register range to transmit from this E-Peer Node.
8014	0..8	Number of drops in target route (Auto-transfer)
8015	0..255	Target Route Drop 1 (Auto-transfer)
8016	0..255	Target Route Drop 2 (Auto-transfer)
8017	0..255	Target Route Drop 3 (Auto-transfer)
8018	0..255	Target Route Drop 4 (Auto-transfer)
8019	0..255	Target Route Drop 5 (Auto-transfer)
8020	0..255	Target Route Drop 6 (Auto-transfer)
8021	0..255	Target Route Drop 7 (Auto-transfer)
8022	0..255	Target Route Drop 8 (Auto-transfer)
8023		Reserved
8024		Reserved
8025	1..32	Buffer Limit
8026	0..128	Auto-transfer Read Count
	2..100	Number of E-Peer Nodes
8027	0..128	Auto-transfer Write Count
		Number of E-Peer register to transmit
8028	1..8192	Auto-transfer Write Destination register (Peripheral)
		Destination Register in other E-Peers
8029		Reserved for future use, do not modify
8030		Reserved for future use, do not modify
8031		Options (See Table 24-26 on Page 181)
8032		Reserved for future use, do not modify
8033		Reserved for future use, do not modify
8034		Reserved for future use, do not modify

Data Port Control Registers

Each of the Data Ports may have independent settings for Drop Number, Baud Rate, Parity, Data bits, Stop bits, Mode, Auto-transfer, etc. These are controlled by register values listed in Table 24-14.

Table 24-14 Ports 1 through 4 Configuration Registers

Port 1	Port 2	Port 3	Port 4	Legal Values	Function
8035	8067	8099	8131	0..199	Drop Number
8036	8068	8100	8132	0..14	Baud Rate (See Table 24-21 on Page 179)
8037	8069	8101	8133	0,1	Data Bits (See Table 24-22 on Page 179)
8038	8070	8102	8134	0,1,2	Parity Bits (See Table 24-23 on Page 179)
8039	8071	8103	8135	0,1	Stop Bits (See Table 24-24 on Page 179)
8040	8072	8104	8136	1..19	Protocol Mode (See Table 24-25 on Page180)
8041	8073	8105	8137	0..256	Packet size limit (Modes 4, 5, and 8)
				1..8192	Auto-transfer Read Source Register (Peripheral)
				0..65535	RNIM Identification Number
8042	8074	8106	8138	0..32767	Time limit (Modes 4, 5, and 8)
				0..32767	MODBUS Host mode retry timeout
				0..65535	RNIM CTS Delay
8043	8075	8107	8139	0..32767	Multidrop window interval
				0..32767	Auto-transfer Interval
				0..65535	RNIM Message Response Timeout
8044	8076	8108	8140	0..200	Priority in Multidrop mode
				1..2048	Auto-transfer Read Destination Register (Mailbox)
				0..65535	RNIM BID Address
8045	8077	8109	8141	0..200	Number of nodes in Multidrop mode
				1..2048	Auto-transfer Write Source Register (Mailbox)
				0..65535	RNIM Number of Retries
8046	8078	8110	8142	0..8	Number of drops in target route (Modes 4,5,8 and Auto-transfer)
8047	8079	8111	8143	0..255	Target Route Drop 1 (Modes 4,5,8 and Auto-transfer)
8048	8080	8112	8144	0..255	Target Route Drop 2 (Modes 4,5,8, and Auto-transfer)
8049	8081	8113	8145	0..255	Target Route Drop 3 (Modes 4,5,8, and Auto-transfer)
8050	8082	8114	8146	0..255	Target Route Drop 4 (Modes 4,5,8, and Auto-transfer)
8051	8083	8115	8147	0..255	Target Route Drop 5 (Modes 4,5,8, and Auto-transfer)
8052	8084	8116	8148	0..255	Target Route Drop 6 (Modes 4,5,8, and Auto-transfer)
8053	8085	8117	8149	0..255	Target Route Drop 7 (Modes 4,5,8, and Auto-transfer)
8054	8086	8118	8150	0..255	Target Route Drop 8 (Modes 4,5,8, and Auto-transfer)
8055	8087	8119	8151	1,2,3,4	MODBUS Host equivalent READ command
8056	8088	8120	8152	5,6,15,16	MODBUS Host equivalent WRITE command
8057	8089	8121	8153	1..16	Buffer Limit
8058	8090	8122	8154	0..128	Auto-transfer Read Count
				0..65535	RNIM Pause Time (Port 0 does not support Mode 12, 13)

8059	8091	8123	8155	0..128	Auto-transfer Write Count
				0..65535	RNIM Message Count (Port 0 does not support Mode 12, 13)
8060	8092	8124	8156	1..8192	Auto-transfer Write Destination Register (Peripheral)
				0..65535	RNIM BID Reply Interval (Port 0 does not support Mode 12, 13)
8061	8093	8125	8157	0..32767	MODBUS Host Offset (Register Bias)
8062	8094	8126	8158		Options (See Table 24-26 on Page 181)
8063	8095	8127	8159	0..127	Modbus Slave Address Base
8064	8096	8128	8160	0..65525	PAD Count in SY/MAX, N-T-N or CTS Delay in 10mS units for Modbus
8065	8097	8129	8161	0..65535	Modbus RTU inter-character timeout in mS. (default is 4 characters)
8066	8098	8130	8162		Reserved for future use, do not modify

Several Modes of operation require several setup registers. The following tables provide a convenient reference to the registers used in these modes.

Table 24-15 Control Registers for Transparent, Share, and Gateway Modes

Port 1	Port 2	Port 3	Port 4	Legal Values	Function
8041	8073	8105	8137	0..256	Packet Size Limit
8042	8074	8106	8138	0..32767	Time Limit
8046	8078	8110	8142	0..8	Number of Drops in target route
8047	8079	8111	8143	0..255	Target route Drop 1
8048	8080	8112	8144	0..255	Target route Drop 2
8049	8081	8113	8145	0..255	Target route Drop 3
8050	8082	8114	8146	0..255	Target route Drop 4
8051	8083	8115	8147	0..255	Target route Drop 5
8052	8084	8116	8148	0..255	Target route Drop 6
8053	8085	8117	8149	0..255	Target route Drop 7
8054	8086	8118	8150	0..255	Target route Drop 8

Table 24-16 Control Registers for Multidrop Mode

Port 1	Port 2	Port 3	Port 4	Legal Values	Function
8043	8075	8107	8139	0..32767	Multidrop window Interval
8044	8076	8108	8140	0..200	Priority in Multidrop mode
8045	8077	8109	8141	0.200	Number of nodes in Multidrop

Table 24-17 Control Registers for MODBUS Host

Port 1	Port 2	Port 3	Port 4	Legal Values	Function
4640..5279	5280..5919	5920..6559	6560..7199		MODBUS Slave Address Table
8042	8074	8106	8138	0..32767	MODBUS Host Retry Timeout
8054	8087	8118	8151	1,2,3,4	MODBUS Host READ command
8055	8088	8119	8152	5,6,15,16	MODBUS Host WRITE command
8061	8093	8125	8157	0..32767	MODBUS Host Offset (Register Bias)
8063	8085	8127	8159	0..127	MODBUS Host Slave Address Base

Table 24-18 Control Registers for Auto-transfer

E-Net Port	Port 1	Port 2	Port 3	Port 4	Legal Values	Function
8011	8043	8075	8107	8139	0..32767	Interval
8009	8041	8073	8105	8137	1..8192	Read Source Register (Peripheral)
8012	8044	8076	8108	8140	1..2048	Read Destination Register (Mailbox)
8026	8059	8090	8122	8154	0..128	Read Count
8013	8045	8077	8108	8141	1..2048	Write Source Register (Mailbox)
8028	8060	8092	8124	8156	1..8192	Write Destination Register (Peripheral)
8027	8059	8091	8123	8155	0..128	Write Count
8014	8046	8078	8110	8142	0..8	Number of Drops in target route
8015	8047	8079	8111	8143	0..255	Target route Drop 1
8016	8048	8080	8112	8144	0..255	Target route Drop 2
8017	8049	8081	8113	8145	0..255	Target route Drop 3
8018	8050	8082	8114	8146	0..255	Target route Drop 4
8019	8051	8083	8115	8147	0..255	Target route Drop 5
8020	8052	8084	8116	8148	0..255	Target route Drop 6
8021	8053	8085	8117	8149	0..255	Target route Drop 7
8022	8054	8086	8118	8150	0..255	Target route Drop 8

Table 24-19   Control Registers for RNIM Master

CRM-560 Register	SPE4/EPE5 Register				Description	Notes
	Port 1	Port 2	Port 3	Port 4		
18	8041	8073	8105	8137	Identification number.	Must be the same for all RNIMs on the same network. CRM-560 defaults to 0 on power-up.
19	8042	8074	8106	8138	Clear to Send (CTS) Delay (10mS units)	CRM-560 defaults to 500mS on power-up.
20	8043	8075	8107	8139	Message Response timeout (10mS units)	CRM-650 defaults to 20 seconds on power-up. The EPE5 also uses this value as the BID timeout.
21	8044	8076	8108	8140	BID address number	01 to 99 Single BID. 100 to 199 Automatic BIDs. 200 to 299 Continuous Single BIDs 300 to 399 Continuous Automatic BIDs.
22	8045	8077	8109	8141	Number of Retries (when no ACK received)	CRM-560 defaults to 3 on power-up.
23	8062	8094	8126	8158	Master Disable	Set bit 9 in the SPE4/EPE5 options register to disable the Master. Set the CRM-560 register to decimal 123 to disable the Master.
25	8058	8090	8123	8155	Pause Time (10mS units)	CRM-560 defaults to 15 seconds on power-up.
26	8059	8091	8124	8156	Message Count (between Pause Time)	CRM-560 defaults to 4 on power-up.
NA	8060	8092	8125	8157	BID Reply Interval	This value determines the amount of time between successive automatic BIDs.
NA	2103	2135	2167	2199	Number of messages in Command Buffer	Read Only Statistic that displays the number of queued messages waiting in the Command buffer.

Table 24-20   Control Registers for RNIM Slave

CRM-560 Register	SPE4/EPE5 Register				Description	Notes
	Port 1	Port 2	Port 3	Port 4		
18	8041	8073	8105	8137	Identification number.	Must be the same for all RNIMs on the same network. CRM-560 defaults to 0 on power-up.
19	8042	8074	8106	8138	Clear to Send (CTS) Delay (10mS units)	CRM-560 defaults to 500mS on power-up.
20	8043	8075	8107	8139	Message Response timeout (10mS units)	CRM-650 defaults to 20 seconds on power-up. The EPE5 also uses this value for the BID timeout.
24	8062	8094	8126	8158	Clear Command Buffer	Set bit 9 in the SPE4/EPE5 options register to clear the Command buffer. Set the CRM-560 register to decimal 210 to remove stored commands from the buffer.
NA	2103	2135	2167	2199	Number of messages in Command Buffer	Read Only Statistic that displays the number of queued messages waiting in the Command buffer.

The above tables make reference to baud rate values, stop bit values, parity values, and mode values. The following tables define these values.

Table 24-21 Baud Rate Values

Baud Register	Baud Rate
0	50
1	75
2	110
3	134.5
4	150
5	300
6	600
7	1200
8	1800
9	2400
10	3600
11	4800
12	7200
13	9600
14	14400
15	19200

Table 24-22 Data Bits Values

Data Register	Data Bits
0	7
1	8

Table 24-23 Parity Values

Parity Register	Parity
0	None
1	Odd
2	Even

Table 24-24 Stop Bits Values

Stop Register	Stop Bits
0	1
1	2

Table 24-25 Port Mode Values

Mode Register	Protocol
1	SY/MAX
2	Net-to-Net
3	Peripheral
4	Transparent
5	Share
6	PLogic
7	Idec
8	Gateway
9	Multidrop
10	MODBUS Host
11	PNIM
12	RNIM Master
13	RNIM Slave
14	MODBUS Gate
15	Transfer
16	Chevron
17	Reserved
18	Modbus ASCII
19	Dual SlaveI

Table 24-26 Options Register Values

Option Bit	Function when Bit CLEAR (Default)	Function when Bit SET
1	SY/MAX Block Check is single byte checksum (BCC) Also Ethernet TCP/IP SNAP mode.	SY/MAX Block Check is two byte cyclic redundancy check (CRC) Also Ethernet TCP/IP non-SNAP mode.
2	Gateway, Share, and Transparent do echo. Normal 205 Route Replacement Telnet enabled for TCP/IP.	Gateway, Share, and Transparent do echo. PanelMate 205,X lookup table routing. Telnet Disable for the E-net port in TCP/IP.
3	Gateway mode replies are terminated by CR only. BOOTP/DHCP Enabled on Ethernet port in TCP/IP Modes.	Gateway mode replies are terminated by CR/LF and are highlighted. Also, Disable BOOTP/DHCP on Ethernet Port in TCP/IP Modes.
4	Gateway, Share, and Transparent messages are terminated by any control character as well as the time and count settings.	Gateway, Share, and Transparent messages are terminated only by time and count termination settings. All characters are treated the same.
5	Normal routing. (Route Replacement OFF)	Route Appendix replaces any existing incoming packet (Route Replacement ON).
6	Auto-Transfer Enabled for E-Net Port. Normal Routing for Ports 1..4	E-Peer Enabled for E-Net Port. "On Ethernet" Enabled for Ports 1..4
7	Multidrop False	Multidrop True
8	Full Duplex (For 4-Wire) BNC enable for EPE5-MMS units.	Half Duplex (For 2-Wire) AUI enable for EPE5-MMS units.
9	RNIM Master enabled. Slave buffer normal. Modbus Host PowerLogic R[8188] Spoofing OFF.	RNIM Master Disabled, Slave buffer cleared. Modbus Host PowerLogic R[8188] Spoofing ON.
10	Normal SMS register 8188 spoofing as set by bit 9.	Uses value in R[Option+1] for the SMS 8188 spoofing.
11	Reserved.	Reserved.
12	Reserved.	Reserved.
13	Reserved.	Reserved.
14	Reserved.	Reserved.
15	Reserved.	Reserved.
16	Reserved.	Reserved.

Options

The Options Register allows the modification of the normal operation of several features of the EPE5.

- Bit 1 controls the error checksum used by SY/MAX, Net-to-Net, and Multidrop mode ports. If this bit is clear then the default single byte BCC is used. If set, the two byte CRC checksum is used. Normal SY/MAX messages use the BCC while the CRC is normally used on modem connections when the parity is disabled.

- Bit 2 determines whether the Gateway, Transparent, and Share ports echo all characters received. This may be useful when using a terminal on a Gateway port to see what is being typed. This feature is also useful when transparently programming Model 50 PLCs with an Idec Port.

  Bit 2 also controls the enhanced Route Appendix operation for use with Eaton PanelMate Operator Interfaces and other devices capable of only two drop routes. When Bit 2 is set on a SY/MAX mode port, if a command message is received with a route of 205,X the EPE5 will use the X entry in the Modbus Slave Routing table for the new route. The message will be routed according to this new route. When the reply from the new route is received at this SY/MAX port, the reversed route X,205 will be sent back to the PanelMate.

Bit 2 determines whether the TELNET application is enabled when in a TCP/IP mode on the Ethernet port. The default value is TELNET enabled (bit cleared).

- Bit 3 determines whether the Gateway Mode terminates its messages (output) with a carriage return or with a carriage return and line feed and the reply is highlighted on ANSI terminals.

  Bit 3 also controls BOOTP/DHCP for the Ethernet port while in any of the TCP/IP modes. If bit 3 is ON then BOOTP/DHCP is disabled.

- Bit 4 determines whether Gateway, Transparent, and Share modes are terminated by control characters such as a carriage return or line feed.

- Bit 5 enables the Route Replacement feature on a SY/MAX mode port. When set, the incoming route is saved and is instead replaced by the route stored in the Target Route Registers. The reply message has the original route reversed and replaced to send back to the originator.

- Bit 6 Enables the E-Peer function on the Ethernet port. If this bit is cleared, then the normal Auto-transfer functions are enabled on the Ethernet port.

  Bit 6 also controls the "On Ethernet" status of the four serial ports.

- Bit 7 sets the Multidrop status of the serial port RS-485 driver. When clear, the TX driver is always enabled (i.e. RS-422). When set, the TX driver is controlled by the CTS signal. When CTS is enabled (ON), the transmit driver is enabled and when CTS is not enabled (OFF), the transmit driver is tri-stated and allowed to "float" thus allowing other devices on the multidrop network to transmit.

- Bit 8 sets the full/half-duplex mode of the serial port RS-485 receiver. When clear, the receiver is always enabled which allows full duplex operation. When this bit is set, the receiver is disabled whenever the port is transmitting. This feature is used on two-wire systems and on devices which echo to prevent the EPE5 port from hearing its own message.

- Bit 9 controls the disabling of the RNIM Master port. Only one RNIM Master may be active on a given RNIM network at a time. Redundant RNIM Masters may be placed on the system but disabled by setting this bit for the Master's port.

  Bit 9 also may be used in the RNIM Slave mode ports to clear the buffer of queued messages waiting for BIDding.

  Bit 9 also is used on Modbus Host ports to provide spoofing of PowerLogic System software. All PowerLogic softwares send a SY/MAX read to register 8188 to determine if the device is online. Not all Modbus devices may be configured to have an address within this range. When this bit is set, the Modbus Host port intercepts a single register SY/MAX read of register 8188 and translates that message to a Modbus Report Slave ID (opcode 17 decimal) message. The Slave ID and the Run/Halt status of the Modbus device are returned as the data to the register 8188 read. The Slave ID byte is returned as the LSB of register 8188. Bit 14 of 8188 will always be set to indicate that this translation has occurred. And Bit 15 of 8188 will be set if the Modbus device is in RUN and clear if the device is in Halt.

- Bit 10 is an enhancement of the Modbus register 8188 spoofing for PowerLogic SMS. If this bit is set, the value in the Modbus Address Starting Base register (R[options+1]) is used as the register for the translated read of 8188. Bits 9 and 10 must both be set for this feature to function.

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 24-27 provides an overview of these registers.

Table 24-27 Module Identification Registers

Register	Legal Values	Definition
8176	Bit 16, Bits 1..5	Port number (not drop number) that is being used to communicate with the module. Bit 16 is always set. Bits 1..5 indicate port number.
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	Bits 0..4	Read state of CTS pins. DO NOT WRITE values to this register!! Writing values to this register may cause unpredictable action of RTS for ports 1..4 and may impede communication!
8188	9990 (hex)	Constant 9990(hex). Indicates NR&D module with name starting at Reg. 8177.

For example, if the EPE5 has a Firmware revision of 25MAY94, Registers 8177..8186 would have the values in Table 24-28.

Table 24-28 Module ID Example

Register	Values (hex)	Packed ASCII Values
8177	4550	EP
8178	4535	E5
8179	2032	2
8180	354D	5M
8181	4159	AY
8182	3934	94
8183	4520	E
8184	2020	
8185	2020	
8186	2020	

Connector Pinouts

RS-422/485 data port (DE9S with slide lock posts) ports 1-4

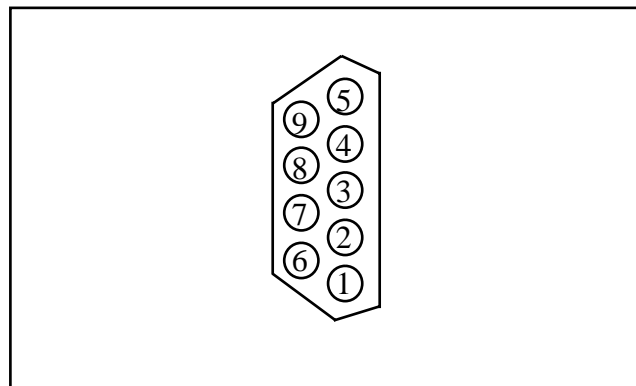| Pin	Name	Description
1	TX-	transmit data (inverted) from EPE5 to output device
2	TX+	transmit data (non-inverted) from EPE5 to output device
3	RX-	receive data (inverted) from data source to EPE5
4	RX+	receive data (non-inverted) from data source to EPE5
5	CTS-	must be more negative than pin 7 to allow EPE5 to transmit
6	RTS-	driven low (0V) when EPE5 is ready to receive data
7	CTS+	must be more positive than pin 5 to allow EPE5 to transmit
8	RTS+	driven high (+5V) when EPE5 is ready to receive data
9	Shield	

Figure 25-1   DE9S Pin configuration

AUI Ethernet port (DB15S with slide lock)

Pin	Name	Description
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 EPE5)
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 (500mA max)
14	VS	Voltage Shield (gnd)
15	CO-B	Control Out - (No connection in EPE5)
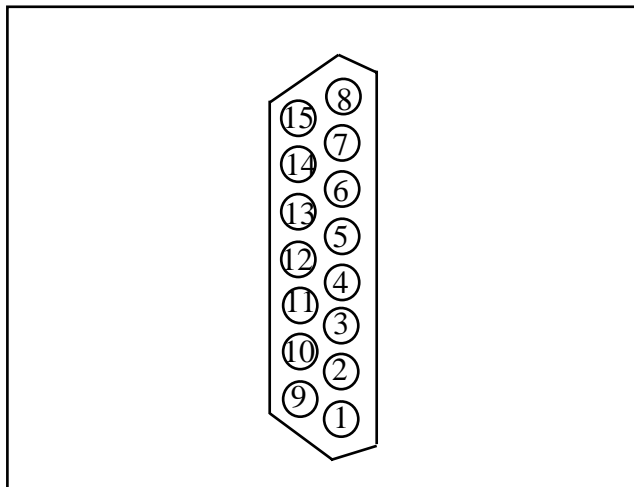
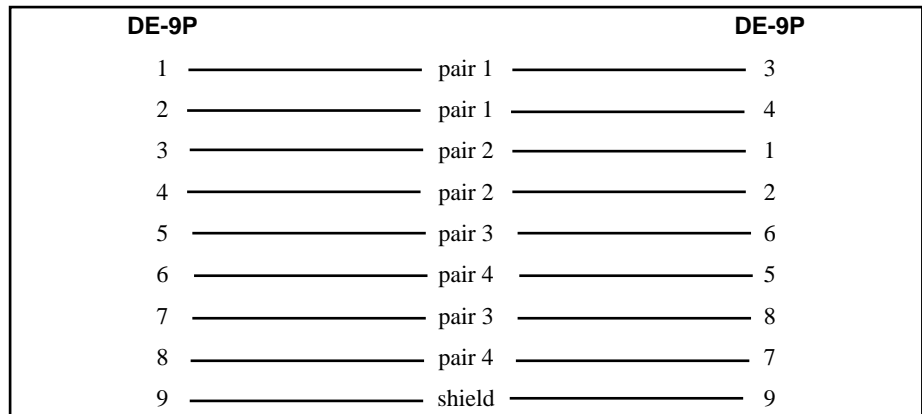**Figure 25-2   DB15S Pin configuration**

Recommended Cabling

EPE5 RS-422 to SY/MAX RS-422 port (Without Handshaking)

DE-9P			DE-9P
1	—————— pair 1	——————	3
2	—————— pair 1	——————	4
3	—————— pair 2	——————	1
4	—————— pair 2	——————	2
5			5
6			6
7			7
8			8
9	—————— shield	——————	9
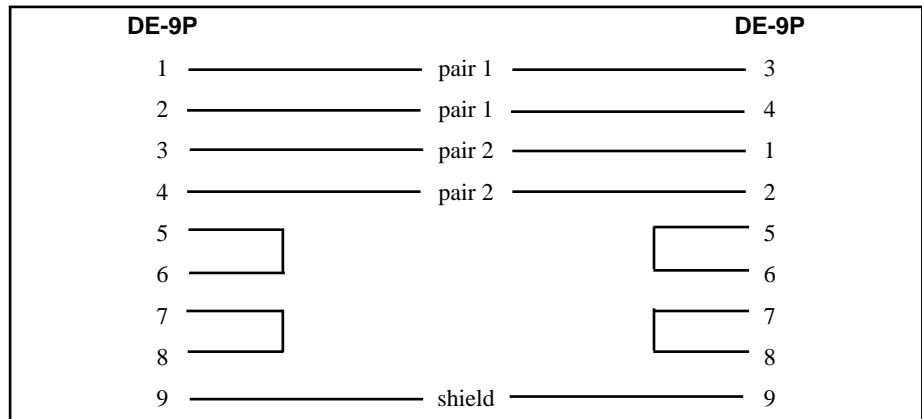
This is a Niobrara **DC1** cable. This cable is used for connecting an EPE5 port to a Square D PLC such as a Model 300, 400, 500, 600, 700 etc. This cable is also use for connecting EPE5 ports to NIMs, SY/LINK RS-422 ports, DLOGs, AIM4 Print/Prog ports, other EPE5s, SPE4s, IBSMs, RM14Ks, 2496Xs, CAM500s, and other SY/MAX ports that do not require active handshake lines.
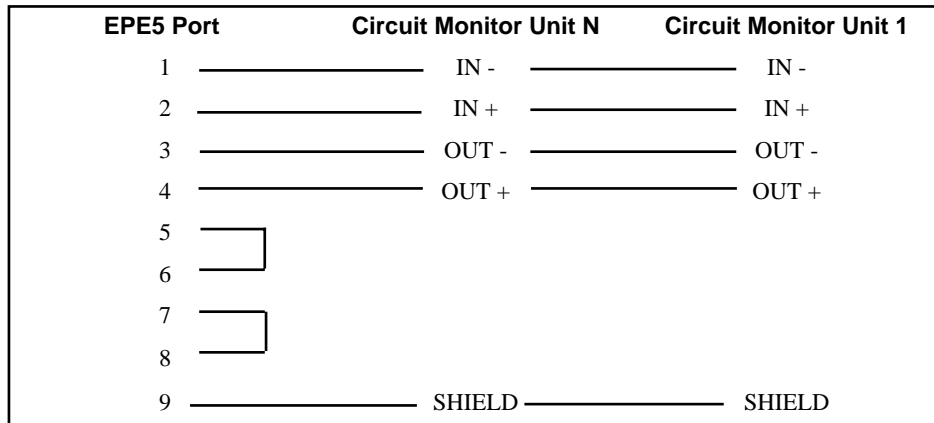
EPE5 RS-422 to SY/MAX RS-422 port (With Handshaking)

DE-9P			DE-9P
1	—————— pair 1	——————	3
2	—————— pair 1	——————	4
3	—————— pair 2	——————	1
4	—————— pair 2	——————	2
5	—————— pair 3	——————	6
6	—————— pair 4	——————	5
7	—————— pair 3	——————	8
8	—————— pair 4	——————	7
9	—————— shield	——————	9

This is a DC2 cable and it is used for connecting the EPE5 to devices that require active handshaking. These devices include: modems, other NIMs, other EPE5s, SPE4s, RM14Ks etc.

> NOTICE: Never use an active handshake line cable to connect to a SY/MAX port that has +5V for handheld or smart cable power. These ports include the Square D PLCs such as the Model 100, 300, 400, 500, 600, and 700 families, the Niobrara AIM4 Print/Prog port, the CAM500 RS-422 port, the UCM1-D port, Port 0 on any SPE4, the SY/MAX port on an IBSM.

EPE5 RS-422 port to PowerLogic RS-485 (4-wire Multidrop Master)

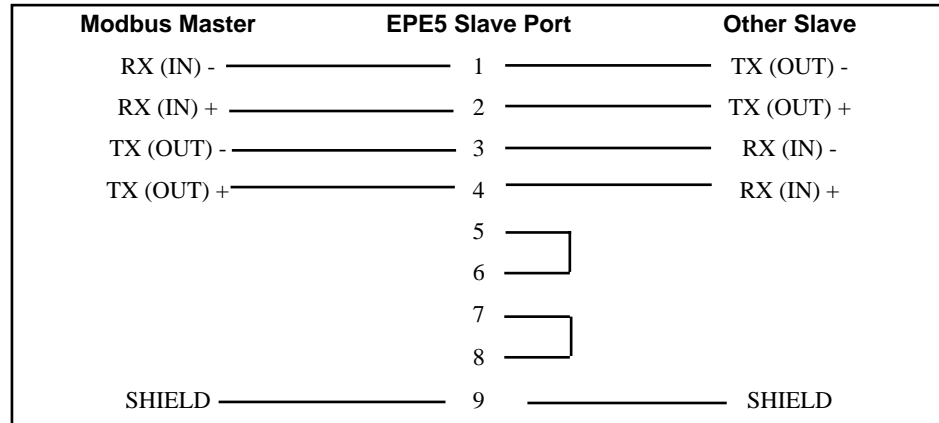| EPE5 Port	Circuit Monitor Unit N	Circuit Monitor Unit 1
1	IN -	IN -
2	IN +	IN +
3	OUT -	OUT -
4	OUT +	OUT +
5		
6		
7		
8		
9	SHIELD	SHIELD

When connecting to PowerLogic, or any other 4-wire multidrop network, always include proper termination at the far end of the network. The EPE5's RS-485 ports have internal biasing and terminating resistor networks so there is no need for termination at the EPE5 end.

For 4-wire networks, such as the PowerLogic network, where the EPE5 is serving as the master, leave the Driver Mode in "PT TO PT". This will enable the EPE5's transmit drivers continuously and force that line to a known state at all times.

Be certain to jumper the RTS/CTS pairs at the EPE5 port.

EPE5 RS-485 port to Modicon RS-485 (4-wire Multidrop Slave)

```
              Modbus Master        EPE5 Slave Port        Other Slave

              RX (IN) - ───────────── 1 ───────────── TX (OUT) -

              RX (IN) + ───────────── 2 ───────────── TX (OUT) +

              TX (OUT) - ──────────── 3 ───────────── RX (IN) -

              TX (OUT) +──────────── 4 ───────────── RX (IN) +

                                      5 ─┐
                                         │
                                      6 ─┘

                                      7 ─┐
                                         │
                                      8 ─┘

              SHIELD ───────────────── 9 ───────────── SHIELD
```
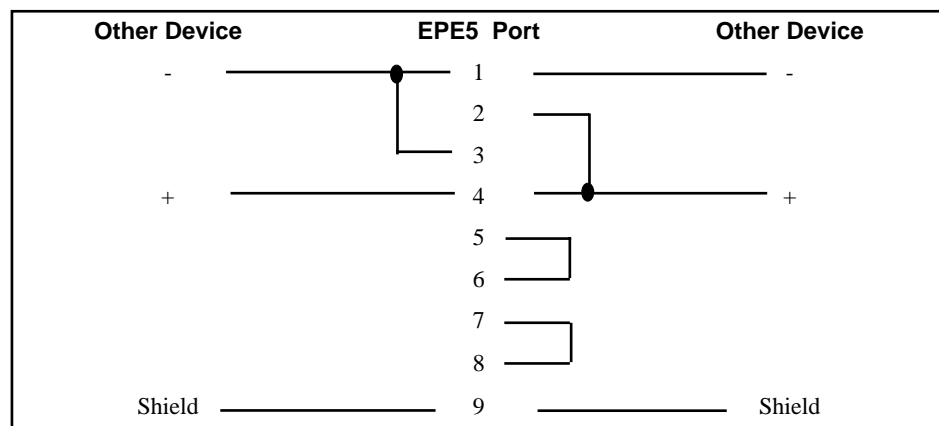
When connecting to Modicon 4-wire multidrop networks, always include proper termination at the far end of the network. The EPE5's RS-485 ports have internal biasing and terminating resistor networks so there is no need for termination at the EPE5.

For 4-wire networks, such as the Modicon network, where the EPE5 is serving as a slave, set the Options bits for Multidrop on so Multidrop is set to TRUE. This will disable the EPE5's transmit drivers and allow that line float so the other slaves may transmit when it is their turn. Also leave the Option for Duplex off for FULL duplex operation. These Options bits may be set with the Driver Mode = FOUR WIRE within EPE5SW.

Be certain to jumper the RTS/CTS pairs at the EPE5 port.

EPE5 RS-485 port to Modicon RS-485 (2-wire Multidrop)

```
              Other Device          EPE5  Port          Other Device

                  -   ──────────●── 1 ─────────────── -

                                │   2 ─┐
                                │      │
                                └── 3  │
                                       │
                  +   ─────────────── 4 ──●─────────── +

                                      5 ─┐
                                         │
                                      6 ─┘

                                      7 ─┐
                                         │
                                      8 ─┘

              Shield ───────────────── 9 ───────────── Shield
```

When connecting to Modicon 2-wire multidrop networks, always include proper termination at the far ends of the network. The EPE5's RS-485 ports have internal biasing and terminating resistor networks so there is no need for termination at the EPE5.

For 2-wire networks, such as the Modicon network,, set the Options bits for Multidrop on so Multidrop is set to TRUE. This will disable the EPE5's transmit drivers and allow that line float so the other slaves may transmit when it is their turn. Also Set the Option for Duplex on for HALF duplex opera-

tion. This will allow the EPE5 to not hear its own transmissions. These Options bits may be set with the Driver Mode = TWO WIRE within EPE5SW.

Be certain to jumper the RTS/CTS pairs at the EPE5 port.

Personal Computer RS-232 to EPE5 RS-422 port

Use of a Niobrara SC406 or SC902 smart cable is recommended, although any RS-232 to RS-422 converter may be used.

Note: The included power supply with the SC406 or SC902 must be used when connecting to ports 1-4 of the EPE5-D.

The SC406 and SC902 RS-232 to RS-422 converter cables may be used whenever a single RS-232 port is required on a EPE5-D.

It should be noted that the SC406 and SC902 do not support handshaking and that functionality of certain modes of the EPE5 may not be implemented. But in most cases this will not be a concern.

27
Applications

This chapter describes a few actual applications for the EPE5 PLUS modules.

Example 1 : Blue Hose SY/NET programming through Ethernet

A personal computer with a Square D SFI-610 Ethernet card is used to program several Model 650 and 450 processors on a LAN using SY/MATE PLUS ver. 2.x software. The factory also includes a "Blue hose" SY/NET network consisting several Model 400 and 600 processors. It is desired to program the non-Ethernet processors from the Ethernet equipped personal computer. The EPE5 is used as a bridge between the Ethernet and Blue Hose SY/NET to allow programming and data exchange between networks.

The EPE5 is located in a rack where the Ethernet and a CRM-510 NIM are present. One of the RS-422 ports of the NIM is connected to a port on the EPE5 in Net-to-Net mode. The baud rates of each unit must be set to match. The drop number of the EPE5 Net-to-Net is set to match the drop number of the NIM port. The E-Net drop number of the EPE5 is set to be different than any other SY/NET Ethernet device on the network.

It should be noted that this application is not limited to programming. The other processors on each network could use this bridge to route packets to each other. This type of bridge could also be used in the opposite direction with a personal computer using a SFI-510 card. The SY/LINK card could be used to program the Ethernet processors through the SY/NET Blue Hose.
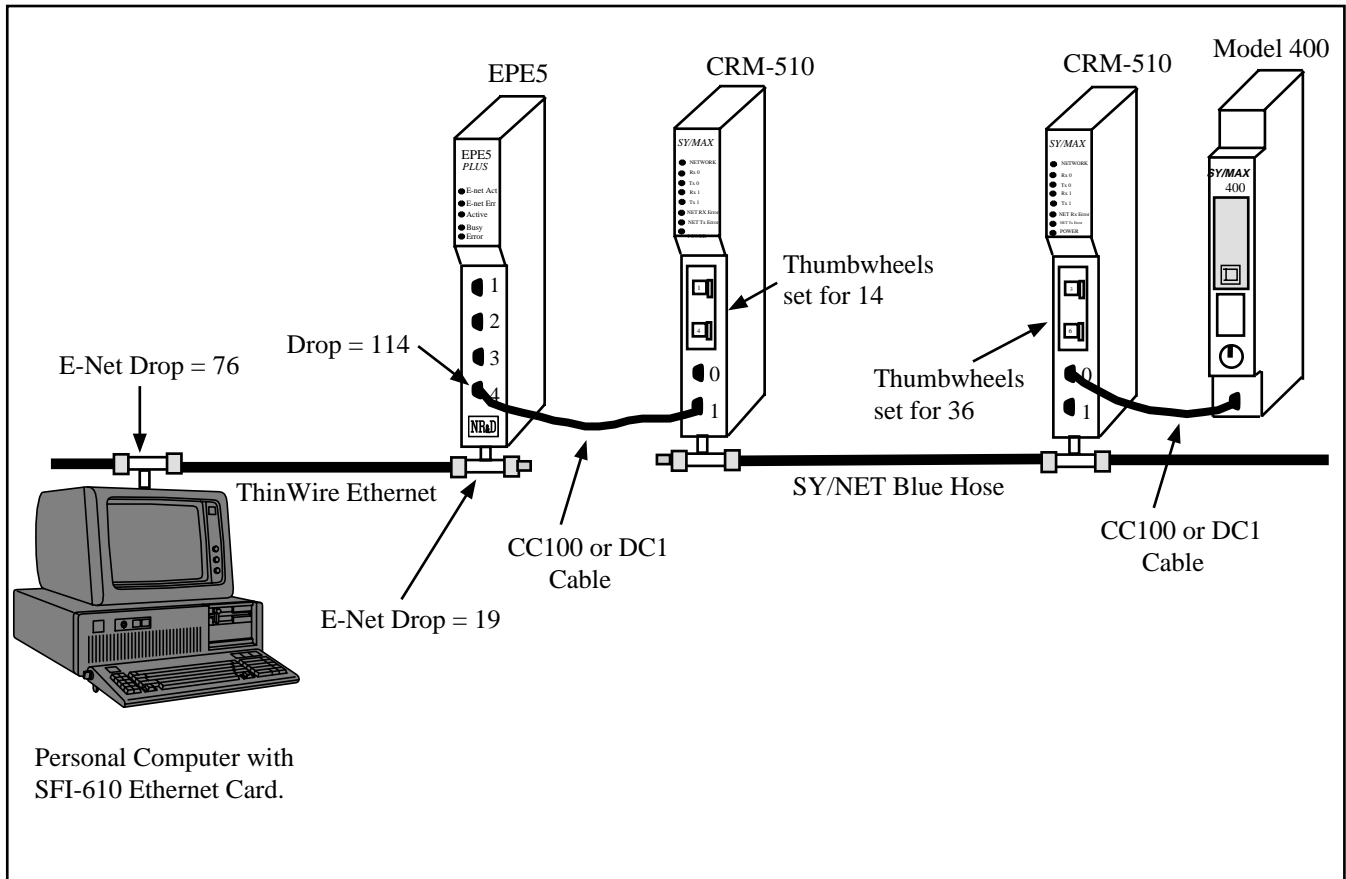
Figure 27-1   NIM Net-to-Net Example

Table 27-1   Personal Computer route

Origin	Target	Route
Personal Computer	Model 400	076 019 114 036

Table 27-2   EPE5 Setup for NIM Net-to-Net Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop
E-Net	19	SY/MAX	NA	NA	NA	NA
4	114	Net-to-Net	9600	E	8	1

Example 2: OI to Model 650

In an upgrading project, an existing Model 650 processor system will receive 8 operator interfaces. The Model 650 is already on a ThinWire network. Throughput requirements will not permit the use of the SPE4 port expander to route the OIs through the 650's RS-422 ports. Since the application is already operating the time required to reprogram the Model 650 to allow rack addressing of two SPE4 PLUS units for direct backplane mailbox access is prohibitive. The solution is to use two EPE5 units with an Ethernet connection to the Model 650.

Both EPE5 units are mounted in Register Racks and a ThinWire is extended to include these modules. Each EPE5 has its E-Net drop number set to a unique value from every other SY/NET E-Net device.

Each OI is connected to a port of the EPE5s. The route of each OI is set for the drop number of the EPE5 RS-422 port, the EPE5 E-Net port, and finally the Model 650 E-Net port.
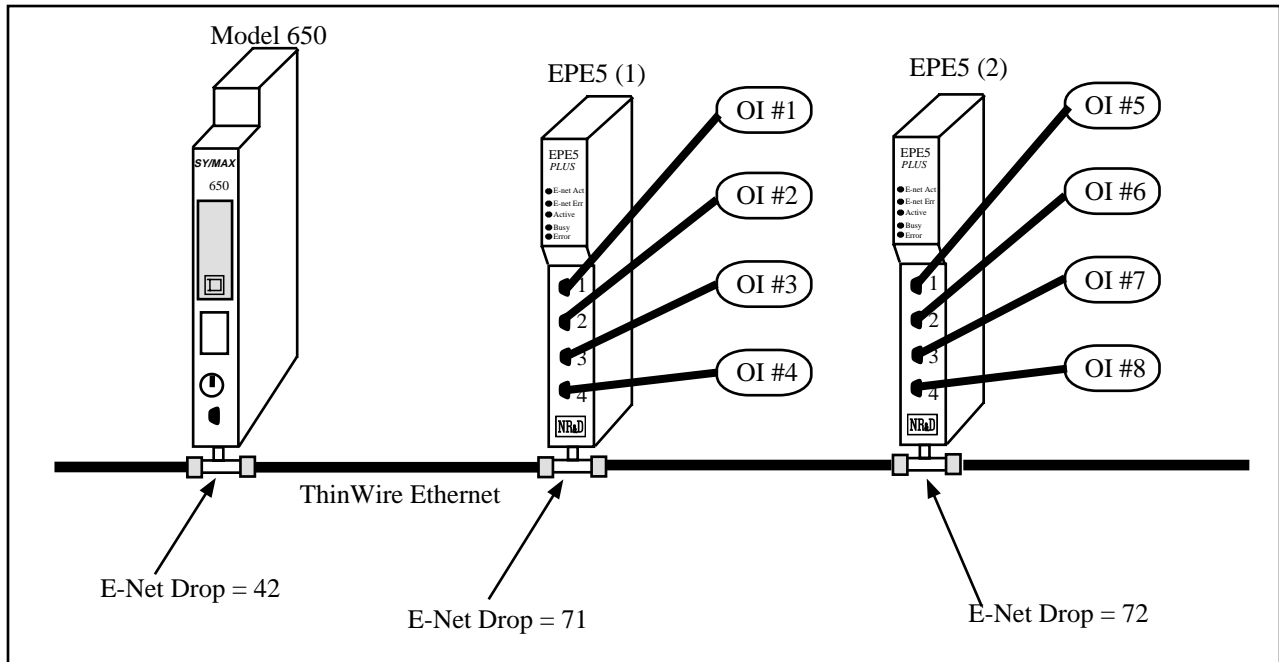

Figure 27-2   EPE5 Operator Interface Ethernet Routing Example

Table 27-3   EPE5 OI Routing Examples

Origin	Target	Route
OI #1	Model 650	001, 071, 042
OI #2	Model 650	101, 071, 042
OI #3	Model 650	002, 071, 042
OI #4	Model 650	102, 071, 042
OI #5	Model 650	003, 072, 042
OI #6	Model 650	103, 072, 042
OI #7	Model 650	004, 072, 042
OI #8	Model 650	104, 072, 042

Table 27-4   EPE5 (1) Setup

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop
E-Net	71	SY/MAX	NA	NA	NA	NA
1	1	SY/MAX	9600	E	8	1
1	101	SY/MAX	9600	E	8	1
1	2	SY/MAX	9600	E	8	1
1	102	SY/MAX	9600	E	8	1

Table 27-5   EPE5 (2) Setup

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop
E-Net	72	SY/MAX	NA	NA	NA	NA
1	3	SY/MAX	9600	E	8	1
1	103	SY/MAX	9600	E	8	1
1	4	SY/MAX	9600	E	8	1
1	104	SY/MAX	9600	E	8	1

On Ethernet

Certain Operator Interfaces do not fully support the 8 levels of the SY/MAX route. For example, the Eaton IDT PanelMate OI only supports a two drop route. The On Ethernet feature of the EPE5 may be used to reduce the number of drops required to reach the Model 650 so this operator interface may be implemented. In the above example, if the On Ethernet feature of each serial port is turned on, the network will now consist of the Ethernet drop numbers: 1, 2, 3, 4, 42, 71 and 72.   The PanelMate would have the Network ID set to its EPE5 port number and the PLC ID set for 42.

Origin	Target	Route
OI #1	Model 650	001, 042
OI #2	Model 650	101, 042
OI #3	Model 650	002, 042
OI #4	Model 650	102, 042
OI #5	Model 650	003, 042
OI #6	Model 650	103, 042
OI #7	Model 650	004, 042
OI #8	Model 650	104, 042

For more information about On Ethernet, see Chapter 22 on page 131.

Example 3: Redundant Networks

A system requires redundant paths among several Model 450 and 650 processors. The basic ThinWire network from processor to processor will serve as the main network. An EPE5 module at each processor with an RS-422 connection to the processor will serve as the redundant network. Upon recognition of a communication fault, by monitoring the status register of communication rungs, each processor could change the communication port and route through the EPE5 Ethernet Network.
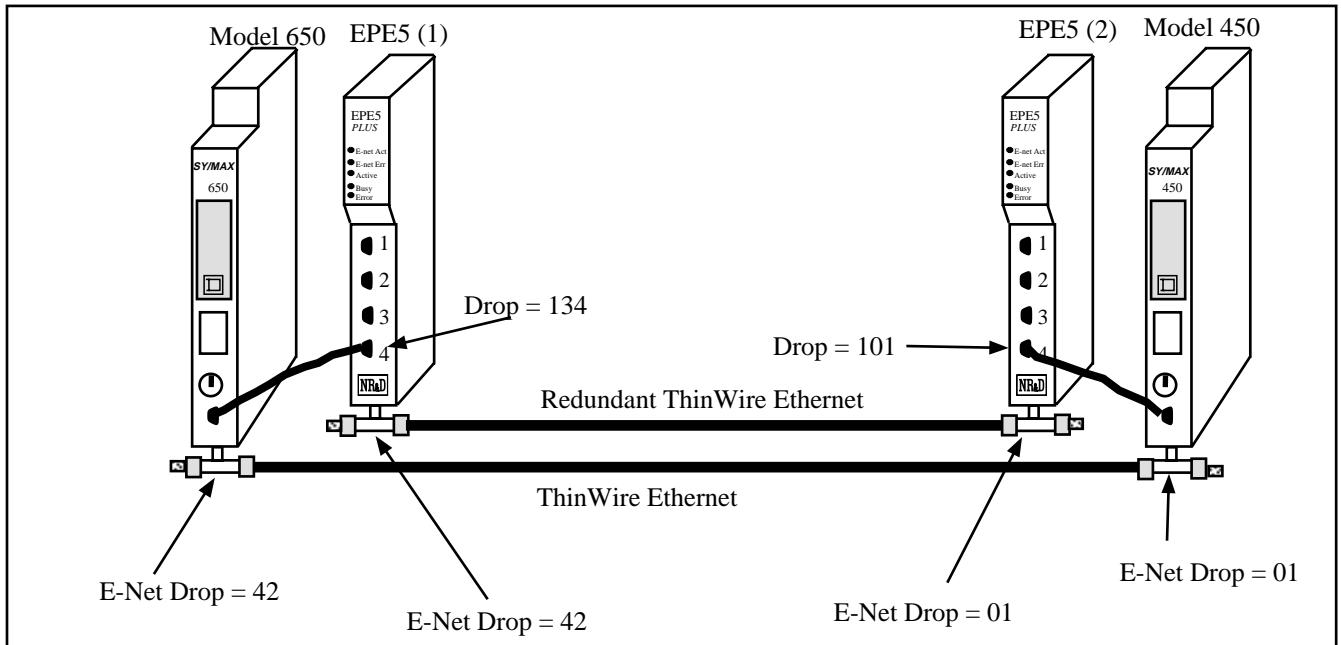
Figure 27-3   Redundant Ethernet Network

Example 4: Auto-Scan of PowerLogic Circuit Monitors

The Auto-Scan feature of the EPE5 may be used to automatically read data from a network of circuit monitors to the EPE5's mailbox registers. This data may be accessed directly from the backplane from a Square D PLC, from the Ethernet port from any device, or from any other serial port with a minimum of read transactions.

In this example, (see Figure 27-5) three CM-100 units addressed 1, 2, and 3 and a CM-2350 unit addressed 4 are connected to Port 1 of an EPE5. This EPE5 port is in PLOGIC mode and has a network drop number of 100. The Transfer Interval is set to 50 to allow a 1/2 second polling rate. Figure 27-4 displays the Edit screen for this example.

```
        E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                                                         06Feb96
                    CONFIGURATION AND UTILITY SOFTWARE     Press F2 for help.
                   ETHERNET   PORT 1       PORT 2      PORT 3      PORT 4
Drop               0          100          101         2           102
On Ethernet        YES        NO           NO          NO          NO
Protocol                      PLOGIC       SY/MAX      SY/MAX      SY/MAX
Baud Rate                     9600         9600        9600        9600
Parity                        EVEN         EVEN        EVEN        EVEN
Data Bits                     8            8           8           8
Stop Bits                     1            1           1           1
Buffer Limit       16         16           16          16          16

Error Check                   BCC


Transfer Interval             50
Transfer Route                NONE
Read Count                    0
Read From                     128
Read To                       0
Write Count                   0
Write To                      0
Write From                    10
```
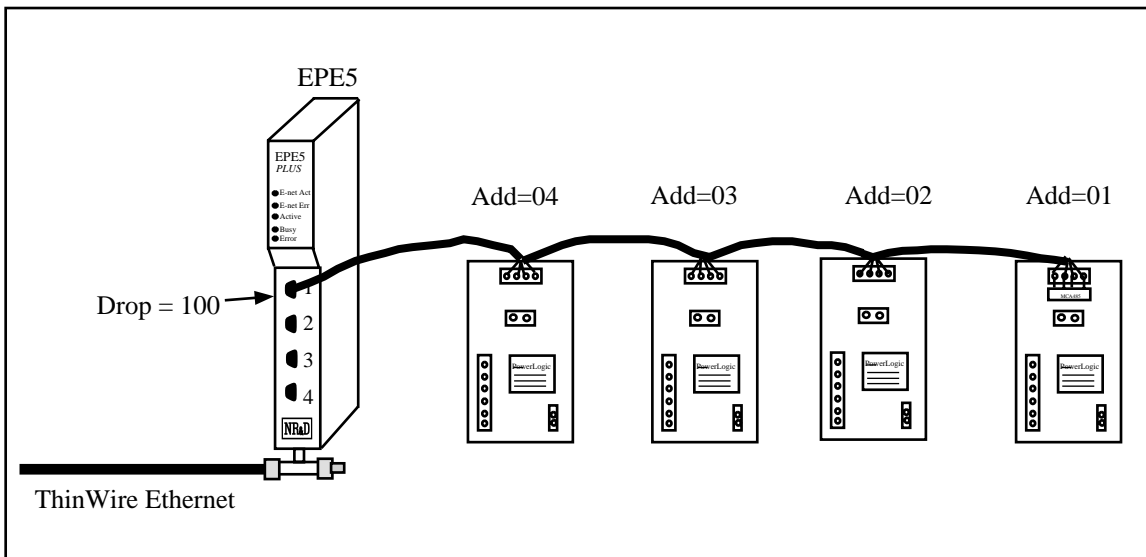
Figure 27-4   Edit Port Parameters Example

Figure 27-5   Auto-Scan Example

Figure 27-6 displays the Auto-Scan Table for this example. Registers 1 through 38 are polled from units 1 through 3 and placed in the EPE5's registers 4 through 111. Circuit monitor 4 is polled twice to gain access to two different blocks of registers. EPE5 registers 1 though 3 provide the status of the polling and bits 1 through 5 should always be set to indicate good replies are being received by the EPE5.

```
           E P E 5    E T H E R N E T    P O R T    E X P A N D E R
Niobrara R&D                                                        06Feb96
                        CONFIGURATION AND UTILITY SOFTWARE
oNline          oFfline            Utility           Setup          Quit
Port 1   Drop 100             SCANNING AUTO TRANSFER          Status 1..3
   ENTRY  LOCAL  REMOTE  COUNT  DIRECTION  ROUTE (from Modbus Slave table)
      1      4      1      38     READ     100,1
      2     42      1      38     READ     100,2
      3     80      1      38     READ     100,3
      4    112   1001      38     READ     100,4
      5    150   1051      20     READ     100,4
      6             0       0     READ     NONE
      7      0      0       0     READ     NONE
      8      0      0       0     READ     NONE
      9      0      0       0     READ     NONE
     10      0      0       0     READ     NONE
     11      0      0       0     READ     NONE
     12      0      0       0     READ     NONE
     13      0      0       0     READ     NONE
     14      0      0       0     READ     NONE
     15      0      0       0     READ     NONE
     16      0      0       0     READ     NONE

Use + and - to select the port.  Type F4 to edit status pointer
```

Figure 27-6   Auto-Scan Table Example

Example 5: Bridging Modbus/TCP to SY/MAX 802.3 for SMS-3000

An old POWERLOGIC SMS-770 system using old non-IP EPE5-D units is to be upgraded to SMS-3000. SMS-770 did not offer direct Ethernet connectivity so a serial connection was used between the personal computer and one of the EPE5-Ds. With proper selections of the routes used by SMS-770, any POWERLOGIC compatible device on the local EPE5-D or remote EPE5-Ds could be accessed. (See figure 27-7) SMS-3000 can be configured is exactly the same fashion using a serial connection to the local EPE5-D. This upgrade would work just as well as the old system but the system performance can be significantly improved by using SMS-3000's built-in Modbus/TCP Ethernet capability and upgrading one of the EPE5-Ds to an EPE5-TCP-D (Figure 27-8). SMS-3000 (and SMS-1500) has direct support for Modbus/TCP (TCP/IP) Ethernet. The EPE5-TCP-D with frimware rev 13Mar2000 or later is capable of supporting Modbus/TCP and SY/MAX 802.3 Ethernet at the same time. It may therefore be used as bridge between the two protocols.
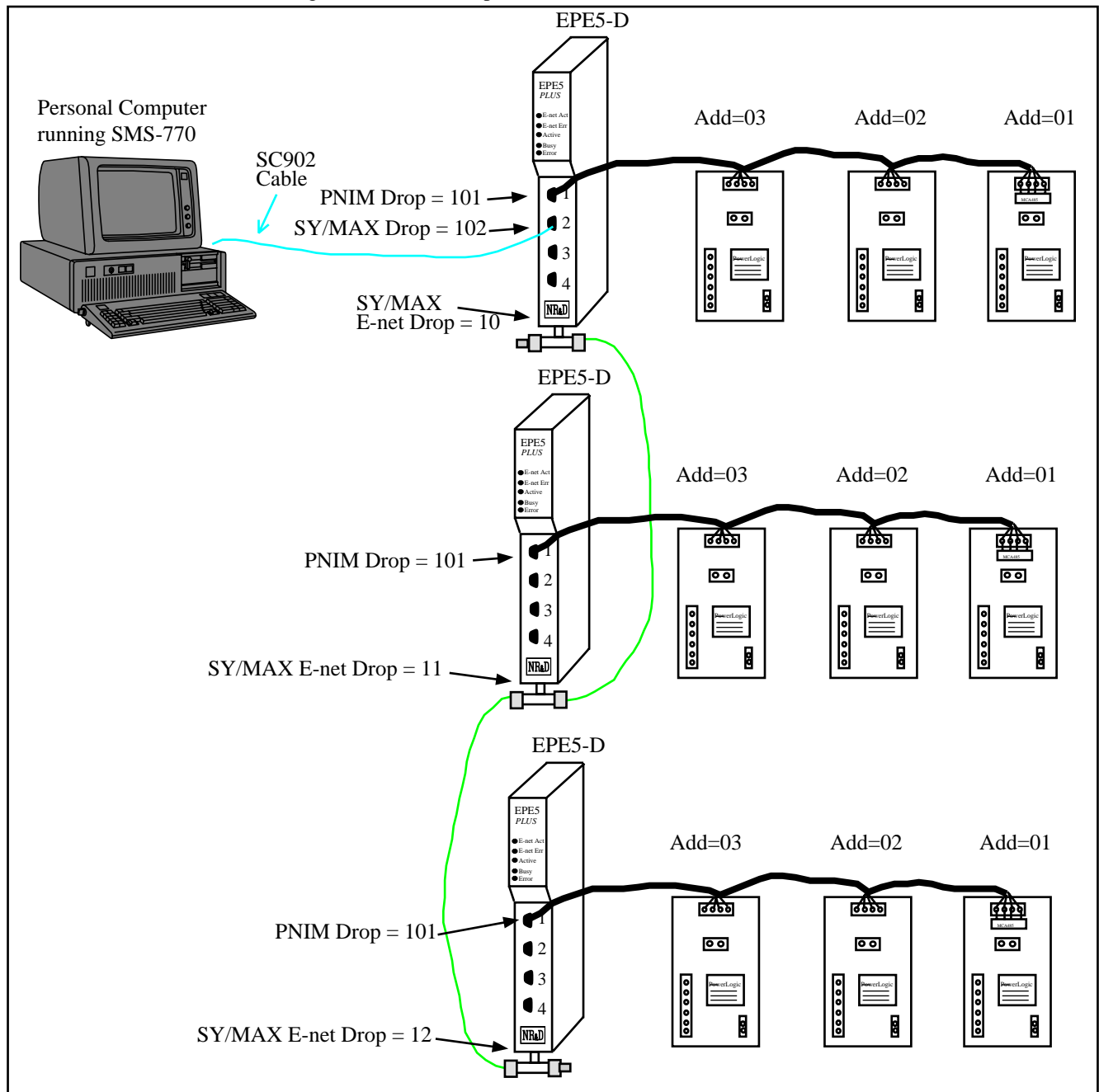
Figure 27-7   Old SMS-770 Configuration

OLD EPE5 Configuration

Each of the EPE5-Ds in the system had a stirng of POWERLOGIC devices connected to Port 1. This port was set to PNIM mode and was given the drop number of 101. Ports 2, 3, and 4 were set to SY/MAX mode with drops of 102, 103, and 104. The Ethernet ports were set to SY/MAX 802.3 drops 10, 11, and 12.

Old SMS-770 Configuration

The SMS-770 computer used its RS-232 SY/MAX serial connection to the EPE5-D through an NR&D SC902 cable. The SMS serial port was set to drop 30 with the connection type of SY/MAX with NIM/PNIM checked.

The routes to each of the CMs are shown in Table 27-6.

Table 27-6   Old SMS-770 Routing

Target	Route
EPE5 10, CM 1	30, 102, 101, 1
EPE5 10, CM 2	30, 102, 101, 2
EPE5 10, CM 3	30, 102, 101, 3
EPE5 11, CM 1	30, 102, 10, 11, 101, 1
EPE5 11, CM 2	30, 102, 10, 11, 101, 2
EPE5 11, CM 3	30, 102, 10, 11, 101, 3
EPE5 12, CM 1	30, 102, 10, 12, 101, 1
EPE5 12, CM 2	30, 102, 10, 12, 101, 2
EPE5 12, CM 3	30, 102, 10, 12, 101, 3
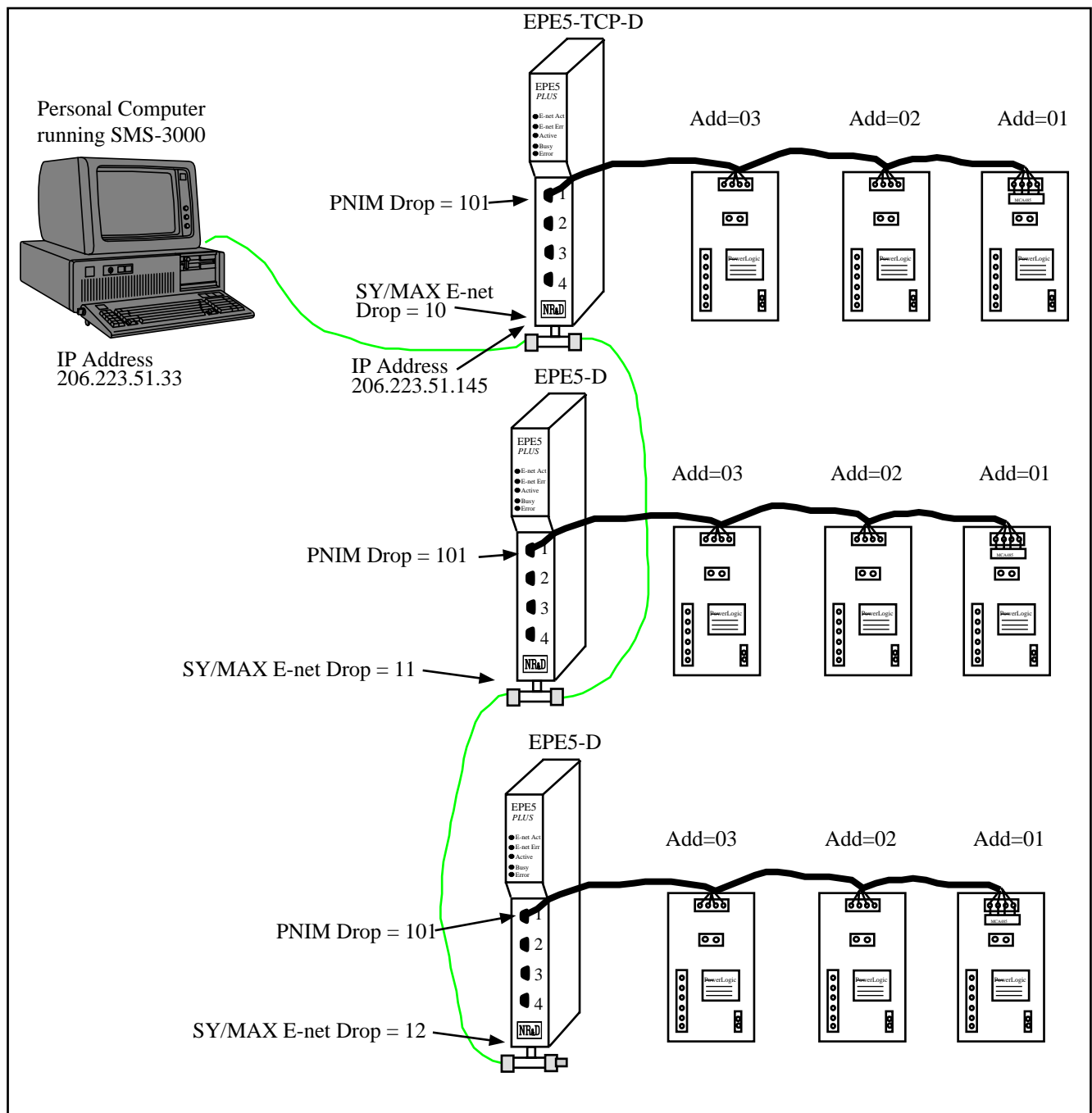
Figure 27-8   New SMS-3000 Configuration

EPE5-TCP Configuration

The new EPE5-TCP will have its serial port 1 set to PNIM mode, drop 101 like the old EPE5-D it replaces. The other serial ports may remain in SY/MAX mode but change thier dorp nubmers to 102, 103, and 104 for consistancy with the old system. It will also have its Ethernet port set to drop 10. Its IP Address will be set to 206.223.51.141 along with a subnet mask of 255.255.255.0 and Default Gate of 206.223.51.1. (The Network Administrator provided the IP Address, Subnet Mask, and Default Gate values.)

The EPE5-TCP will need entries in the Modbus Routing Table for its Ethernet port.

Table 27-7   Ethernet Modbus Server Routing Table for EPE5-TCP

Index	Route
1	101,1
2	101,2
3	101,3
4	10,11,101,1
5	10,11,101,2
6	10,11,101,3
7	10,12,101,1
8	10,12,101,2
9	10,12,101,3

The TCP Routing table for the EPE5-TCP must have entries 11 and 12 set to 0.0.0.0 with downstream routes set to NONE. Setting these entries to 0.0.0.0 forces the EPE5-TCP to use the SY/MAX 802.3 protocol for messages routed out of the Ethernet port. In the above table, entries 4 through 9 have the EPE5-TCP's Ethernet drop number (10) as the first entry. This causes the incoming message to be routed back to the Ethernet port. The next drop in the route (11 or 12) is the TCP Routing Table entry. This entry is 0.0.0.0 for both 11 and 12 so SY/MAX 802.3 is choosen for the Ethernet protocol. The remainder of the message is just like the old system.

Table 27-8   TCP Routing Table for EPE5-TCP

Drop	IP Address	Downstream Route
11	0.0.0.0	NONE
12	0.0.0.0	NONE

SMS-3000 Configuration

The SC902 cable from the SMS computer may is removed and an Ethernet card is installed to replace it. The Ethernet network is extended from EPE5 #10 to the computer. The EPE5-TCP is added as "Communication Connection" using the "Modbus/TCP Driver" with its IP Address of "206.223.51.141". Each of the CMs will be added as devcies using "Connection Name: EPE5". The "Device Address" will be choosen to match the "Destination Index" in the EPE5-TCP's Modbus Server Table.

Table 27-9   Device Address entries for SMS-3000

Device Address	Target
1	EPE5 10, CM 1
2	EPE5 10, CM 2
3	EPE5 10, CM 3
4	EPE5 11, CM 1
5	EPE5 11, CM 2
6	EPE5 11, CM 3
7	EPE5 12, CM 1
8	EPE5 12, CM 2
9	EPE5 12, CM 3

Appendix A

Modbus/TCP Protocol Specifications

The complete Modbus/TCP protocol information is located at http://www.modicon.com/openmbus/ on the Internet.

Appendix B
NR&D On the Internet

Internet Connection

Niobrara is now on the World Wide Web and can be found at **http://www.niobrara.com** 24 hours a day. Our web site offers product information, cutsheets, application notes, anonymous ftp of our latest software, as well as E-mail to customer support and marketing.

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