

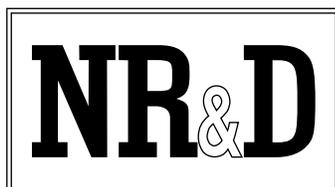
# EPE5

## Installation and Programming Manual

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This Manual describes the EPE5 SY/MAX<sup>®</sup> Ethernet Port Expander Module, its uses and set up. It also describes the use of the EPE5SW programming software.

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# Introduction

The Niobrara EPE5 is a SY/MAX<sup>®</sup> Ethernet compatible communication switching and translating module mounted in and powered by the SY/MAX register rack. The EPE5 conforms to the SY/MAX 802.3 Communication Protocol. The EPE5 retains all of the features of the popular **SPE4 PLUS** SY/MAX Port Expander with the addition of a high speed Ethernet port in place of Port 0.

The ThinWire 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. The EPE5 and Square D processors can coexist on existing Ethernet networks with other devices and protocols such as DECnet and TCP/IP.

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. A MS-DOS compatible program, EPE5SW, is provided with the module for ease of configuration.

The EPE5 is available in the following standard configuration:

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

**NOTE:** The EPE5-D and EPE5-A units only support the SY/MAX 802.3 Ethernet protocol. The EPE5-TCP-D and EPE5-TCP-A units support the SY/MAX 802.3 as well as NRD/TCP and Modbus/TCP Ethernet protocols.

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

As a port expander, the EPE5 is capable of routing SY/MAX protocol messages between its five ports (four data ports, and one Ethernet port) according to SY/MAX routing conventions. Applications for this function include:

- Interconnecting multiple SY/MAX processors
- Interconnecting non-Ethernet SY/MAX devices to Ethernet
- Allowing redundant Ethernet networks for Ethernet processors
- Connecting one programming terminal to multiple processors
- Connecting multiple operator interfaces to one processor
- Connecting multiple printers or displays to a single processor port
- Using one remote service modem to multiple devices

- Connecting more than two devices to one SY/NET NIM

As a protocol translator, the EPE5 is capable of:

- Changing baud rate and word structure
- Connecting POWERLOGIC® Circuit monitors to SY/MAX devices
- Connecting POWERLOGIC Circuit monitors to Ethernet
- Connecting POWERLOGIC Circuit monitors to MODBUS®
- Translating SY/MAX read and write messages to the Micro-1 network
- Translating SY/MAX read and write messages to the Model 50 network
- Translating SY/MAX read and write messages to the MODBUS network (MODBUS Master)
- Translating MODBUS network messages to SY/MAX read and write messages (MODBUS Slave)
- Generating SY/MAX read and write messages from simple ASCII commands
- Routing SY/MAX packets over multidrop lines, radios, or modems
- Routing non-SY/MAX information through SY/MAX or SY/NET media

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. 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.

The EPE5 may be thought of as an Ethernet NIM, with four ports instead of two. Communication packets arrive at one of its ports and go through a transformation to become a SY/MAX protocol packet. That packet is then routed to the appropriate destination according to SY/MAX conventions. The exact nature of the packet depends upon the mode of the incoming port.

SY/MAX and Net-to-Net mode ports expect the incoming data to already conform to the SY/MAX protocol and they simply route that data to its proper destination. Gateway mode ports expect a certain ASCII command protocol to determine the appropriate packet configuration, i.e. read, write, print. Transparent mode ports take incoming ASCII and build SY/MAX network print packets.

If the destination of a routed packet is an EPE5 port, that packet may be translated into another communication format. For example, MODBUS mode ports convert SY/MAX register read and write packets into MODBUS RTU format packets. The MODBUS reply is then converted back to SY/MAX and returned to the originator.

The result is that many previously incompatible protocol devices may now be easily connected in a cost effective manner. A personal computer may be connected to an EPE5 in Gateway mode and through simple programming be allowed to collect data from a network of Model 50 PLC, MODBUS peripherals, SY/MAX processors, POWERLOGIC Circuit monitors, other NR&D Modules such as the AIM4 or CAM500. This list is by no means complete. Of course it does not have to be a personal computer, it could be another PLC of a different make with ASCII capabilities.

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.

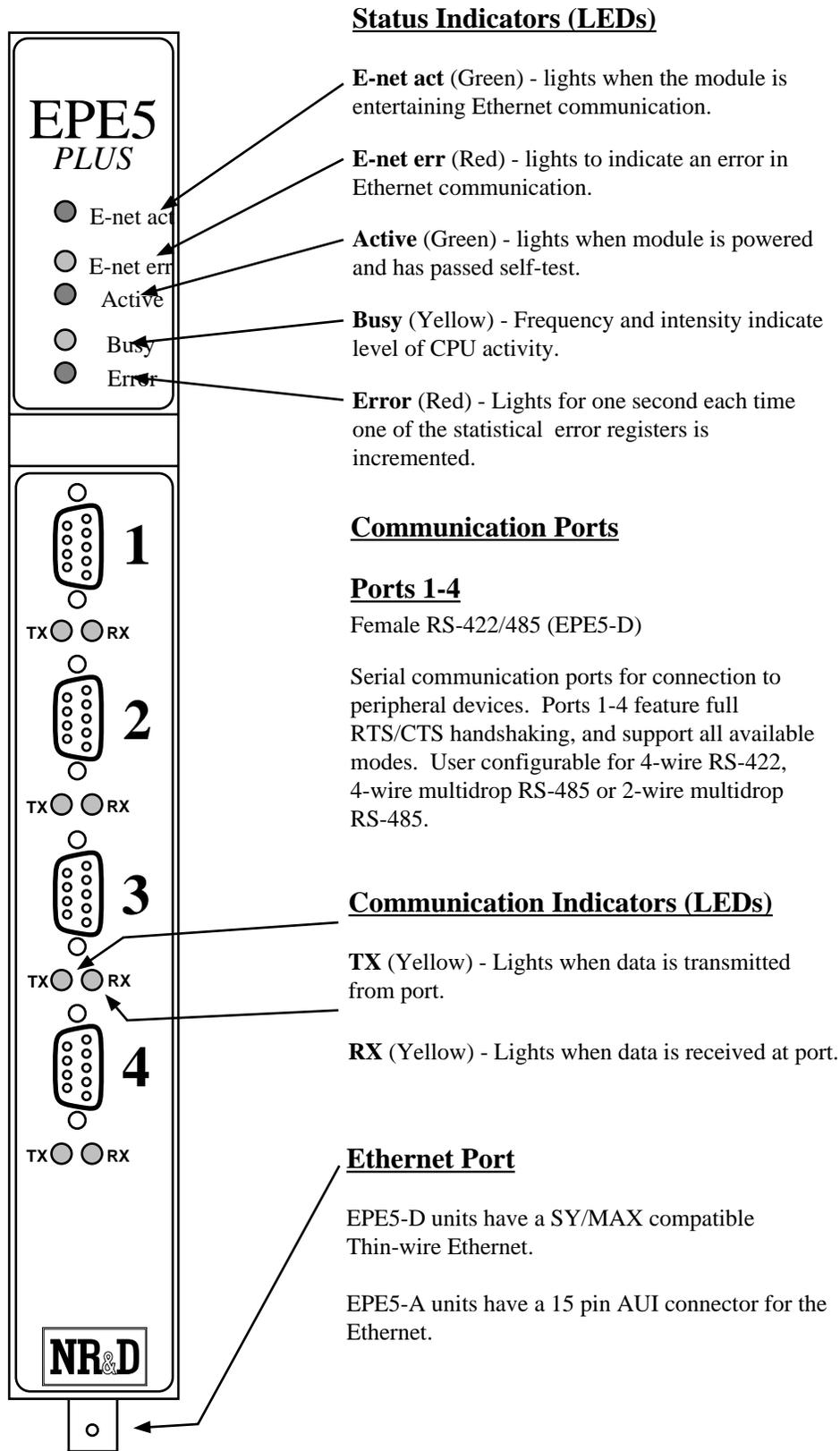


Figure 1-1 EPE5 Front Panel



## 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 address stoppage of communication to the other device will immediately occur.

### WARNING

Connecting two SY/MAX 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 D-1 on Page 188 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
          C O N F I G U R A T I O N   A N D   U T I L I T Y   S O F T W A R E
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 127.

```

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
          C O N F I G U R A T I O N   A N D   U T I L I T Y   S O F T W A R E
online   offline   Utility   Setup   Quit

          C O N F I G U R E   T H I S   C O M P U T E R
          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 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 2-2 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

- 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 SC406 (or SC902) 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.

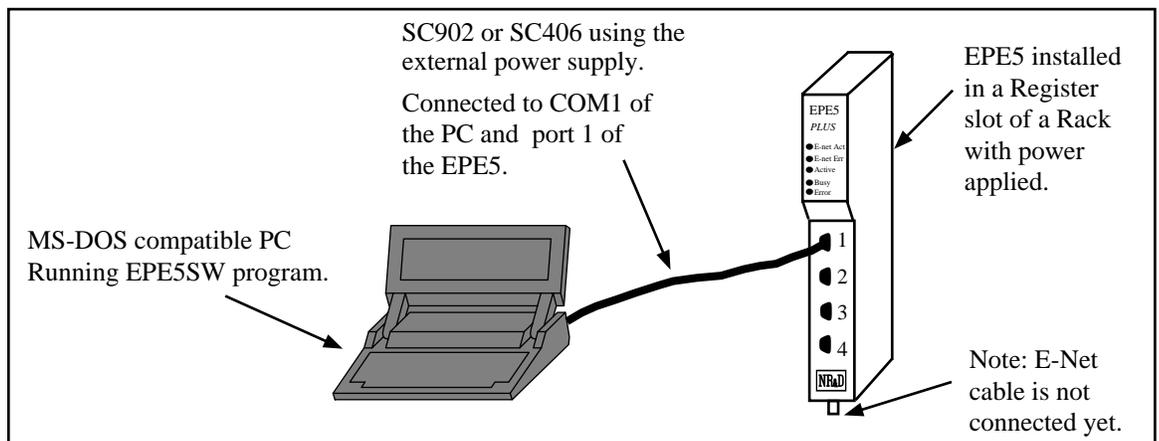


Figure 2-3 EPE5 Initial Configuration Setup

- 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 127.

- 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 and press Enter. The EPE5 is now ready to be connected to the Ethernet Network.

**WARNING**

Connecting two SY/MAX 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 D-1 on Page 188 to keep an accurate record of network devices in use.

| 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   | CONFIGURATION AND UTILITY SOFTWARE |        |        |        | 29Oct96            |
|  |                                    |        |        |        | 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

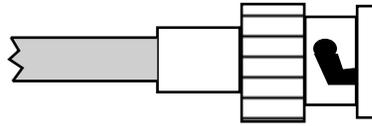
| NR&D Part Number | Square D Equivalent Part Number | Description                          |
|------------------|---------------------------------|--------------------------------------|
| EN1              | CC601                           | Ethernet Cable (thin wire 6ft long)* |
| EN611            | 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.

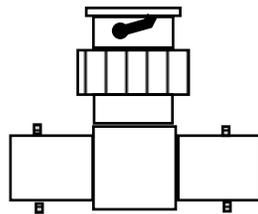
### **Ethernet Cable End (EN611)**



**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.

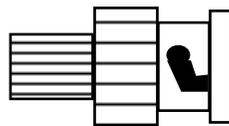
### **Ethernet TEE Connector (EN612)**



**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.

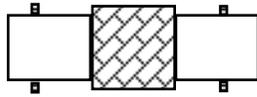
### **Ethernet Terminator (EN613)**



**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.

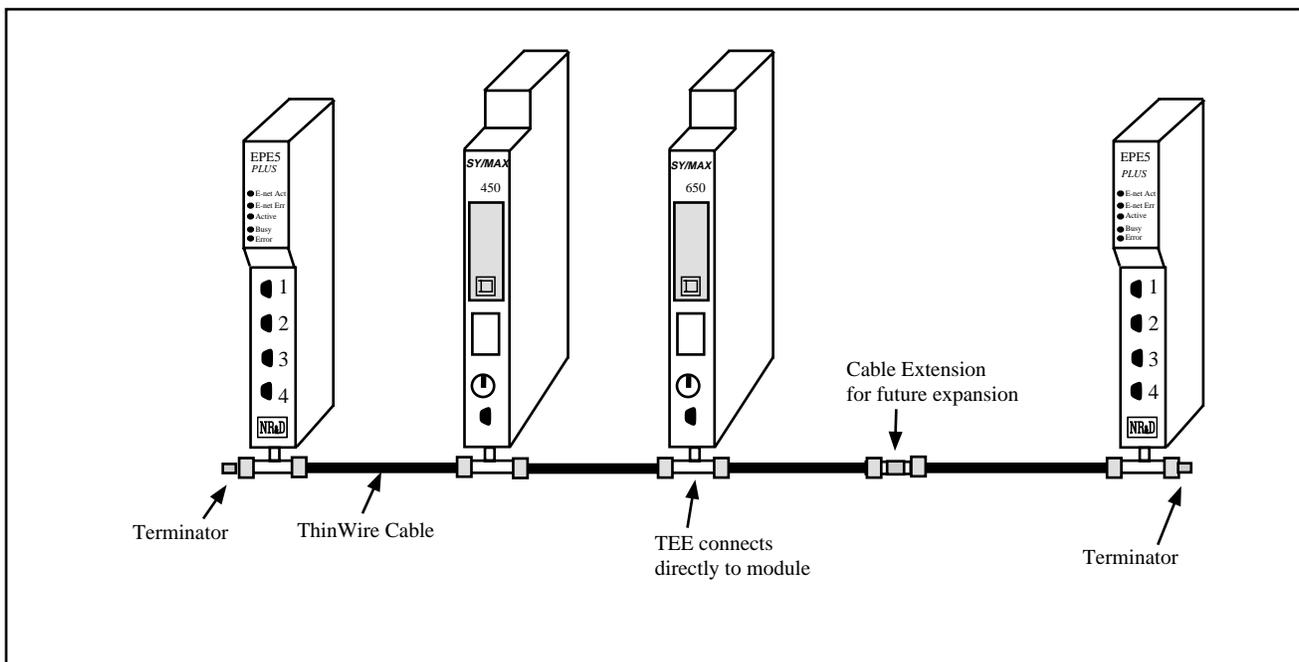
## Ethernet Cable Extension or Barrel (EN614)



**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**

See **Appendix A Ethernet Communication Overview** on page 163 for an overview of Ethernet including discussions of repeaters, hubs, and network limitations.

## 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.

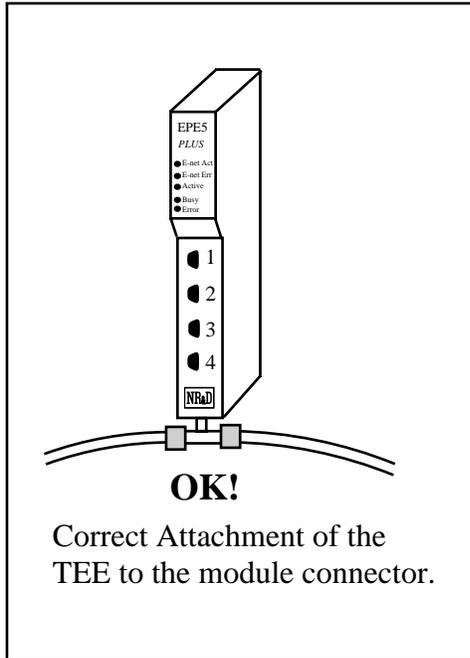


Figure 2-10 Correct TEE connection

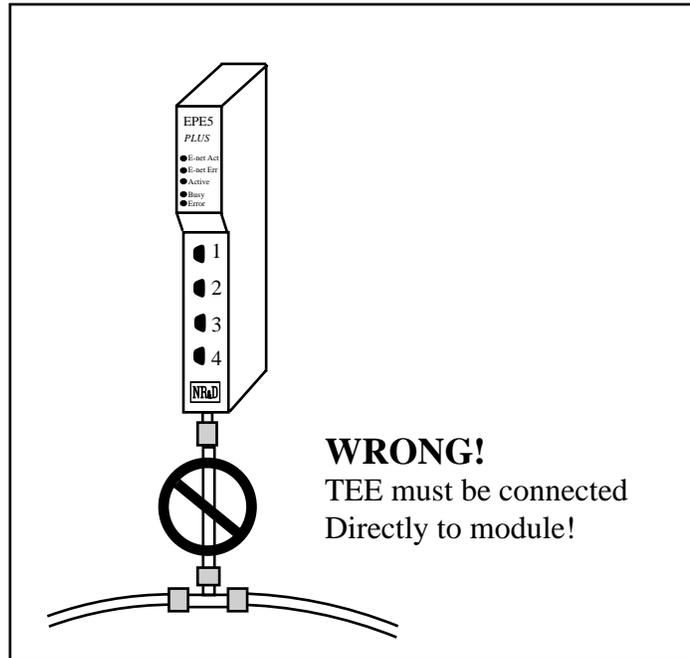


Figure 2-11 Incorrect TEE connection

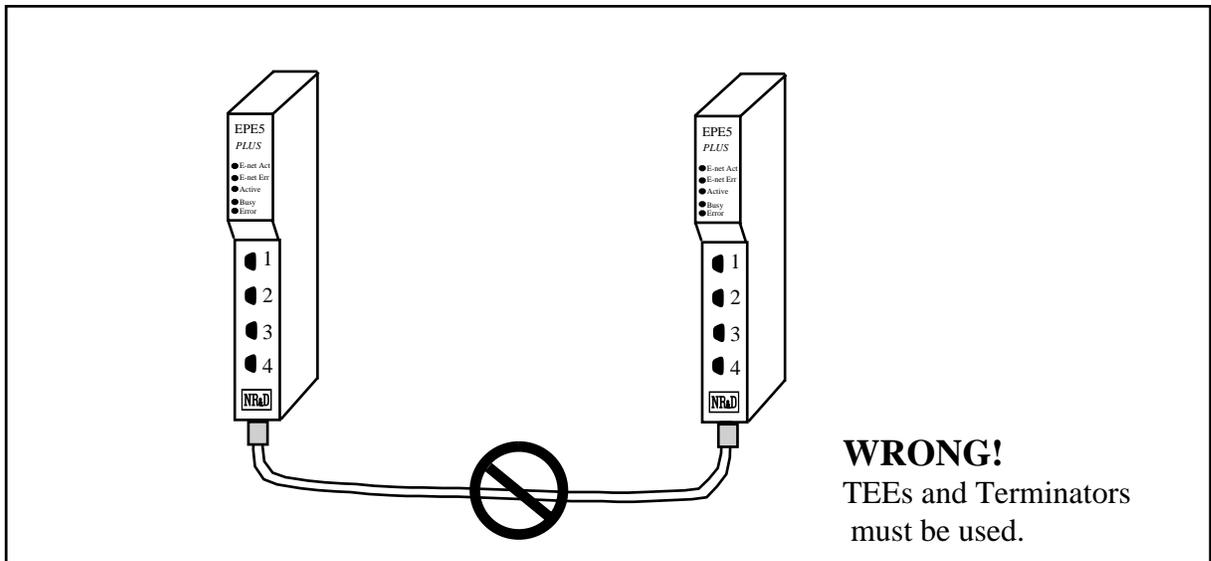


Figure 2-12 Incorrect Cable Connection

- 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 21 and 22 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 20 on page 131.

## 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 Ethernet units on the network. If two Ethernet ports have the same Ethernet Drop Number, they will stop communicating and must be manually reset. It is recommended that Table D-1 on Page 188 be used to keep an accurate record of all Ethernet Drop Numbers on the network. 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, 002, 003, and 004. 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<sup>®</sup> PLUS ver. 2.x in parity= NONE setting. The CRC checksum 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 132**.

## 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 an 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 acknowledgement. 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.



## SY/MAX MODE

### 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

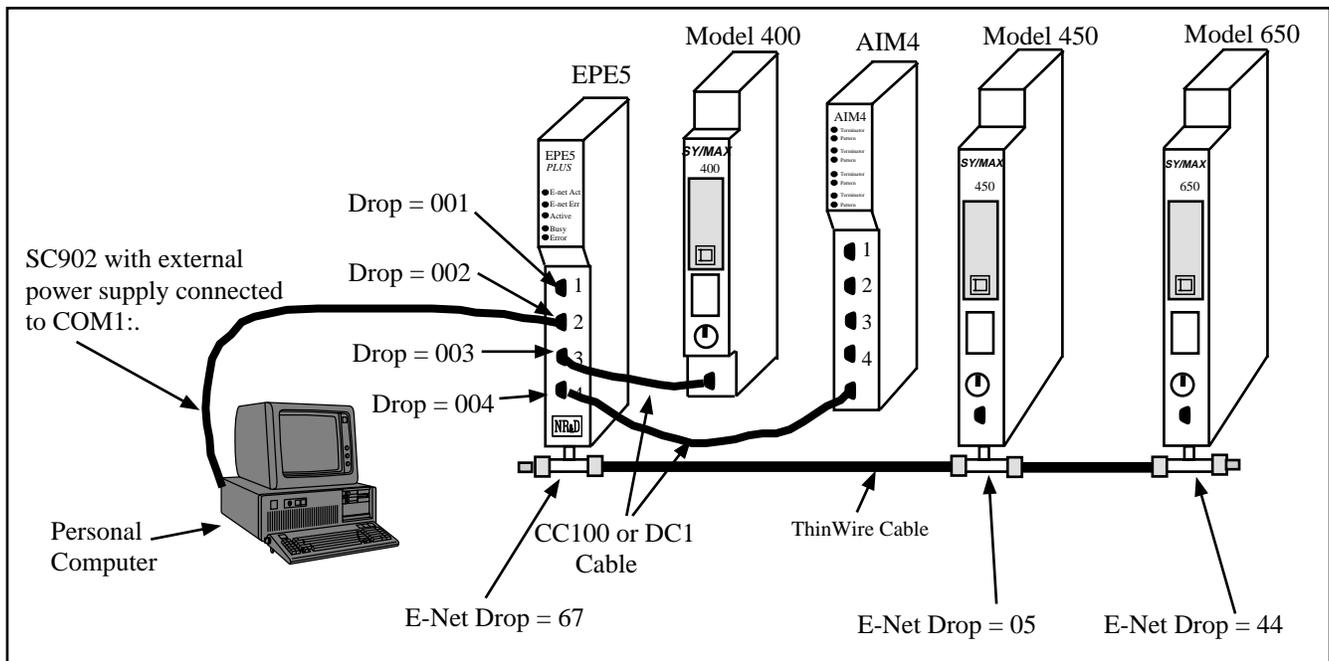
Figure 4-1, is an example of connecting three SY/MAX rack PLCs, a NR&D AIM4 ASCII Input Module, and a Personal computer together so that they may exchange data and be programmed by a single personal computer by means of the proper routing of communication packets. The Personal computer is connected to 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 4-1 below:

**Table 4-1 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 4-2 gives the route required for the personal computer to reach each of the devices.



**Figure 4-1 SY/MAX Mode Example**

**Table 4-2 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 4-3 shows the routes required for a few of these combinations.

**Table 4-3 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 4-4 below illustrates a few examples of equivalent routes to the EPE5.

**Table 4-4 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.

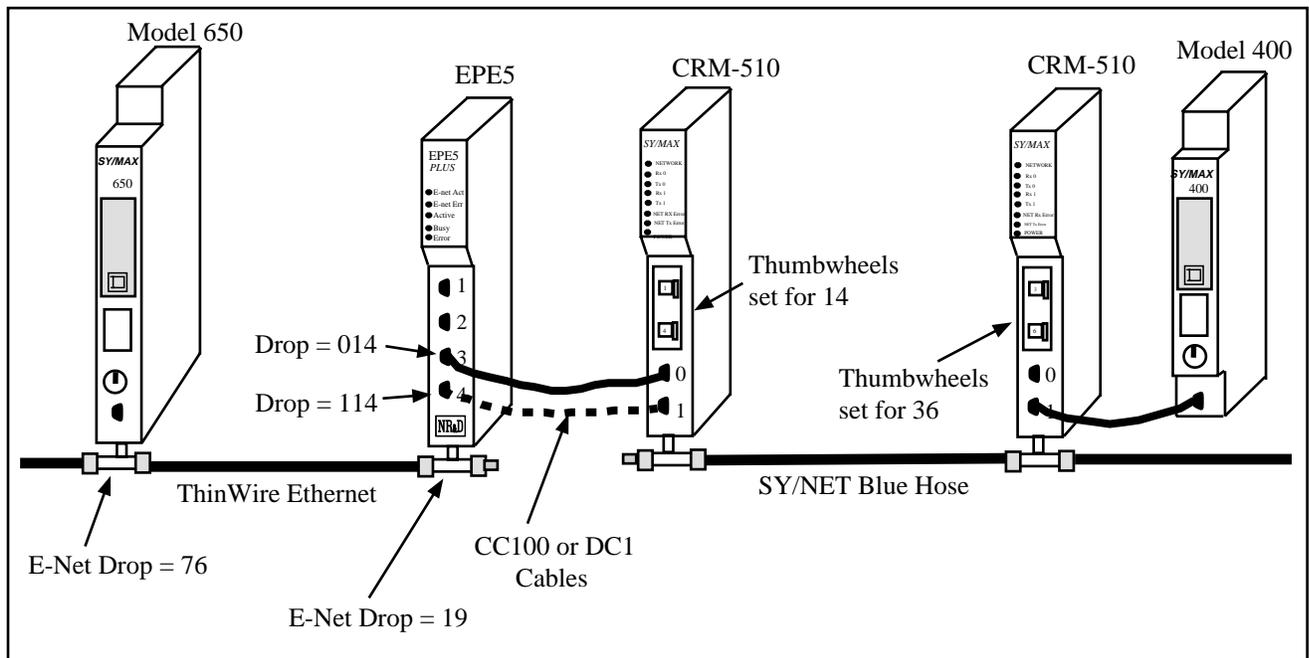


## NET-TO-NET MODE

### 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<sup>®</sup> 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 5-1 NIM Net-to-Net Example**

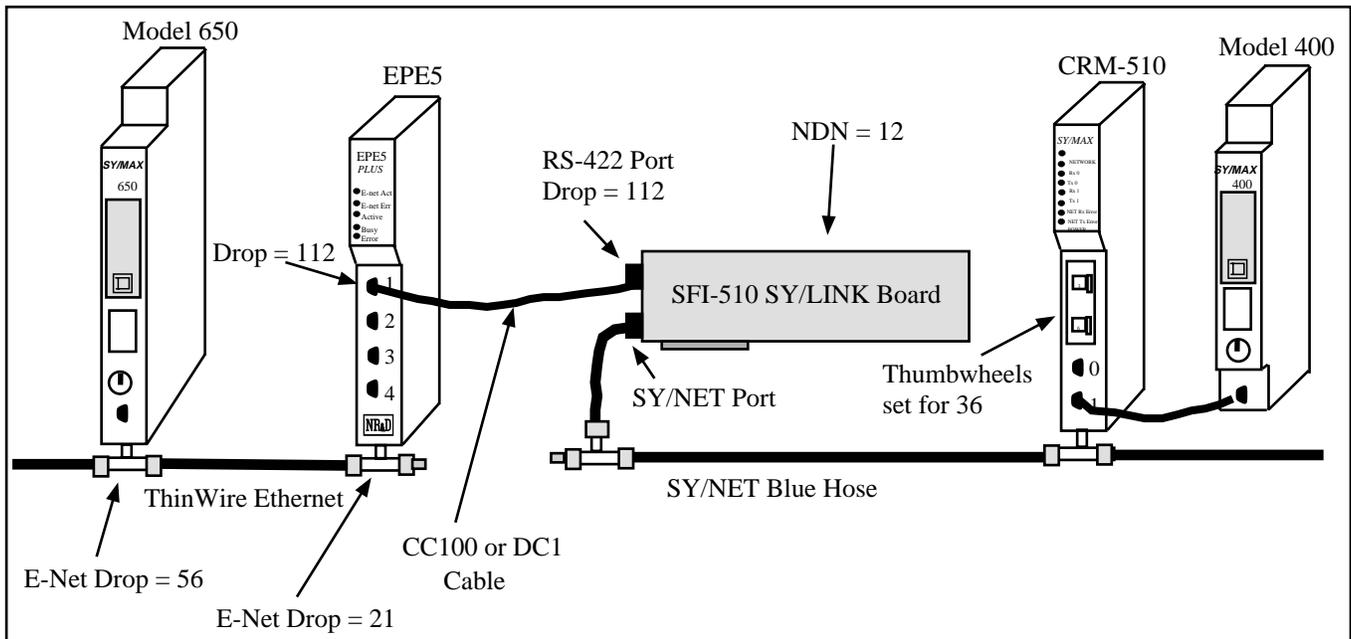
| Origin    | Target    | Route                                      |
|-----------|-----------|--|
| Model 650 | Model 400 | 076, 019, 014, 136 (Using the solid wire)  |
| Model 400 | Model 650 | 136, 114, 019, 076 (Using the dotted wire) |

**Table 5-1 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 5-2 SY/LINK Net-to-Net Example**

**Table 5-2 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 5-3 EPE5 Setup for SY/LINK Net-to-Net Connection**

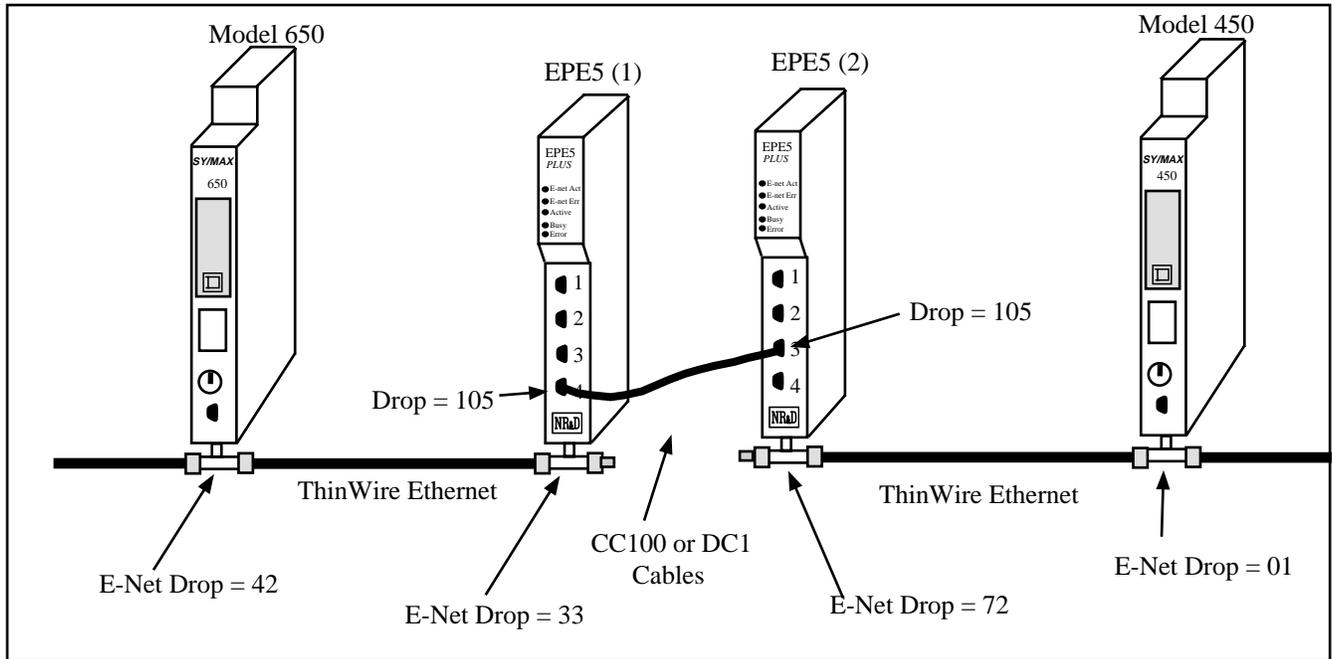
| Port  | Drop # | Mode       | Baud Rate | Parity | Data | Stop | Error Check |
|-------|--------|------------|-----------|--------|------|------|-------------|
| E-Net | 21     | SY/MAX     | NA        | NA     | NA   | NA   | NA          |
| 1     | 112    | Net-to-Net | 9600      | E      | 8    | 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 5-3.

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 5-3 EPE5 Net-to-Net Example**

**Table 5-4 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 5-5 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 5-6 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 18 on page 105.

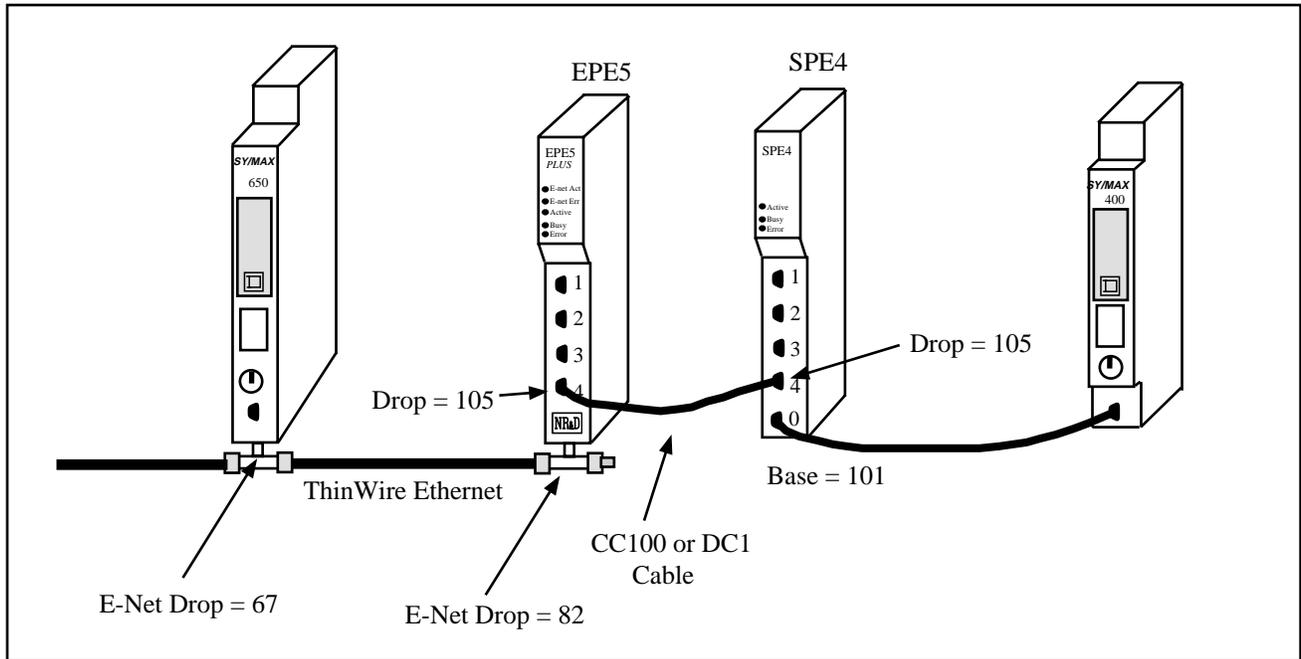
Also, for a much higher speed SY/MAX Ethernet bridge, consider using a pair of Niobrara MEB modules. The Modbus Plus ports may be used to provide a 1Mb/sec network hop for much better throughput between the Ethernets.

**Table 5-7 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 5-4. 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 5-4 SPE4 Net-to-Net Example**

**Table 5-8 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 5-9 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 5-10 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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## Peripheral Mode

### 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.

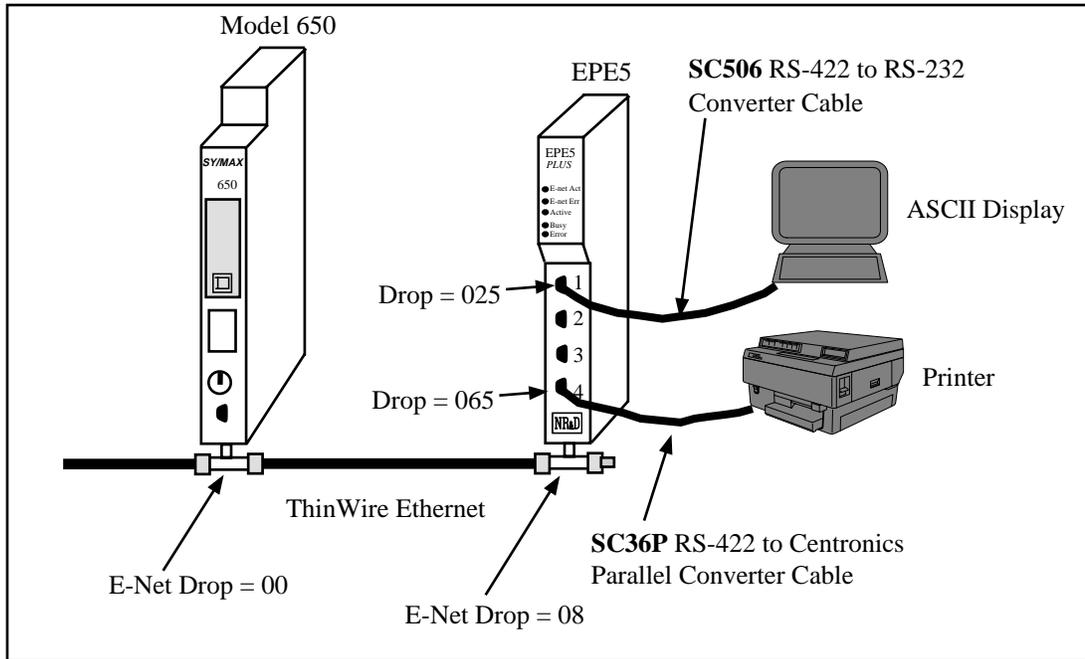
#### Driver Mode

The Driver Mode setting for the Peripheral mode allows the control of the RS-485 transmitter and 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.



**Figure 6-1 Peripheral mode example**

### Peripheral Mode Example

**Table 6-1 Peripheral Routing Examples**

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

**Table 6-2 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).

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## Transparent and Share Modes

### Modes 4,5: Transparent, Share

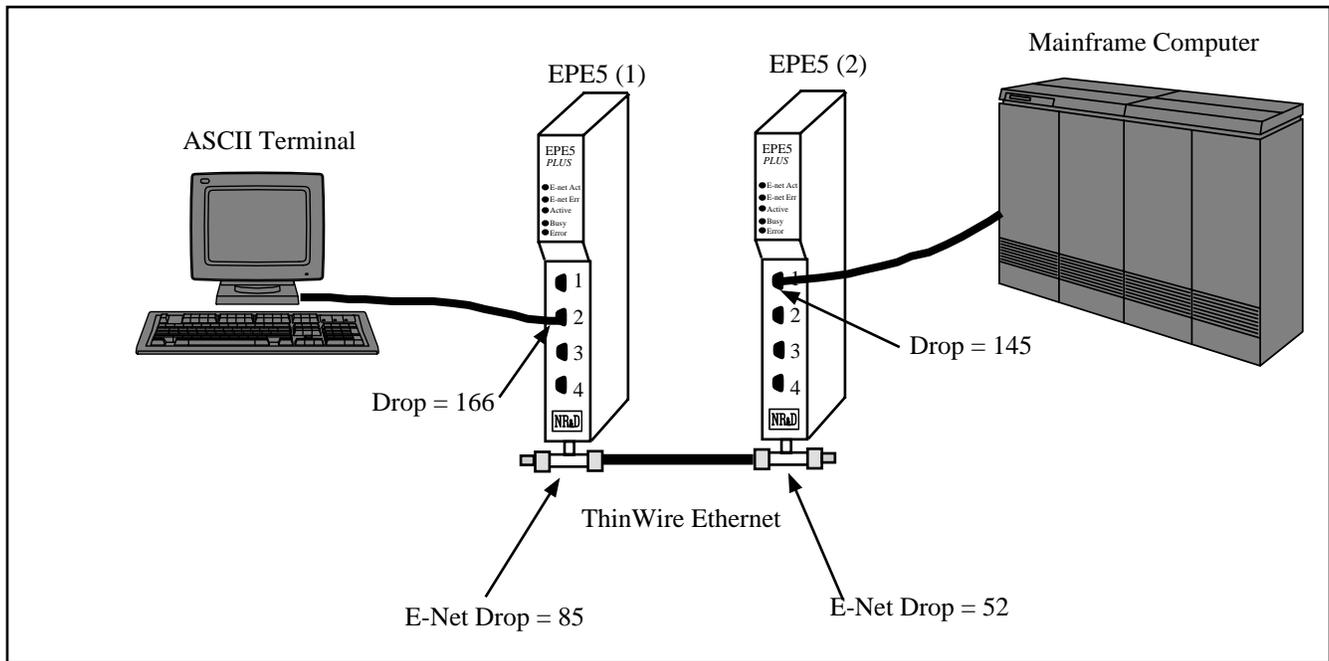
Transparent and Share modes are identical except for the behavior of the RTS pin (see RTS/CTS Handshaking, on page below). These modes are used to interface non-SY/MAX devices to the SY/MAX environment so that their communications can be carried on the SY/NET network or through SY/MAX modems or routers 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 7-1 Transparent Mode Example**

**Table 7-1 Transparent Routing Examples**

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

**Table 7-2 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 7-3 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.



## PLogic and PNIM Modes

### Mode 6: PLOGIC

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 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 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.



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.

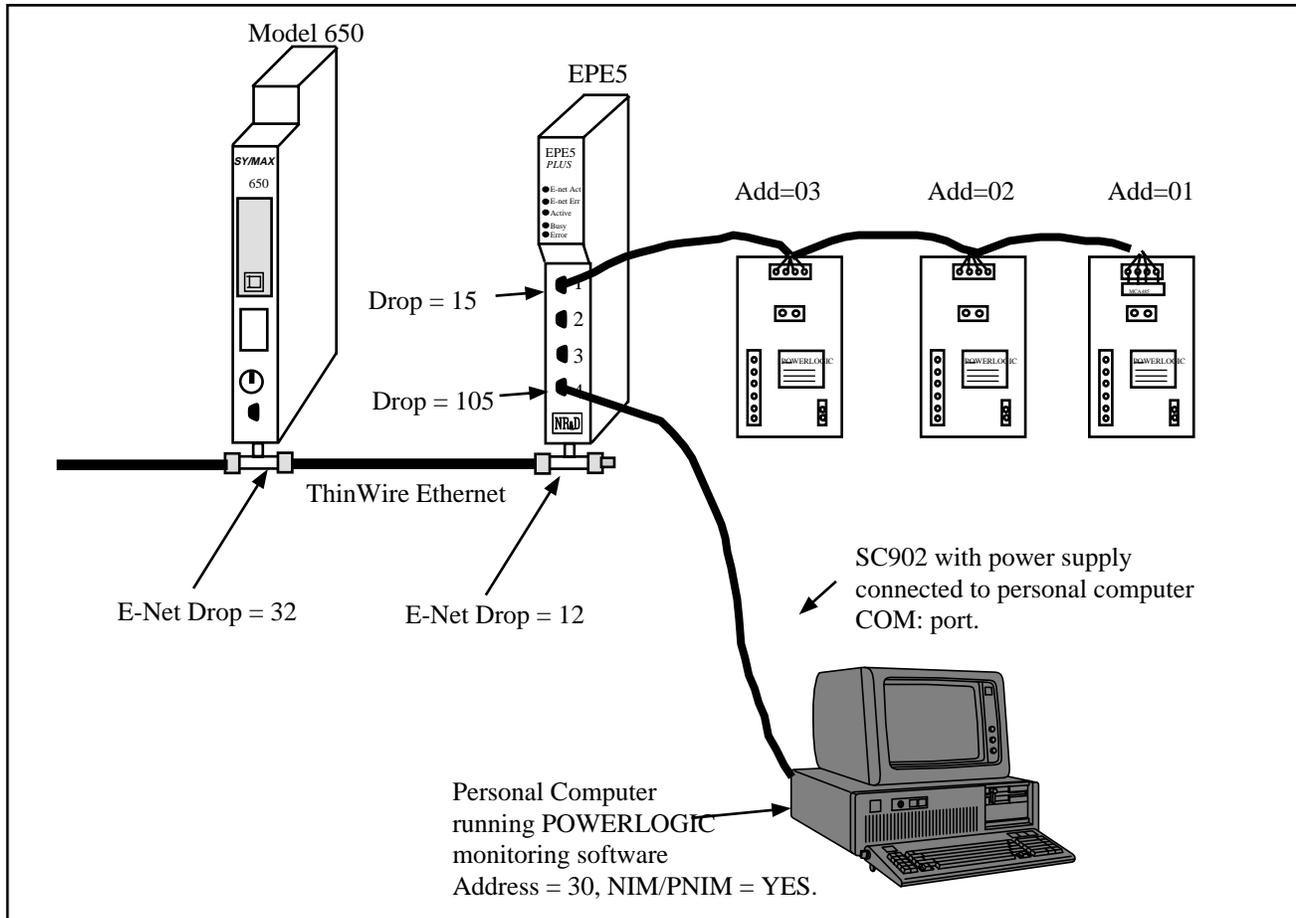
The PNIM mode is different from the PLOGIC mode. The PLOGIC mode uses the modified SY/MAX protocol that the POWERLOGIC Circuit monitors can use. Since the PLOGIC mode conforms to the SY/MAX protocol, other SY/MAX devices may be used to extend the connection from the EPE5 port to the Circuit Monitors, 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 8-2 POWERLOGIC Example**

**Table 8-3 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 8-4 EPE5 Setup for POWERLOGIC Connection**

| Port  | Drop # | Mode   | Baud Rate | Parity | Data | Stop |
|-------|--------|--------|-----------|--------|------|------|
| E-Net | 12     | SY/MAX | NA        | NA     | NA   | NA   |
| 1     | 015    | PNIM   | 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 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 9-1 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 9-2 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

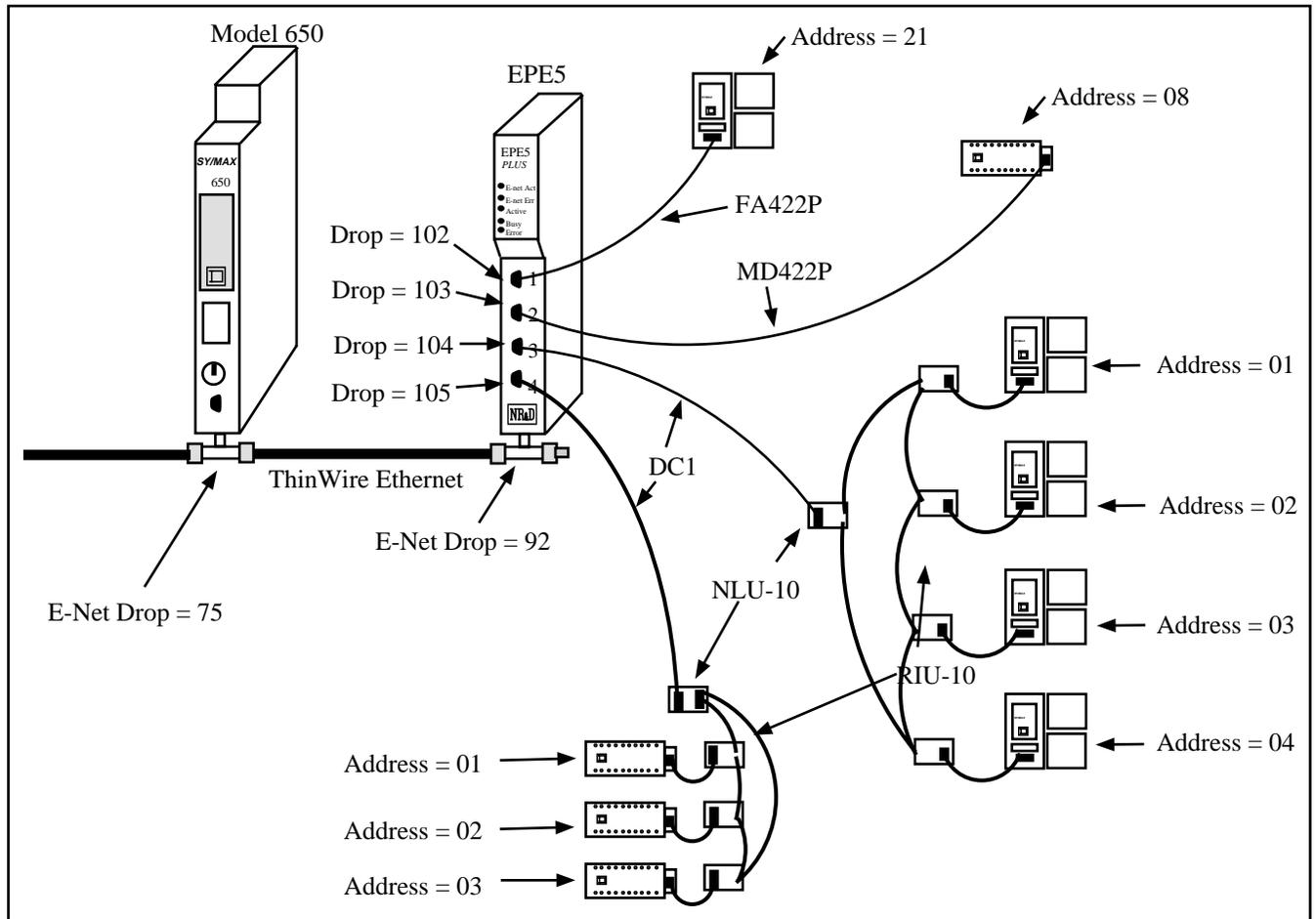


Figure 9-1 IDEC Mode Example

Table 9-3 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 9-4 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    |

## 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

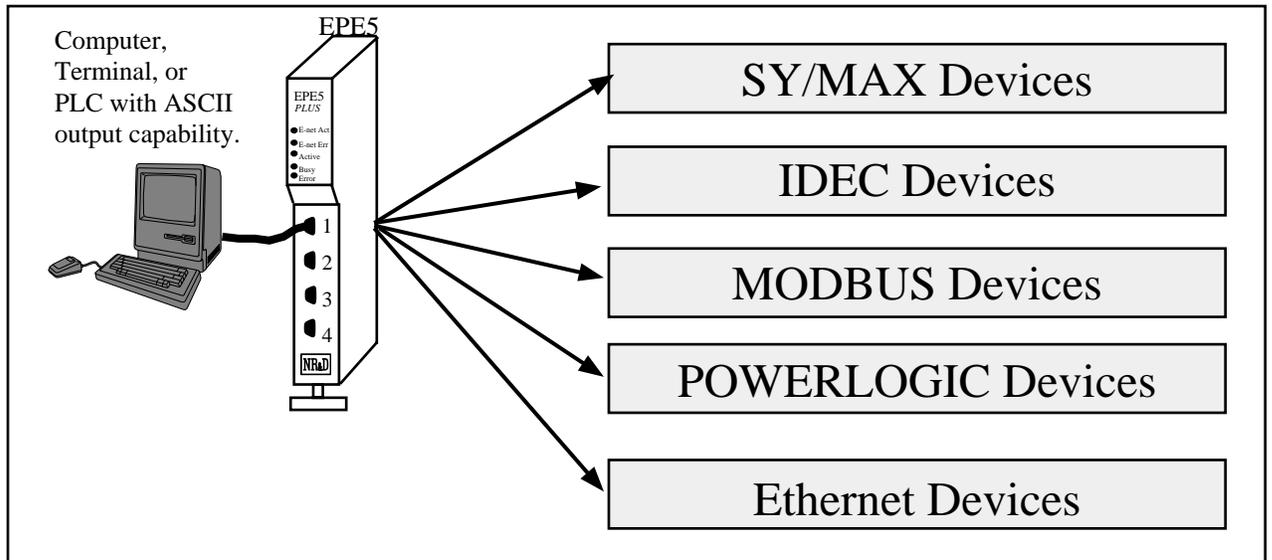
The Gateway Omit command is a network print command that omits the carriage return and line feed sequence. This allows the printing of exact characters from a peripheral port without the addition of the carriage return and line feed. If no terminator is needed, use the inter-character timeout or character 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 10-1 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 10-2 represents a view of the Terminal Emulator from EPE5SW connected to an EPE5 Gateway port.

```

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

```

**Figure 10-2 Terminal Emulator connected to Gateway port**

**Table 10-1 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

```



## Multidrop Mode

### 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.

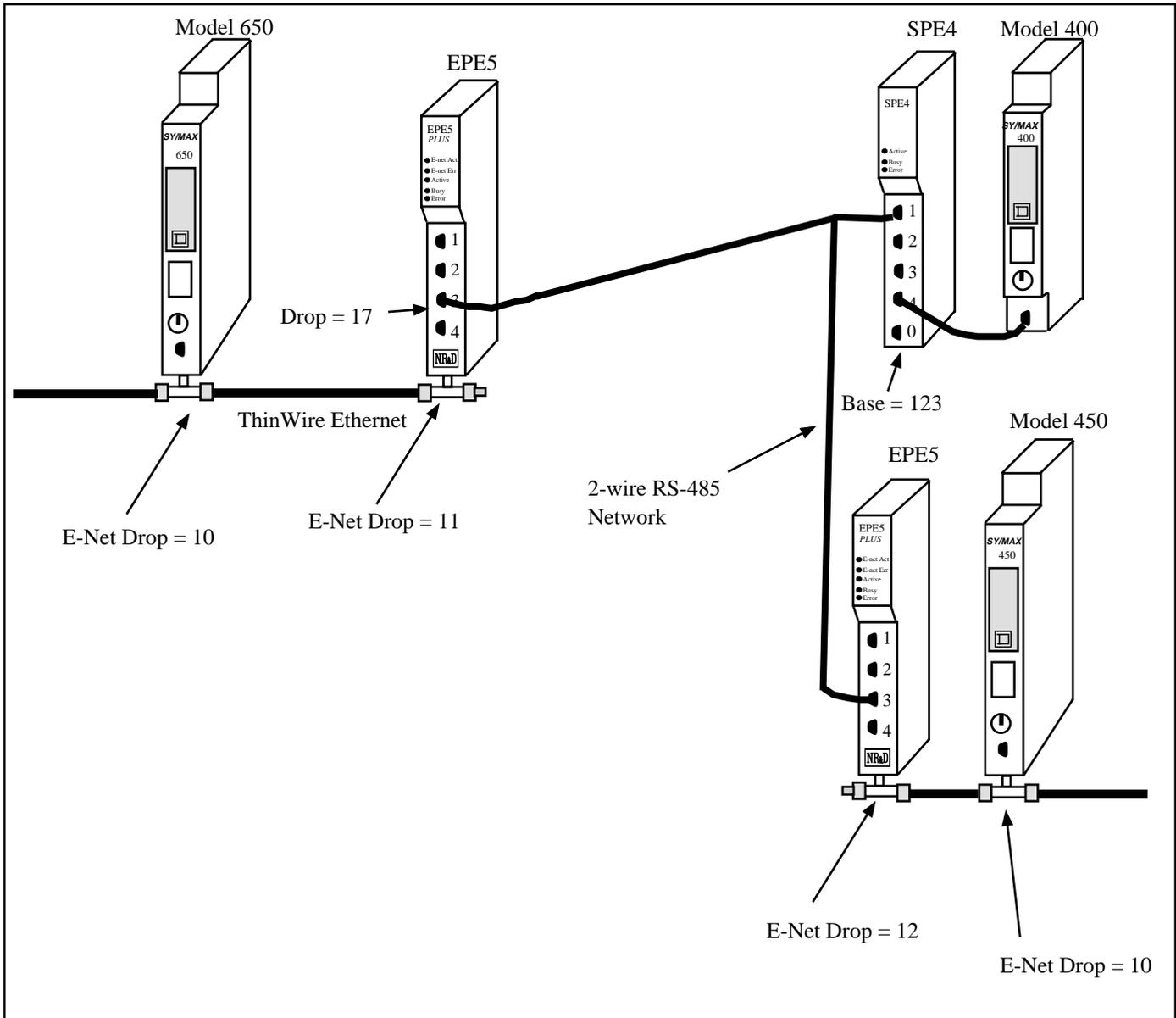
**NOTICE:** The MULTIDROP mode is ideally suited for use with a 2-wire RS-485 multidrop network. If a radio or multidrop modem network is to be used, it is recommended that the RNIM mode be used. It is better suited for radio and other multidrop modem applications.

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 11-1 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 11-1 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 11-2 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 11-3 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 11-4 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.



## MODBUS Mode

The Modbus protocol is implemented in a wide variety of products including Modicon® PLCs, temperature controllers, flowmeters, intelligent valve systems, etc. The EPE5 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 EPE5 Modbus Gate and ASCII modes provide reversible translations from SY/MAX messages to Modbus messages and vice versa using a defined series. The Modbus Host mode is used when an explicit opcode and bias is required for a specific master application.

NOTE: Modbus Gate and Modbus ASCII modes provide the same translations between SY/MAX and Modbus. There is presently no ASCII version of the Modbus Host mode.

### 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.<sup>1</sup>

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 0xxxx. Input bits (coils) are described by values in the range 1xxxx. Input registers have values 3xxxx and Output registers have values of 4xxxx. Consequently the Modbus protocol requires separate messages to access the data in each of these areas. See Table <Modbus function code list>.

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.

<sup>1</sup> 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 12-1 MODBUS Function Code List**

| Function Code | Description               | MODBUS Address Range |
|---------------|---------------------------|----------------------|
| 01            | Read Coil Status          | 0XXXX                |
| 02            | Read Input Status         | 1XXXX                |
| 03            | Read Holding Register     | 4XXXX                |
| 04            | Read Input Registers      | 3XXXX                |
| 05            | Force Single Coil         | 0XXXX                |
| 06            | Preset Single Register    | 4XXXX                |
| 15            | Force Multiple Coils      | 0XXXX                |
| 16            | Preset Multiple Registers | 4XXXX                |

## SY/MAX Message Addressing

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

**Table 12-2 SY/MAX Messages**

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

In the SY/MAX family of processors, only the Priority messages listed above are supported. 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, MPE3, ADM) 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. Untranslatable 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 12-3.

**Table 12-3 SY/MAX to Modbus Translations**

| <b>SY/MAX Message</b>   | <b>Modbus Message</b>   |
|---|---|
| Priority Read (0x20)  | Read Holding Registers (3)  |
| Non-Priority Read (0x00)  | Read Holding Registers (3) Registers 1 ..8192 detranslated as Priority Read   |
| Priority Write (0x1E)   | Write Multiple Registers (16)   |
| Non-Priority Write (0x02) with mask all zeroes  | Write Multiple Registers (16) registers 1..8192 detranslate as Priority Write |
| Non-Priority Write (0x02) with mask all zeroes  | Force Multiple Coils (15) with bit and byte counts = 0                        |
| Non-Priority Write (0x02) with mask containing < 16 contiguous ones, count = 1, and register < 2048 | Force Multiple Coils (15)   |
| Non-Priority Write (0x02) with a mask a single one, register count = 1 and register < 2048          | Force Single Coil (5)   |

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. Note that accessing registers 8193..16384 reads or writes that status portion of SY/MAX register 1..8182.

Modbus devices should preferably use opcodes 3 and 16 to access registers in SY/MAX devices because these queries translate with legal status register addresses. Other Modbus opcodes may be used but are not guaranteed to be accepted by all SY/MAX end nodes (i.e. PowerLink). All Niobrara SY/MAX ports will accept the SY/MAX translation of any translatable Modbus query. Table 12-4 lists the Modbus to SY/MAX translations.

**Table 12-4 Modbus to SY/MAX Translations**

| <b>Modbus Message</b>   | <b>SY/MAX Message</b>  |
|---|--|
| 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) register 1..8192   | Priority Read (0x20) with status register address 0x0006   |
| Read Holding Registers (3) register 8193..16384   | Non-Priority Read (0x00) status field with Transnum 0x03   |
| Read Input Registers (4) register 1..8192   | Priority Read (0x00) with status register address 0x0009   |
| Force Single Coil (5)   | Non-Priority Write (0x02) with Transnum 0x05 and single bit set in mask  |
| Preset Single Register (6) register 1..8192   | Priority Write (0x1e) with status register address 0x00d   |
| Preset Single Register (6) register 8193..16384   | Non-Priority Write (0x02) status field with Transnum 0x06  |
| Force Multiple Coils (15) if start coil on word boundary and bit count integral multiple of 16.   | Priority Write (0x1e) with status register address 0x001f  |
| 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 0xff) mask   |
| Write Multiple Registers (16) register 1..8192  | Priority Write (0x1e) with status register address 0x0020  |
| Write Multiple Registers (16) register 8193..16384  | Non-Priority Write (0x02) with Status field with Transnum 0x10   |

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.

## Master Operation

The Modbus Gate and Modbus Host modes may be used to connect Modbus RTU slaves and networks of RTU slaves to SY/NET. The Modbus Gate (and Modbus ASCII) mode uses the translations in Table 12-3 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:

$$\text{MODBUS address} = (\text{SY/MAX REMOTE address}) + (\text{Register Bias})$$

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 12-5 displays the SY/MAX register to Modicon Register relationship for the EPE5 Modbus Host Master translation.

**Table 12-5 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:

$$\text{Coil Start Address} = (((\text{SY/MAX REMOTE address}) + (\text{Register Bias}) - 1) * 16) + 1$$

The start address refers to the address of bit 1 of the SY/MAX register. Table 12-6 displays the SY/MAX bit relationship to the Modbus coils for the EPE5 Modbus Master.

**Table 12-6 SY/MAX Bit to Modbus Coil Relationship**

| <b>SY/MAX Register</b> | <b>SY/MAX Bits</b> | <b>Modbus Bits Bias = 0</b> | <b>Modbus Bits Bias = 1</b> | <b>Modbus Bits Bias = 500</b> |
|------------------------|--------------------|-----------------------------|-----------------------------|-------------------------------|
| 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                   |

## 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

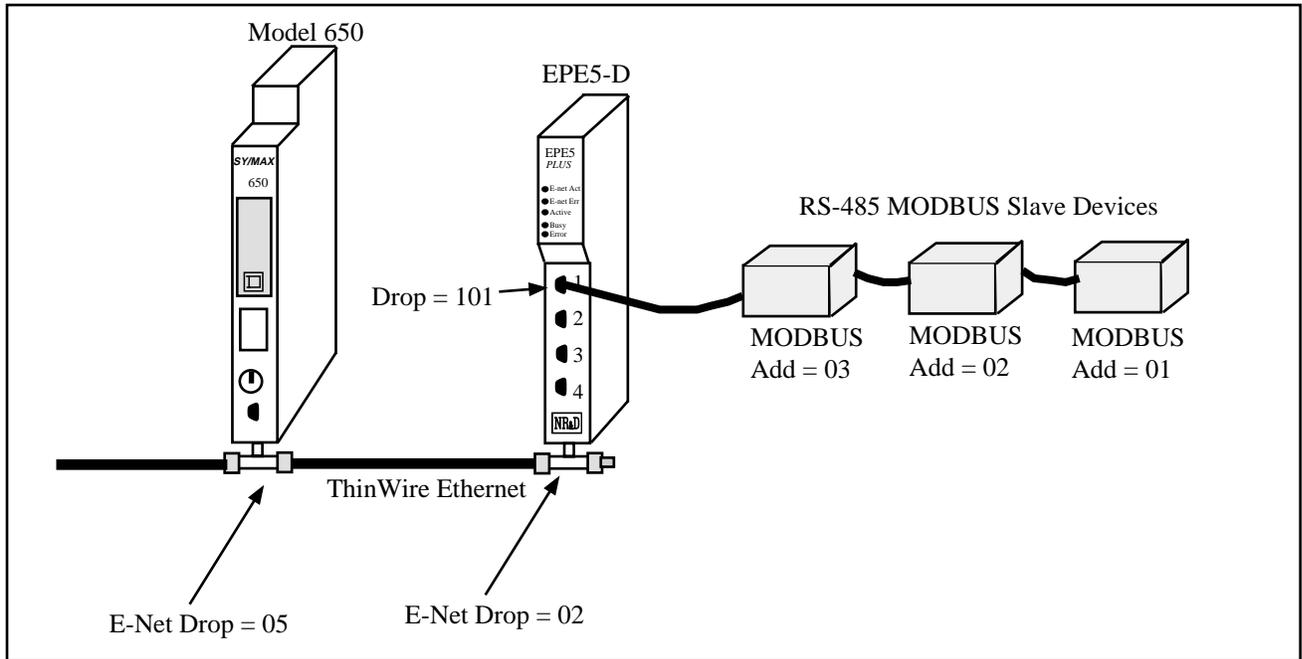


Figure 12-1 MODBUS Master Mode Example

Table 12-7 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 12-8 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.

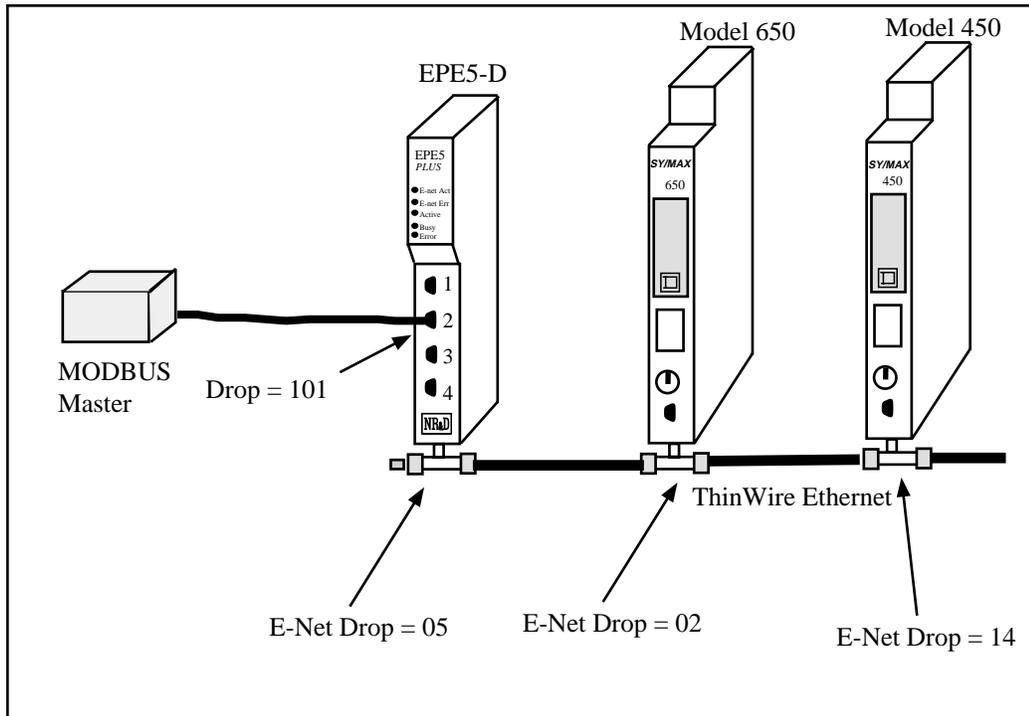


Figure 12-2 OTHER Modbus Slave Example

Table 12-9 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 12-10 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.

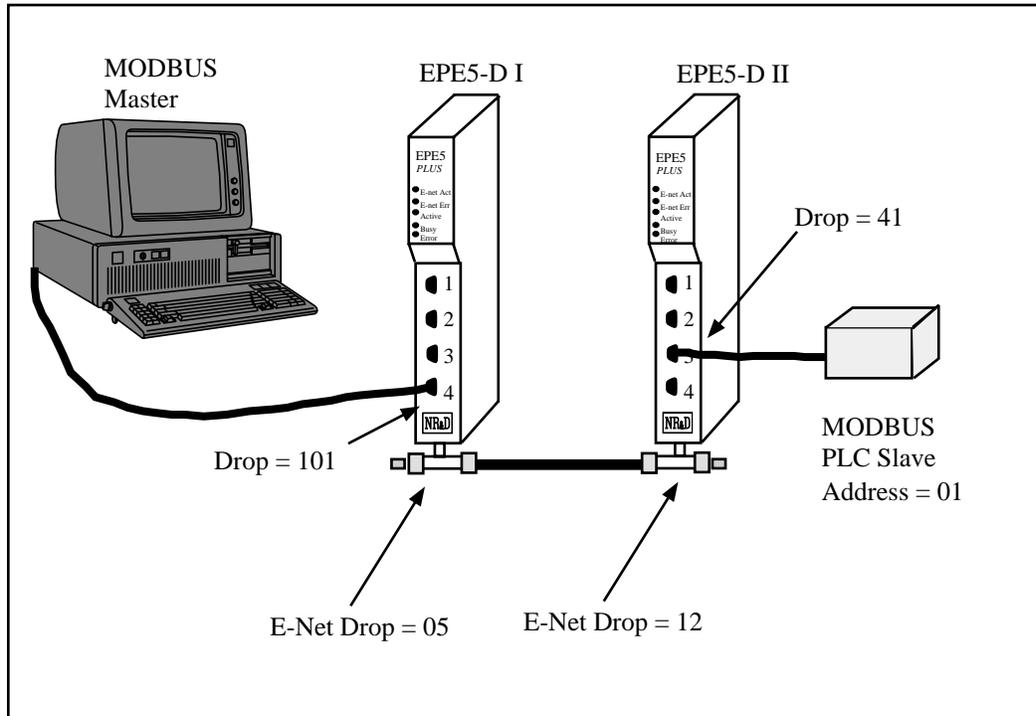


Figure 12-3 Modbus through SY/MAX Example

Table 12-11 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 12-12 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 12-13 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 12-4 displays a Modbus Routing table for the previous application from the Edit Modbus Routing screen of EPE5SW.

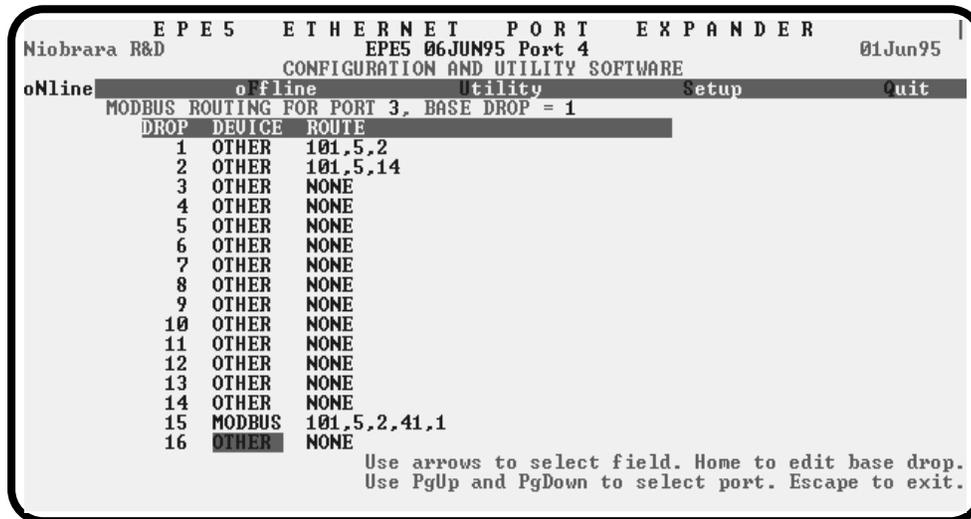


Figure 12-4 EPE5SW Modbus Routing Editing Screen

## 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 12-14 displays the currently used PLC IDs from Modicon.

Table 12-14 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.

If the Modbus Slave device is not a Modicon PLC and/or doesn't respond to the opcode 17 message, a user defined register in the slave may be used for the register 8188 poll. If bits 9 and 2 of the option register for the EPE5 port are both set on, the port will send a read to the address defined in the "Modbus Address Starting Base" register for that port.

**Table 12-15 SMS R[8188] Falsing Configuration Registers**

| EPE5 Port | Options Register | Modbus Address Starting Base |
|-----------|------------------|------------------------------|
| 1         | 8062             | 8063                         |
| 2         | 8094             | 9095                         |
| 3         | 8126             | 8127                         |
| 4         | 8158             | 8159                         |

For example, a Modbus slave is attached to EPE5 port 3. This slave only responds to reads of Holding registers 1 through 10, so it is decided that register 1 of the slave will be polled by SMS for the "Health Check".. Bits 2 and 9 of EPE5 register 8126 are both set on and register 8127 has the value 1. Now when SMS performs a read of the slave register 8188, the EPE5 will translate that read to ask for the value in Holding register 1.

### **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. Unfortunately, the Modbus (and Modbus Plus) protocol has no version of a random access read. Therefore it is not possible to translate a SY/MAX Random read to a single Modbus read. Because of this incompatibility, the Modbus Host mode must be used to connect 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 encapsulate SY/MAX Random Access Reads into transparent packets for shipment across the Modbus media and hence require another Modbus Gate or Niobrara Modbus Plus translation to disencapsulate the SY/MAX read. This technique allows the full use of the Random Read with SY/MAX and POWERLOGIC equipment.

NOTE: The MEB is now able to translate SY/MAX Random Access Reads into multiple Modbus Plus Reads targeted to devices on its local MB+ network. See the MEB manual for more information.



## 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 recommended that the MULTIDROP Mode be used rather than RNIM. (See page 65.) 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, MEB4s, 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:

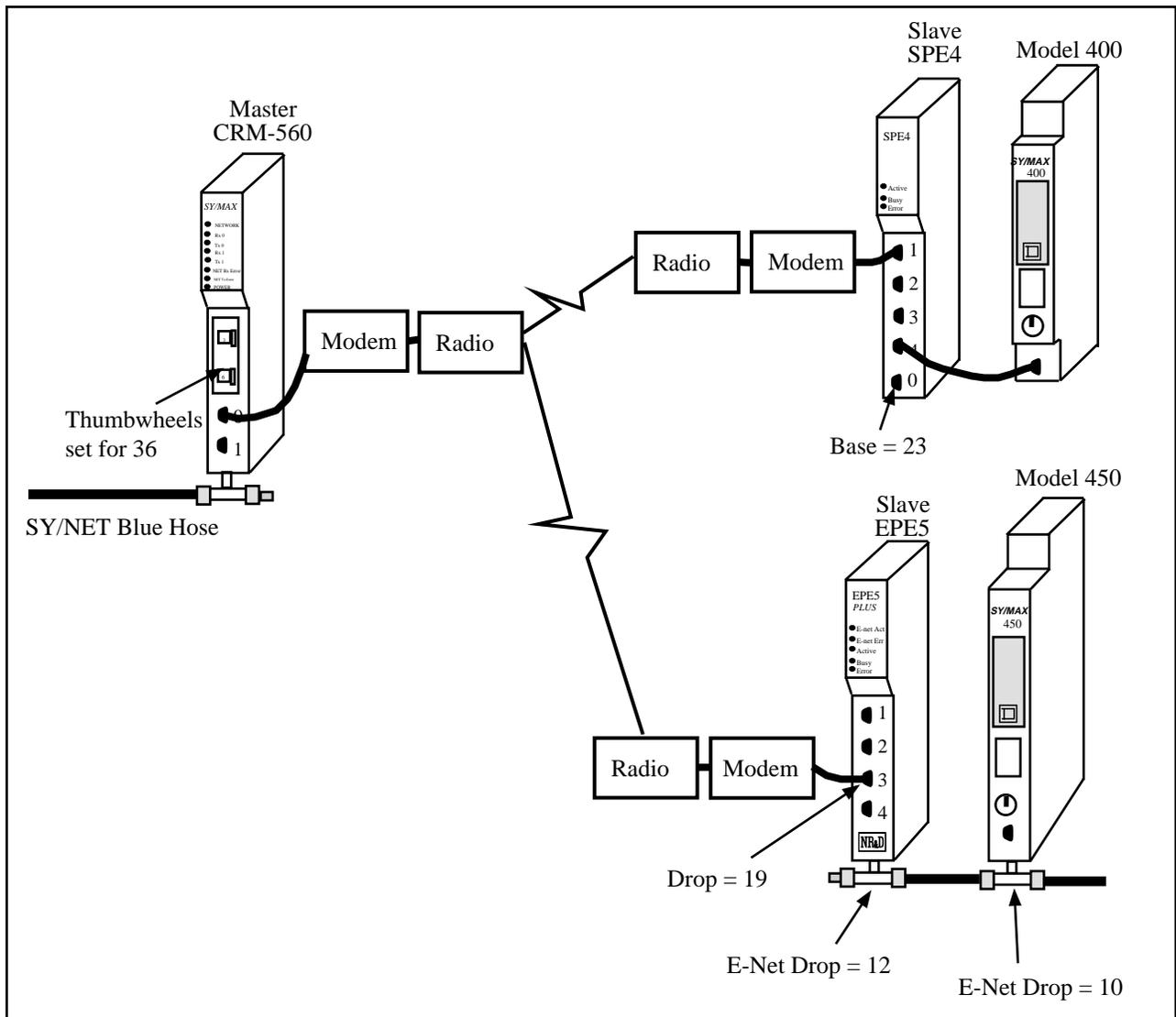
- Direct Master originated to Slave (NORMAL operation)
- Slave originated to Master (BID operation)
- Slave to Slave command relaying (STORE/FORWARD operation)
- Master originated broadcasting (BROADCAST operation)

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 13-1, 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 13-1 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, ...

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:

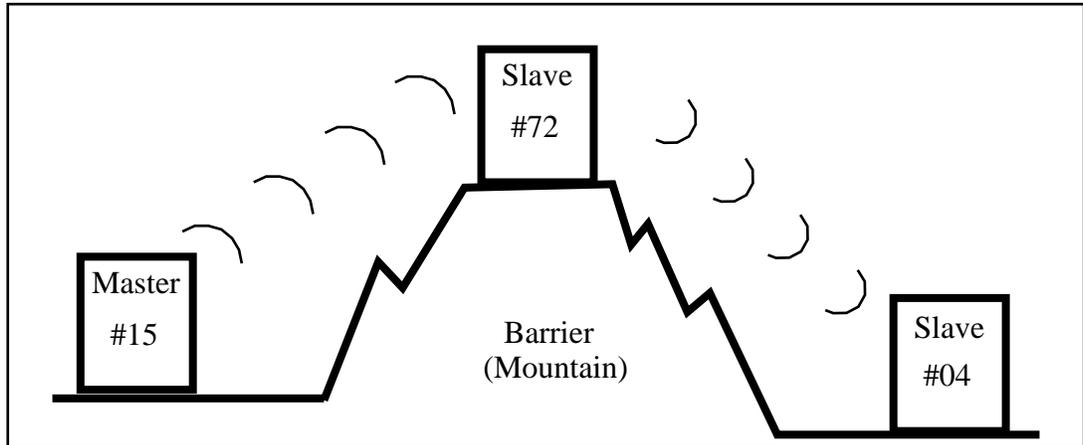
- 1 A value is written to the Bid address register.
- 2 A BID is sent to that address - 300.
- 3 The Master waits for the Reply timeout amount of time.
- 4 The Master waits for the BID interval amount of time. All queued NORMAL messages will be sent during the BID interval delay.
- 5 If the BID address 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 13-2 RNIM Repeater Example**

Figure 13-2 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 13-1 and this response will be acting upon the internal registers within the EPE5.

**Table 13-1 Broadcast Route Values**

|                   | Slave Drop # | CRM-560 Slave Port | EPE5 Response | Broadcast Route Value |
|-------------------|--------------|--------------------|---------------|-----------------------|
| General Broadcast | 00-99        | #1                 | Internal      | 254                   |
|                   |              | Twin-ax            | Internal      | 253                   |
| Partial Broadcast | 90-99        | #1                 | Internal      | 252                   |
|                   |              | Twin-ax            | Internal      | 251                   |
|                   | 80-89        | #1                 | Internal      | 250                   |
|                   |              | Twin-ax            | Internal      | 249                   |
|                   | 70-79        | #1                 | Internal      | 248                   |
|                   |              | Twin-ax            | Internal      | 247                   |
|                   | 60-69        | #1                 | Internal      | 246                   |
|                   |              | Twin-ax            | Internal      | 245                   |
|                   | 50-59        | #1                 | Internal      | 244                   |
|                   |              | Twin-ax            | Internal      | 243                   |
|                   | 40-49        | #1                 | Internal      | 242                   |
|                   | Twin-ax      | Internal           | 241           |                       |
| 30-39             | #1           | Internal           | 240           |                       |
|                   | Twin-ax      | Internal           | 239           |                       |
| 20-29             | #1           | Internal           | 238           |                       |
|                   | Twin-ax      | Internal           | 237           |                       |
| 10-19             | #1           | Internal           | 236           |                       |
|                   | Twin-ax      | Internal           | 235           |                       |
| 00-09             | #1           | Internal           | 234           |                       |
|                   | Twin-ax      | Internal           | 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 13-2 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 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 13-2 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.<br>100 to 199 Automatic BIDs.<br>200 to 299 Continuous Single BIDs<br>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 13-3 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 13-3 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 EPE5w 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.



## Transfer Mode

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 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.

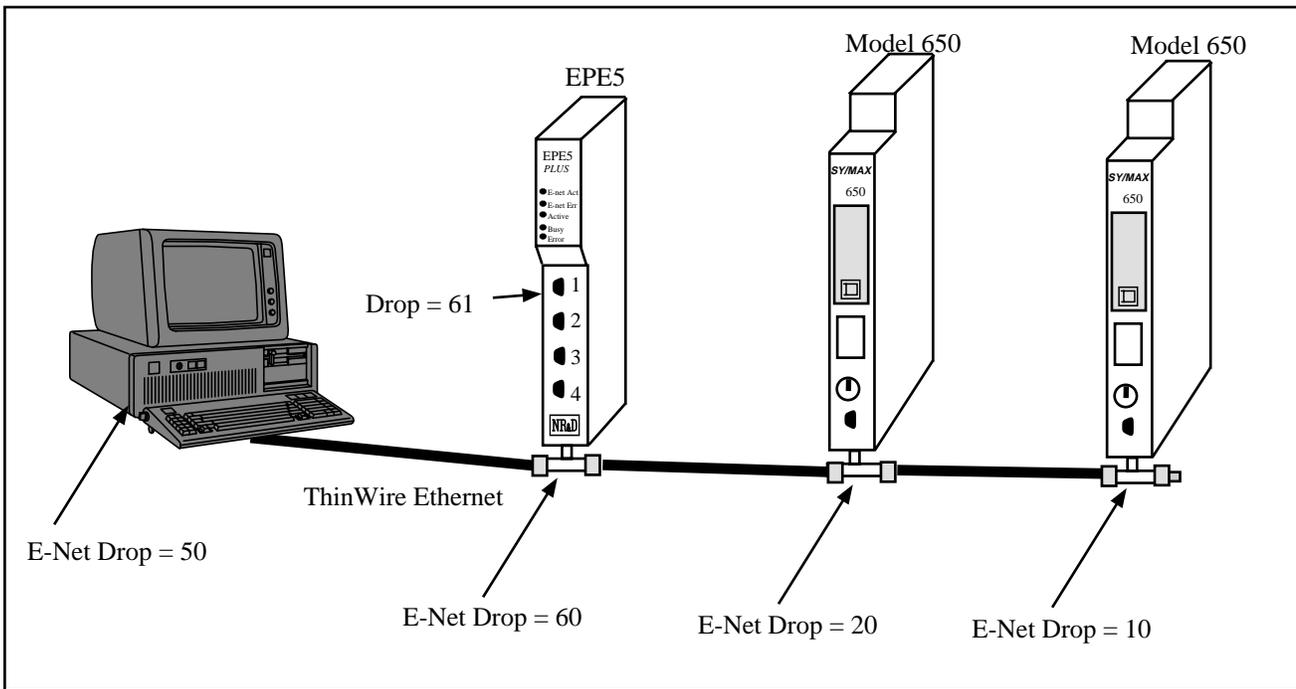
### Transfer Example

Figure 14-1 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 14-1 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 14-1 Transfer Route Registers**

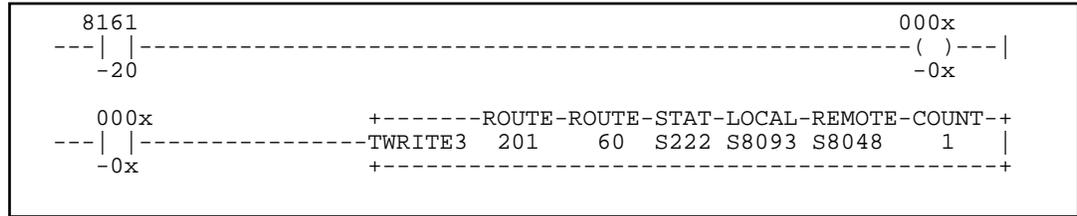
| MEB Register | Description         | Settings for 20 as Primary | Settings for 10 as Primary |
|--------------|---------------------|----------------------------|----------------------------|
| 8046         | # of drops in route | 2                          | 2                          |
| 8047         | 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.



**Figure 14-2 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.



## Chevron Mode

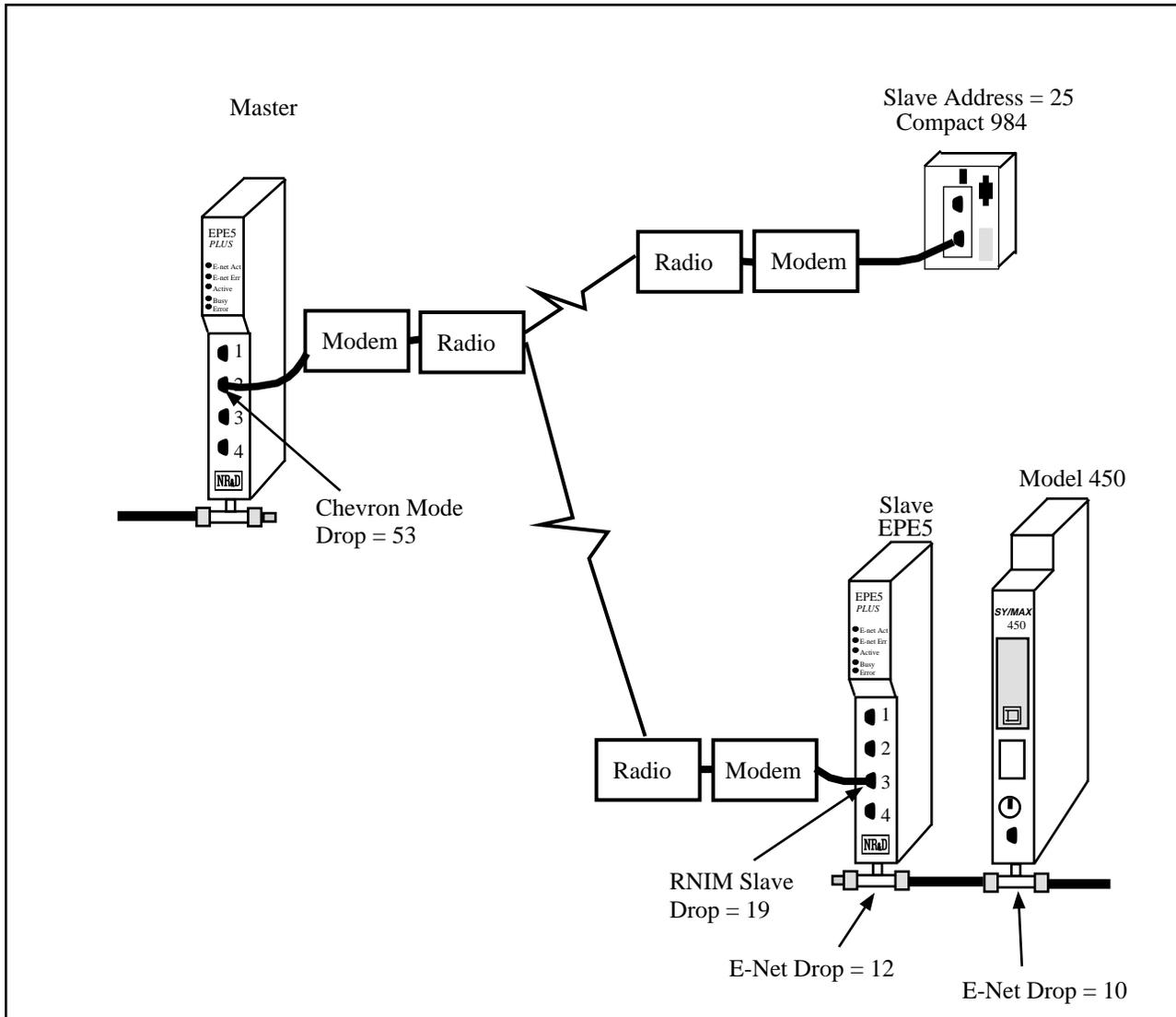
The Chevron mode is a combination of the RNIM Master and Modbus Gate modes to allow the integration of remote SY/MAX and Modbus devices on the same multidrop network. Incoming messages with the drop number following the Chevron Port's drop number within the range of 0 through 99 are sent out as RNIM 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-565 RNIMs, SPE4s, EPE5s, and MEBs. Any Modbus RTU slave device with active RTS/CTS handshaking may also be used in a Chevron network as a Slave.

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. No error message is posted to the originating device. It is up to the originating device to timeout and retry the message. This action was implemented to accommodate MODSOFT and allow PLC programming across a Chevron type network. 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 15-1 Chevron Example**

An example application of the Chevron mode is displayed in Figure 15-1. 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 an 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.

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## 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.



## 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 17-1 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 17-2 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.

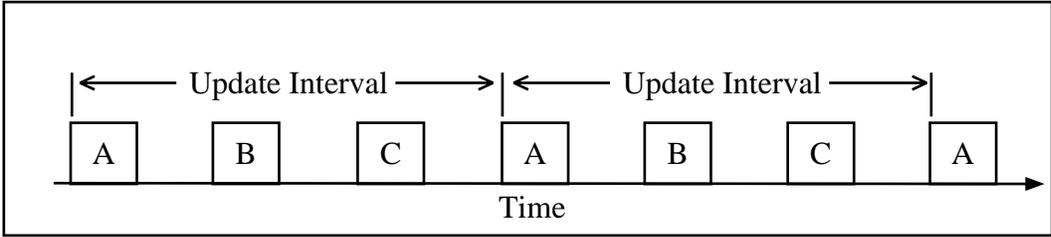
The update interval should be selected depending on system requirements and PLC scan time. As a rule of thumb, don't attempt to update faster than 1 or 2 milliseconds per node. There is no point in updating the peer-to-peer network much faster than the PLC can scan, but bear in mind that there is no 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 111 for more information.

Figure 17-1 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 17-1 E-PEER Update Interval Timing**



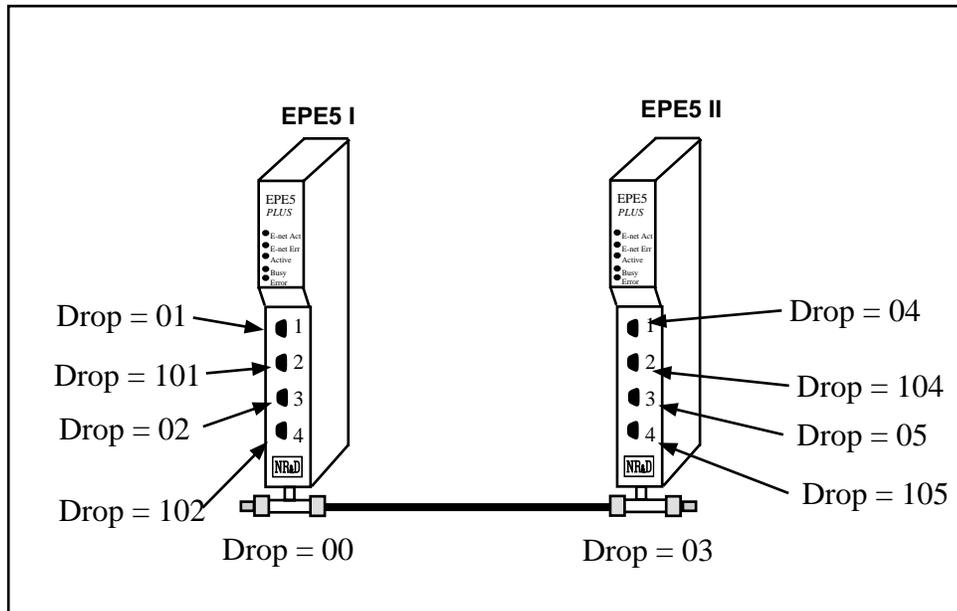
---

## On Ethernet Option

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 18-1 On Ethernet Example**

In Figure 18-1 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 18-1 shows several possible routes for communication.

**Table 18-1 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 I Port 2  | 104, 3, 0, 101 |
| EPE5 II Port 2 | EPE5 I Port 2  | 104, 0, 101    |
| EPE5 II Port 2 | EPE5 I Port 2  | 104, 3, 101    |
| EPE5 II Port 2 | EPE5 I Port 2  | 104, 101       |
| EPE5 I Port 1  | EPE5 I Port 2  | 1, 2           |
| EPE5 II Port 3 | EPE5 II Port 4 | 5, 105         |

---

## Configuration Software EPE5SW

### EPE5SW

The EPE5SW software program is provided free of charge to EPE5 users. This software is used to configure the operational parameters of the EPE5. EPE5SW can be operated in either online or offline modes.

EPE5SW uses the SY/MAX protocol for the configuration; 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.

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 19-1 on page 108. 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.

```

EPE5  ETHERNET  PORT  EXPANDER
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 19-1 EPE5SW Startup Screen**

If offline mode is selected, a second menu appears as shown in Figure 19-2 on page 108. 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.

```

EPE5  ETHERNET  PORT  EXPANDER
Niobrara R&D                                06Feb96
CONFIGURATION AND UTILITY SOFTWARE
oNline  oFfline  Utility  Setup  Quit

Read from disk to memory
Write from memory to disk
Edit configuration in memory
edit Modbus routing
edit Auto scan table
Send memory to module
Fetch memory from module
Print configuration in memory
Delete configuration file
Quit offline functions

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) 1994,1994 Niobrara R&D Corporation. All rights reserved.

```

**Figure 19-2 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 19-3. 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.

| EPE5 ETHERNET PORT EXPANDER |                                    |        |        |        |        |                    |
|-----------------------------|------------------------------------|--------|--------|--------|--------|--------------------|
| Niobrara R&D                | CONFIGURATION AND UTILITY SOFTWARE |        |        |        |        | 290ct96            |
|                             | ETHERNET                           | PORT 1 | PORT 2 | PORT 3 | PORT 4 | Press F2 for help. |
| 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 19-3 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. 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.

## 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, and PNIM. The default mode is SY/MAX.

## 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:

### 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.

### 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 be the result of the following formula:

$$\text{MODBUS value} = \text{SY/MAX register} + \text{Offset value} - 1$$

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 19-4.

```

EPE5  ETHERNET  PORT  EXPANDER
Niobrara R&D      EPES 06JUN95 Port 4      01Jun95
CONFIGURATION AND UTILITY SOFTWARE      Press F2 for help.
oNline  oNline  Utility  Setup  Quit
          0      PORT 1  PORT 2  PORT 3  PORT 4
Drop          1          101      2      102
Protocol      SY/MAX  PERIPHERAL  GATEWAY  SY/MAX
Baud Rate    9600    9600      9600    9600
Parity       EVEN    EVEN      EVEN    EVEN
Data Bits    8
Stop Bits    1
Buffer Limit 16

          PRINT SCREEN
Output file:
PRN

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 19-4 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 filename as an ASCII text file.

### F2 Help Window

Pressing the F2 key will present the help window shown in Figure 19-5. Pressing any key will return to the previous location

```

EPE5  ETHERNET  PORT  EXPANDER
Niobrara R&D      EPES 06JUN95 Port 4      01Jun95
CONFIGURATION AND UTILITY SOFTWARE      Press F2 for help.
oNline  oNline  Utility  Setup  Quit
          0      PORT 1  PORT 2  PORT 3  PORT 4
Drop          1          101      2      102
Protocol      SY/MAX  PERIPHERAL  GATEWAY  SY/MAX
Baud Rate    9600    9600      9600    9600
Parity       EVEN    EVEN      EVEN    EVEN
Data Bits    8
Stop Bits    1
Buffer Limit 16

          PARAMETER EDITOR HELP
Beware of changing the port you are connected
to which is displayed at top center of screen.
Use Up and Down arrows, Page Up, and Page Down
to select a field.
Use Left and Right arrows, Home, and End to
select a port.

In multiple choice fields, + key increases, -
decreases, and spacebar increases to the last
choice and then wraps to the first choice.
In numeric fields, type new value and ENTER.

Type ESC to exit online parameter editor.
Type F10 to clear error window.
Type F3 for real time statistics.
Type F9 to change Sy/Max communication setup.

Press any key to close help window.

```

Figure 19-5 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 19-6 and 19-7.

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

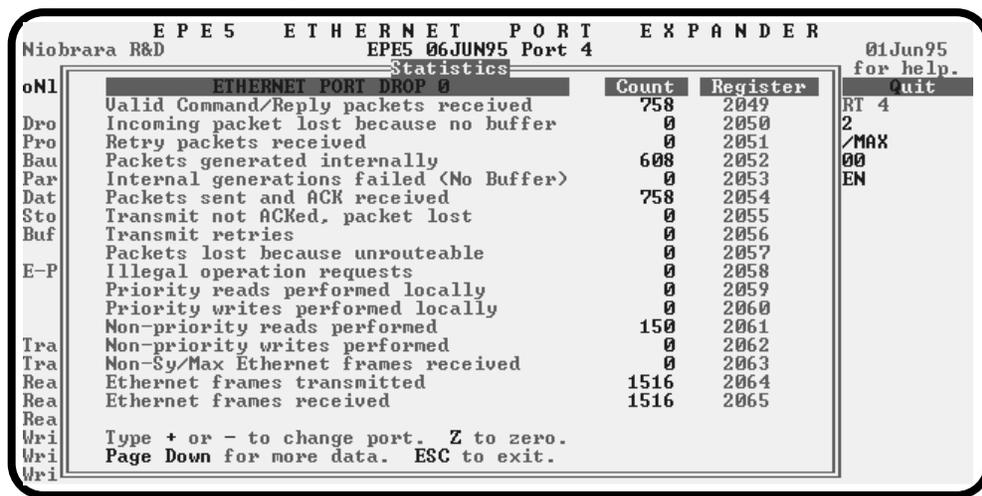


Figure 19-6 Ethernet Port Statistical Screen (Page 1)

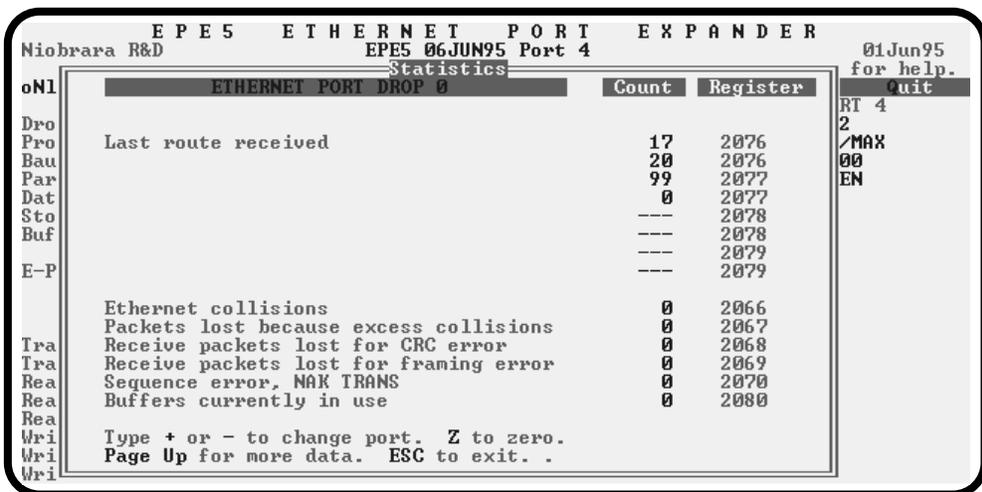


Figure 19-7 Ethernet Port Statistical Screen (Page 2)

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 134. 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 19-8 and 19-9.

| EPE5 ETHERNET PORT EXPANDER |  |                     |      |
|-----------------------------|--|---------------------|------|
| Niobrara R&D                |  | EPE5 06JUN95 Port 4 |      |
| Statistics                  |  |                     |      |
|                             | Count                                  | Register            |      |
| oN1                         | PORT 4 DROP 102                        |                     | quit |
|                             | 1837                                   | 2177                | RT 4 |
| Dro                         | 0                                      | 2178                | 2    |
| Pro                         | 0                                      | 2179                | /MAX |
| Bau                         | 0                                      | 2180                | 00   |
| Par                         | 0                                      | 2181                | EN   |
| Dat                         | 1836                                   | 2182                |      |
| Sto                         | 0                                      | 2183                |      |
| Buf                         | 1                                      | 2184                |      |
|                             | 0                                      | 2185                |      |
| Err                         | 0                                      | 2186                |      |
| Rou                         | 0                                      | 2187                |      |
| Rou                         | 0                                      | 2188                |      |
|                             | 1833                                   | 2189                |      |
| Tra                         | 4                                      | 2190                |      |
| Tra                         | 0                                      | 2191                |      |
| Rea                         | 18661                                  | 2192                |      |
| Rea                         | 36966                                  | 2193                |      |
| Rea                         |  |                     |      |
| Wri                         | Type + or - to change port. Z to zero. |                     |      |
| Wri                         | Page Down for more data. ESC to exit.  |                     |      |
| Wri                         |  |                     |      |

Figure 19-8 Port 1.4 Statistical Screen (Page 1)

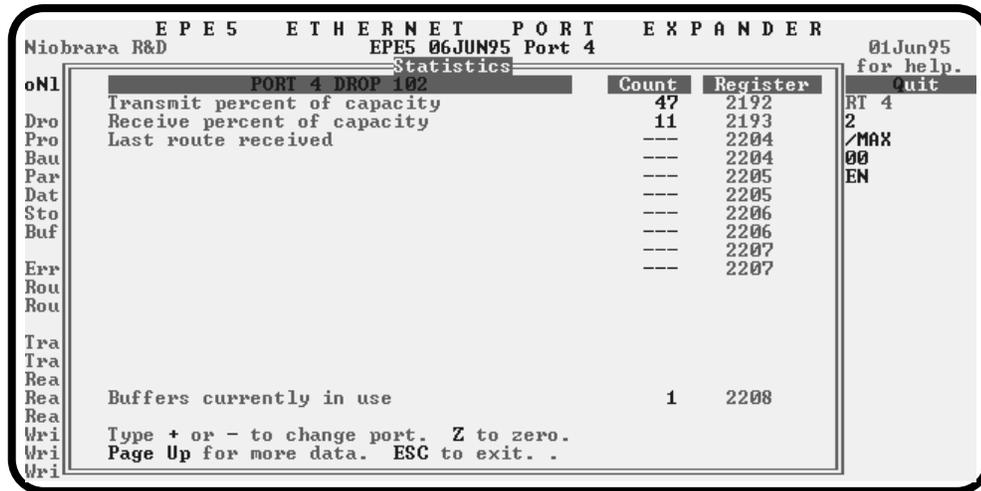


Figure 19-9 Port 1.4 Statistical Screen (Page 2)

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 135. 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 mode are capable of operating as a MODBUS RTU Slave as well as a Master. 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. 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.

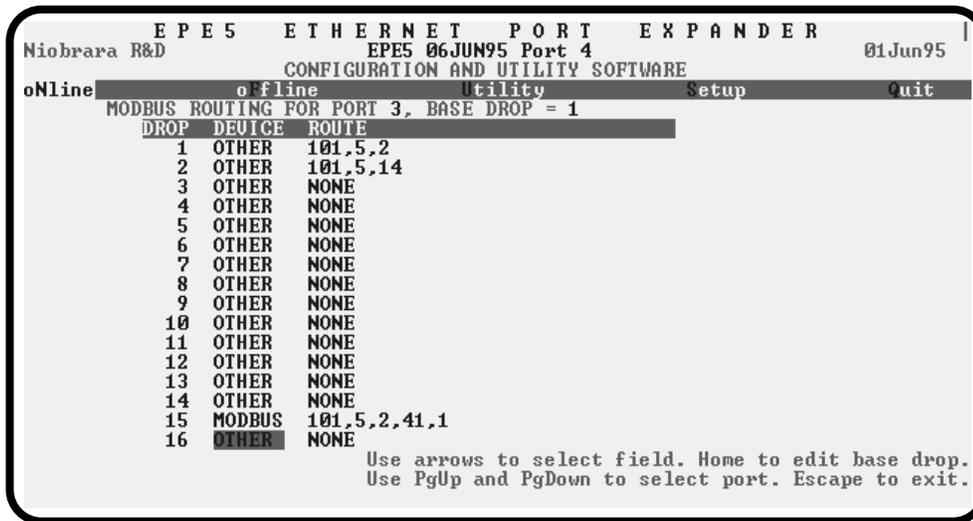


Figure 19-10 Edit Modbus Slave Routing

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 19-10 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.

## 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 device register), Count, type of operation (READ or WRITE), and the Route to the peripheral. Up to 48 entries may be included per port. Figure 19-11 displays an example of the Auto-Scan edit screen.

```

EPE5 ETHERNET PORT EXPANDER
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 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 19-11 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.

## 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.

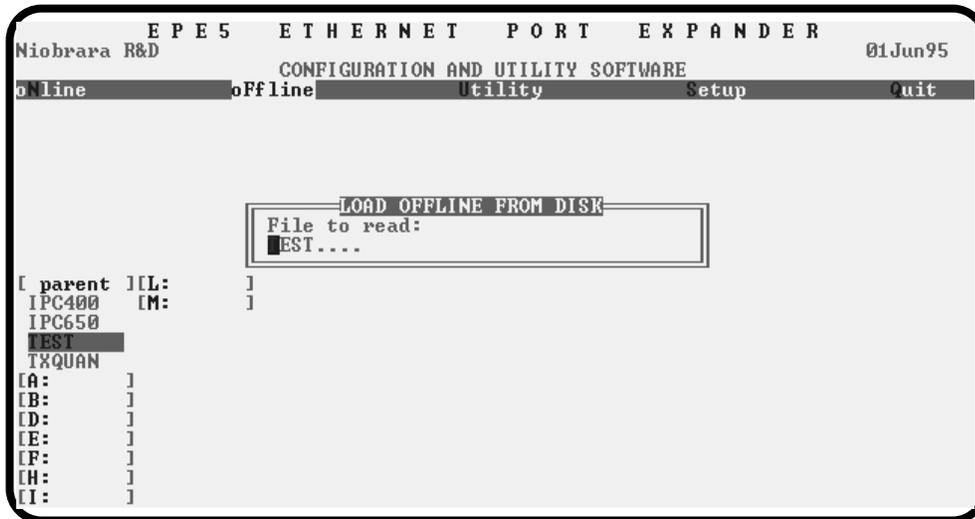


Figure 19-12 oFfline Read from Disk to Memory

### "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 .AIM to the name and the file will be placed in the directory which is shown in the bottom half of the screen. To create a file in a directory other than the current one, use the arrow and **ENTER** keys to traverse the directory tree until a listing of the desired directory is shown in the bottom half of the screen. Then type in the file name and press **ENTER**. If you specify (either by typing or by pointing) a file that already exists, you will be prompted for approval before that file is overwritten.

### "Edit configuration in memory"

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

| EPE5                               |      | ETHERNET PORT EXPANDER |        |        |      |         |
|------------------------------------|------|------------------------|--------|--------|------|---------|
| Niobrara R&D                       |      | EPE5 06JUN95 Port 4    |        |        |      | 01Jun95 |
| CONFIGURATION AND UTILITY SOFTWARE |      |                        |        |        |      |         |
| REGSTR                             | HEX  | UNSIGN                 | SIGNED | BINARY |      | STAT    |
| 1                                  | 0000 | 0                      | 0      | 0000   | 0000 | A000    |
| 2                                  | 0000 | 0                      | 0      | 0000   | 0000 | A000    |
| 3                                  | 8000 | 32768                  | -32768 | 1000   | 0000 | E000    |
| 4                                  | 0000 | 0                      | 0      | 0000   | 0000 | E000    |
| 5                                  | 0000 | 0                      | 0      | 0000   | 0000 | E000    |
| 6                                  | 0000 | 0                      | 0      | 0000   | 0000 | E000    |
| 7                                  | 0000 | 0                      | 0      | 0000   | 0000 | E000    |
| 8                                  | 1234 | 4660                   | 4660   | 0001   | 0010 | E000    |
| 9                                  | FEFE | 65278                  | -258   | 1111   | 1110 | E000    |
| 10                                 | 04D2 | 1234                   | 1234   | 0000   | 0100 | E000    |
| 11                                 | 0000 | 0                      | 0      | 0000   | 0000 | A000    |
| 12                                 | 0000 | 0                      | 0      | 0000   | 0000 | A000    |
| 13                                 | 0000 | 0                      | 0      | 0000   | 0000 | A000    |
| 14                                 | 0000 | 0                      | 0      | 0000   | 0000 | A000    |
| 15                                 | 0000 | 0                      | 0      | 0000   | 0000 | A000    |
| 16                                 | 0000 | 0                      | 0      | 0000   | 0000 | A000    |
| 17                                 | 0000 | 0                      | 0      | 0000   | 0000 | A000    |
| 18                                 | 0000 | 0                      | 0      | 0000   | 0000 | A000    |
| 19                                 | 0000 | 0                      | 0      | 0000   | 0000 | A000    |
| 20                                 | 0000 | 0                      | 0      | 0000   | 0000 | A000    |

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

Figure 19-13 View Registers

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

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

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

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

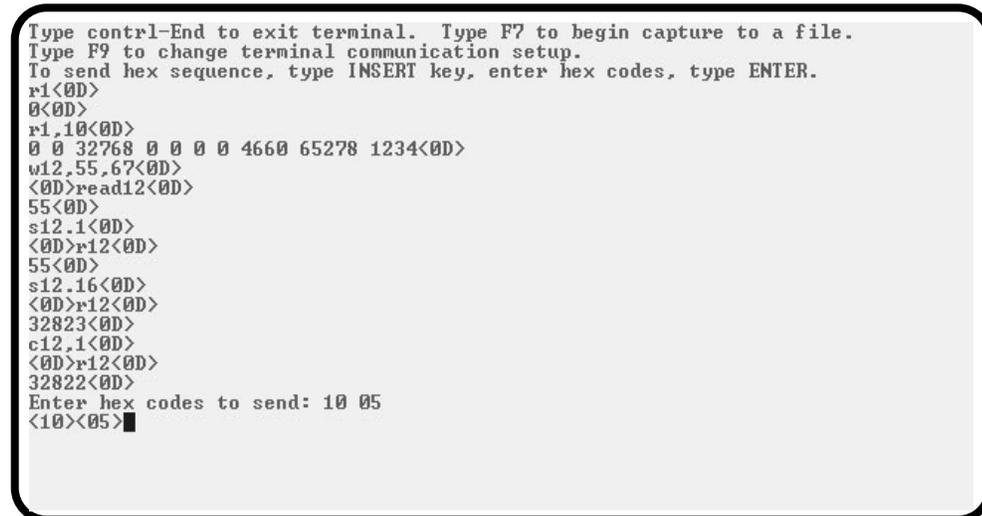
This register viewer is highly useful in that it allows easy editing of the data in the register being viewed. By pressing 0..9 in the decimal fields or 0..9, or A..F in the hex field, an editing mode is entered. New data may be entered at this time. Pressing the Enter key or moving to a new field with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

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

The STAT field displays the status register associated with the data register. The STATUS field is a read only display and can not be modified by the Register Viewer. Two common values are E000 and A000. A000 is the hex representation that the PLC recognizes as a PLC OUTPUT register. E000 is for a PLC INPUT register. This allows easy recognition of registers 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 19-14.



```
Type ctrl-End to exit terminal. Type F7 to begin capture to a file.
Type F9 to change terminal communication setup.
To send hex sequence, type INSERT key, enter hex codes, type ENTER.
r1<0D>
0<0D>
r1.10<0D>
0 0 32768 0 0 0 0 4660 65278 1234<0D>
w12,55.67<0D>
<0D>read12<0D>
55<0D>
s12.1<0D>
<0D>r12<0D>
55<0D>
s12.16<0D>
<0D>r12<0D>
32823<0D>
c12,1<0D>
<0D>r12<0D>
32822<0D>
Enter hex codes to send: 10 05
<10><05>█
```

**Figure 19-14 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.

# 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.

## SY/MAX 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.

```

EPE5  ETHERNET  PORT  EXPANDER
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 19-15 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.

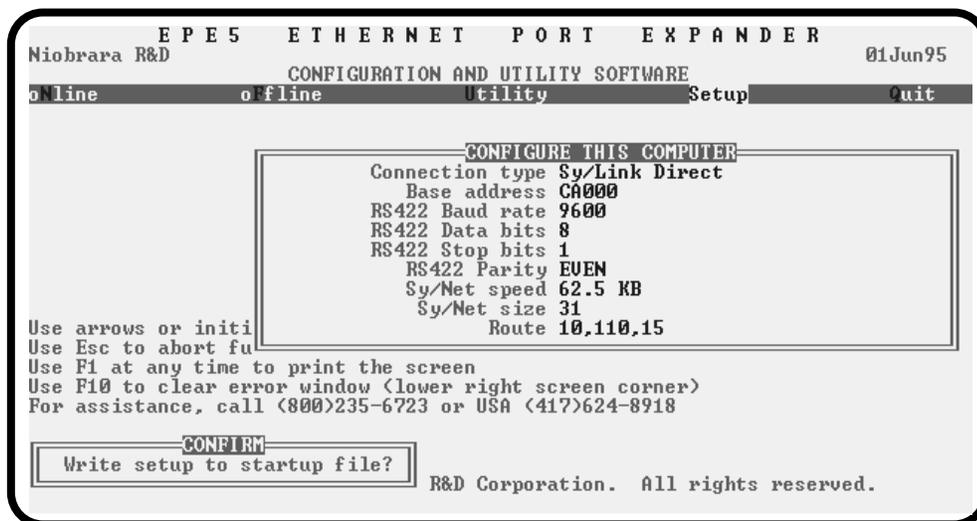


Figure 19-16 SY/LINK Setup Screen

**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 made through the SY/NET network to another NIM, the choice does not matter.

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

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

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

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

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

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

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

**Route** - The first drop in the route defines the network address of the SY/LINK board. Since the personal computer is connected to the SY/LINK card through the edge connector of the card, port 0, the drop number must start with 0. The remaining two digits of that drop should be selected not to match any other device on the SY/NET. For instance, there are three NIMs on the network addressed 01, 02, and 03. It seems logical to make the SY/LINK card be at address 04 so the first drop in the route field will be 004. The next drop will be that of the NIM port connected to the 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.

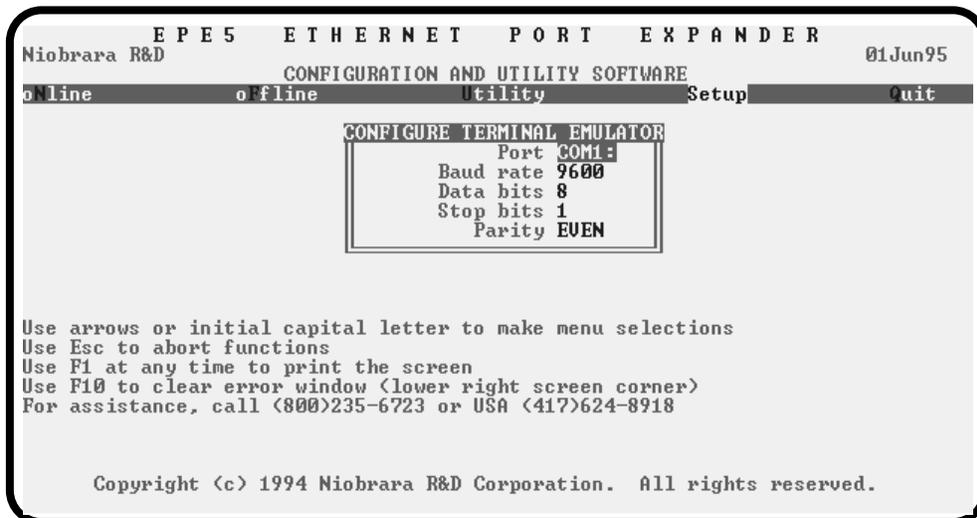
## SFI-610 SETUP

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.

## 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.



**Figure 19-17 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.

## 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 20-1 Module Register Overview**

| Register   | Function   |
|------------|--|
| 1..2048    | Rack Addressable Mailbox registers for user applications |
| 2049..2208 | Statistics Registers (See Tables 20-4 and 20-5)          |
| 2009..2999 | Reserved for future use, do not modify                   |
| 3000..3302 | Ethernet Addresses (See Table 20-6)                      |
| 3303       | E-Peer Active Nodes Register                             |
| 3410..3999 | Auto-Scan Tables   |
| 4640..7199 | Modbus Slave Address Look-up Tables (See Table 20-4)     |
| 7200..7999 | Reserved for future use.                                 |
| 8001..8162 | Setup and Configuration (See Tables 20-10, 20-11, 20-12) |
| 8176..8188 | Module identification (See Table 20-25)                  |

## 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 the registers in the PLC by the following formula:

$$\text{PLC Register} = \text{Rack Start Address} + \text{Mailbox Register}$$

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.

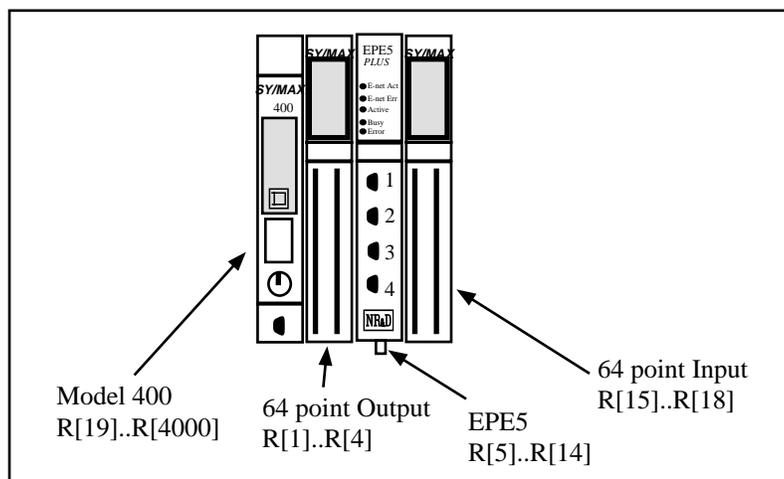
### NOTICE

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 20-1. 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 20-1 Mailbox Setup Example**

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

**Table 20-2 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 20-3 after each register has been written at least once.

**Table 20-3 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 20-4.

**Table 20-4 Ethernet Port Statistics Registers**

| Register | Incremented when the following occurs:                            |
|----------|---|
| 2049     | SY/MAX Ethernet commands/replies received.                        |
| 2050     | Incoming E-Net SY/MAX packet lost because no available buffer.    |
| 2051     | Retry packets received.   |
| 2052     | Packets generated locally. (Auto-transfer)                        |
| 2053     | Packet generation failed because no available buffer.             |
| 2054     | Packet transmitted successfully.                                  |
| 2055     | Transmission failed.  |
| 2056     | Transmission retry.   |
| 2057     | Packet lost because of unrecognized or illegal drop or bad route. |
| 2058     | Illegal SY/MAX operation request on local registers.              |
| 2059     | Priority read received and performed upon local registers.        |
| 2060     | Priority write received and performed upon local registers.       |
| 2061     | Non-Priority read received and performed upon local registers.    |
| 2062     | Non-Priority write received and performed upon local registers.   |
| 2063     | Non-SY/MAX Ethernet packet received.                              |
| 2064     | Ethernet packets transmitted.                                     |
| 2065     | Ethernet packets received.  |
| 2066     | Ethernet collisions.  |
| 2067     | Ethernet transmit packets lost to excess collisions.              |
| 2068     | Ethernet receive packets with CRC error.                          |
| 2069     | Ethernet receive packets with framing error.                      |
| 2070     | Ethernet NAK TRANS sent (Sequence error).                         |
| 2071     | 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 20-5.

**Table 20-5 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.              |

## Ethernet Addresses of Known Drops Registers

The IEEE 802.3 protocol requires each physical device on the Ethernet to have a unique address. (This address the address of the Ethernet controller and is not to be confused with the SY/MAX drop number 00..99.) This address is a 6 byte number and its value is governed by the IEEE. Each company that

makes Ethernet devices is assigned a block of addresses by the IEEE. All NR&D Ethernet products will have addresses with the form 00-20-BD-XX-XX-XX.

The EPE5 provides a listing of the physical Ethernet 802.3 address of each known active SY/MAX device on the network (See Table 20-6). These values are placed in Registers 3000..3302 with three registers allocated for each address. The Ethernet address requires six bytes of data and this data is split into two bytes per register. The following formulas will provide the registers containing the Ethernet address of each of the 100 possible devices on the SY/MAX network:

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

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

**Table 20-6 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 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 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.

## 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 20-7 Auto-Scan Configuration Registers**

| Port 1 Register | Port 2 Register | Port 3 Register | Port 4 Register | Data Bytes |       | Description            |
|-----------------|-----------------|-----------------|-----------------|------------|-------|------------------------|
|                 |                 |                 |                 | MSB        | LSB   |                        |
| 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

This 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 in 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 20-8 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 20-9)

**Table 20-9 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.

## 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 20-10.

**Table 20-10 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 20-11 provides a list of these registers.

**Table 20-11 Ethernet Port Control Registers**

| Port 0 | Legal Values | Function   |
|--------|--------------|--|
| 8003   | 0..99        | Ethernet SY/MAX drop number.                               |
| 8004   |              | Reserved (IP sub-net mask)                                 |
| 8005   |              | Reserved (IP sub-net mask)                                 |
| 8006   |              | Reserved (IP address)                                      |
| 8007   |              | Reserved (IP address)                                      |
| 8008   | 2            | Protocol Mode (Presently 2, SY/MAX 802.3 only)             |
| 8009   | 1..8192      | Auto-transfer Read Source Register (Peripheral)            |
| 8010   |              | Reserved (TCP/IP port number).                             |
| 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 20-24 on Page 147)                      |
| 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 20-12.

**Table 20-12 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 20-19 on Page 145)                         |
| 8037   | 8069   | 8101   | 8133   | 0,1          | Data Bits (See Table 20-20 on Page 145)                         |
| 8038   | 8070   | 8102   | 8134   | 0,1,2        | Parity Bits (See Table 20-21 on Page 145)                       |
| 8039   | 8071   | 8103   | 8135   | 0,1          | Stop Bits (See Table 20-22 on Page 145)                         |
| 8040   | 8072   | 8104   | 8136   | 1..11        | Protocol Mode (See Table 20-23 on Page 146)                     |
| 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  |

| Port 1 | Port 2 | Port 3 | Port 4 | Legal Values | Function   |
|--------|--------|--------|--------|--------------|--|
| 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 20-24 on Page 147)                            |
| 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   |              | Reserved for future use, do not modify                           |
| 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 20-13 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 20-14 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 20-15 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 20-16 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 20-17 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.<br>100 to 199 Automatic BIDs.<br>200 to 299 Continuous Single BIDs<br>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 20-18 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 20-19 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 20-20 Data Bits Values**

| Data Register | Data Bits |
|---------------|-----------|
| 0             | 7         |
| 1             | 8         |

**Table 20-21 Parity Values**

| Parity Register | Parity |
|-----------------|--------|
| 0               | None   |
| 1               | Odd    |
| 2               | Even   |

**Table 20-22 Stop Bits Values**

| Stop Register | Stop Bits |
|---------------|-----------|
| 0             | 1         |
| 1             | 2         |

**Table 20-23 Port Mode Values**

| <b>Mode Register</b> | <b>Protocol</b> |
|----------------------|-----------------|
| 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    |

**Table 20-24 Options Register Values**

| Option Bit | Function when Bit CLEAR (Default)  | Function when Bit SET   |
|------------|--|---|
| 1          | SY/MAX Block Check is single byte checksum (BCC)   | SY/MAX Block Check is two byte cyclic redundancy check (CRC)  |
| 2          | Gateway, Share, and Transparent do echo. Normal 205 Route Replacement  | Gateway, Share, and Transparent do echo. PanelMate 205,X lookup table routing.  |
| 3          | Gateway mode replies are terminated by CR only.  | Gateway mode replies are terminated by CR/LF and are highlighted.   |
| 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)   | Half Duplex (For 2-Wire)  |
| 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         | Reserved.  | Modbus R[8188] Spoofing using pointer register.   |
| 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 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 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 along with Bit 9 is used on Modbus Hosts ports to provide spoofing of POWERLOGIC System software. If both Bits 10 and 9 are set, a register read of 8188 will be translated into a register read of the value in EPE5 register (options + 1). This register is normally the Modbus Address Starting Base.

## 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 20-25 provides an overview of these registers.

**Table 20-25 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 20-26.

**Table 20-26 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 |  |

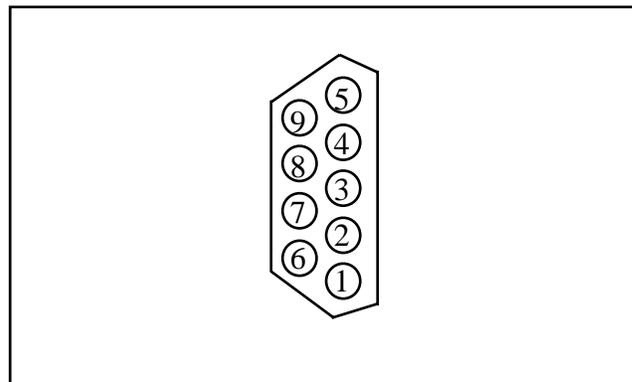
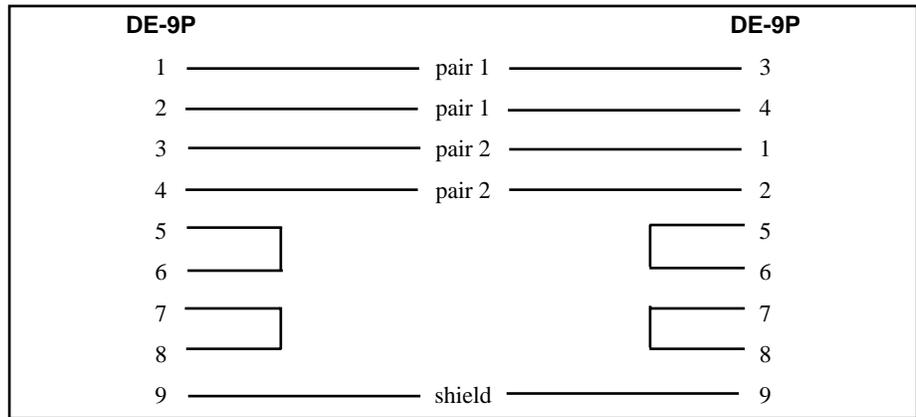


Figure 21-1 DE9S Pin configuration



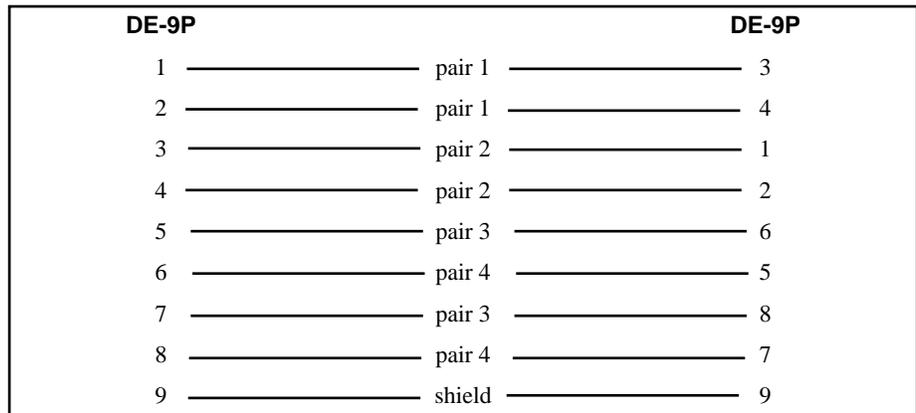
## Recommended Cabling

### EPE5 RS-422 to SY/MAX RS-422 port (Without Handshaking)



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.

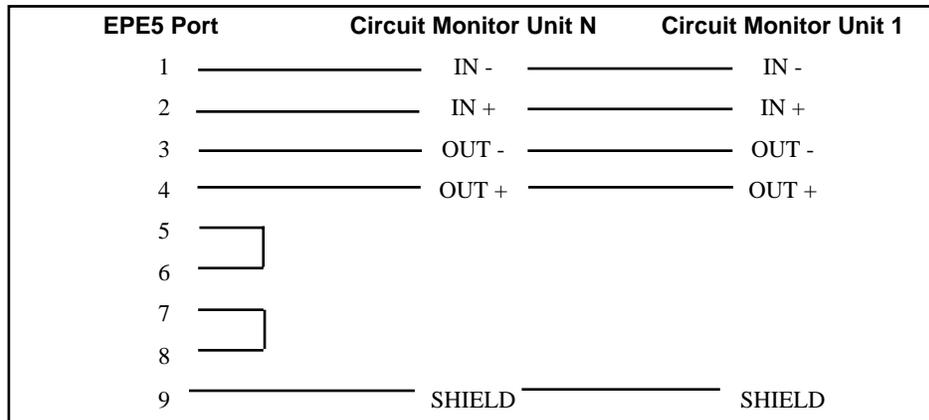
### EPE5 RS-422 to SY/MAX RS-422 port (With Handshaking)



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)

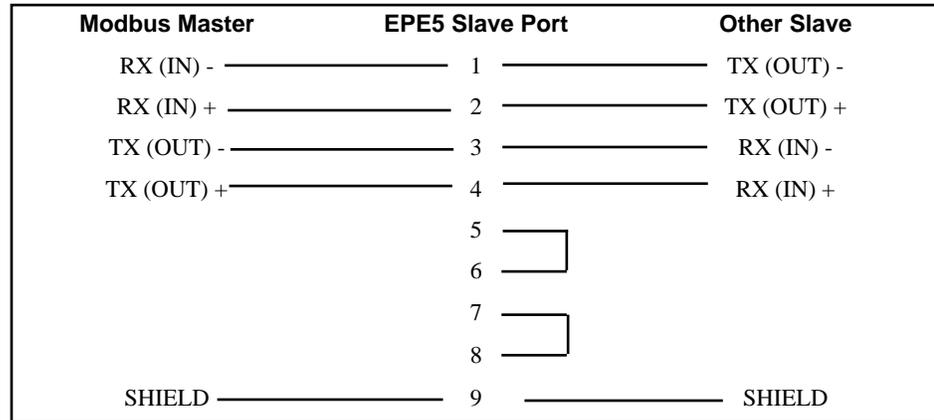


When connecting to POWERLOGIC, or any other 4-wire multidrop network, always include proper termination at the far end of the network. The EPE5's RS-485 ports have internal biasing and terminating resistor networks so there is no need for termination at the EPE5 end.

For 4-wire networks, such as the POWERLOGIC network, where the EPE5 is serving as the master, leave the Options bits for Multidrop off so Multidrop is set to FALSE. This will enable the EPE5's transmit drivers continuously and force that line to a known state at all times. Also leave the Option for Duplex off for FULL duplex operation. These Options bits may be set with the Driver Mode = Pt to Pt within EPE5SW.

Be certain to jumper the RTS/CTS pairs at the EPE5 port.

## EPE5 RS-485 port to Modicon RS-485 (4-wire Multidrop Slave)

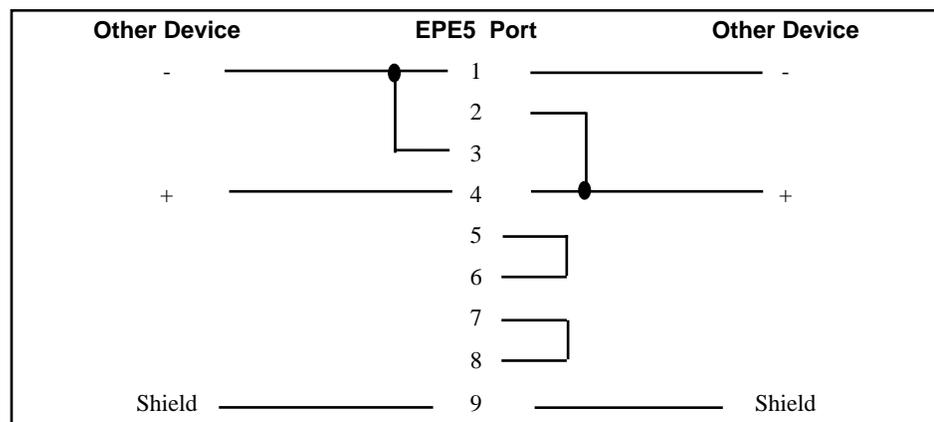


When connecting to Modicon 4-wire multidrop networks, always include proper termination at the far end of the network. The EPE5's RS-485 ports have internal biasing and terminating resistor networks so there is no need for termination at the EPE5.

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)



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.

---

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.

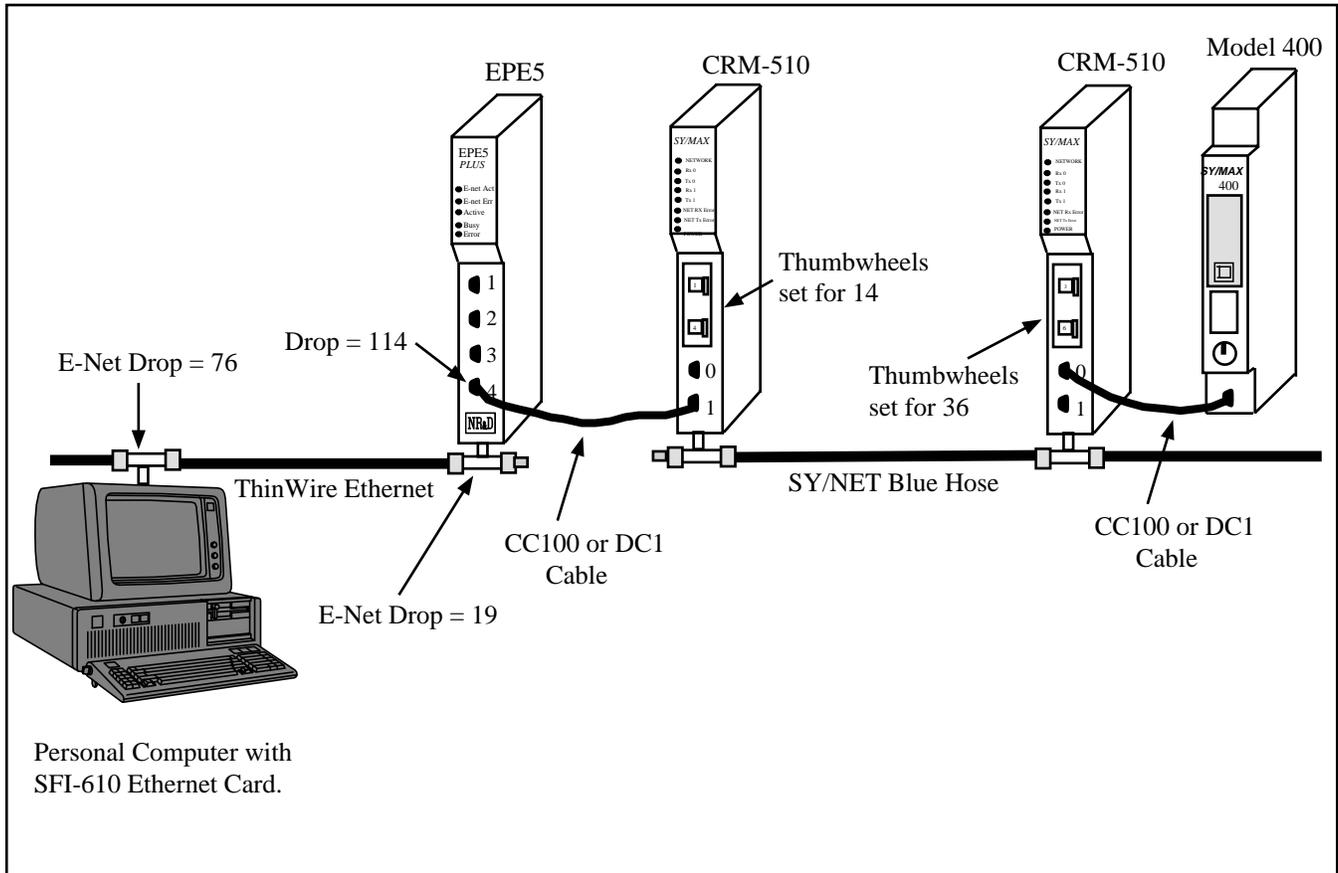


Figure 23-1 NIM Net-to-Net Example

Table 23-1 Personal Computer route

| Origin            | Target    | Route           |
|-------------------|-----------|-----------------|
| Personal Computer | Model 400 | 076 019 114 036 |

Table 23-2 EPE5 Setup for NIM Net-to-Net Connection

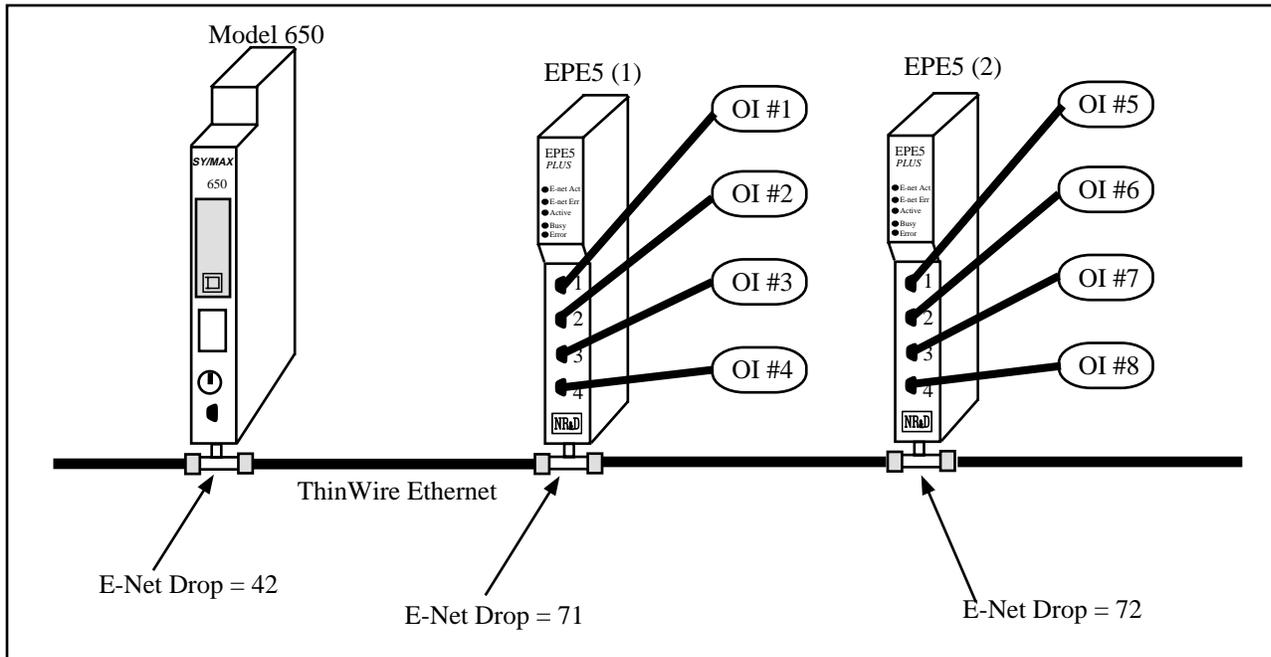
| Port  | Drop # | Mode       | Baud Rate | Parity | Data | Stop |
|-------|--------|------------|-----------|--------|------|------|
| E-Net | 19     | SY/MAX     | NA        | NA     | NA   | NA   |
| 4     | 114    | Net-to-Net | 9600      | E      | 8    | 1    |

## 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 23-2 EPE5 Operator Interface Ethernet Routing Example**

**Table 23-3 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 23-4 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 23-5 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 18 on page 105.

## 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.

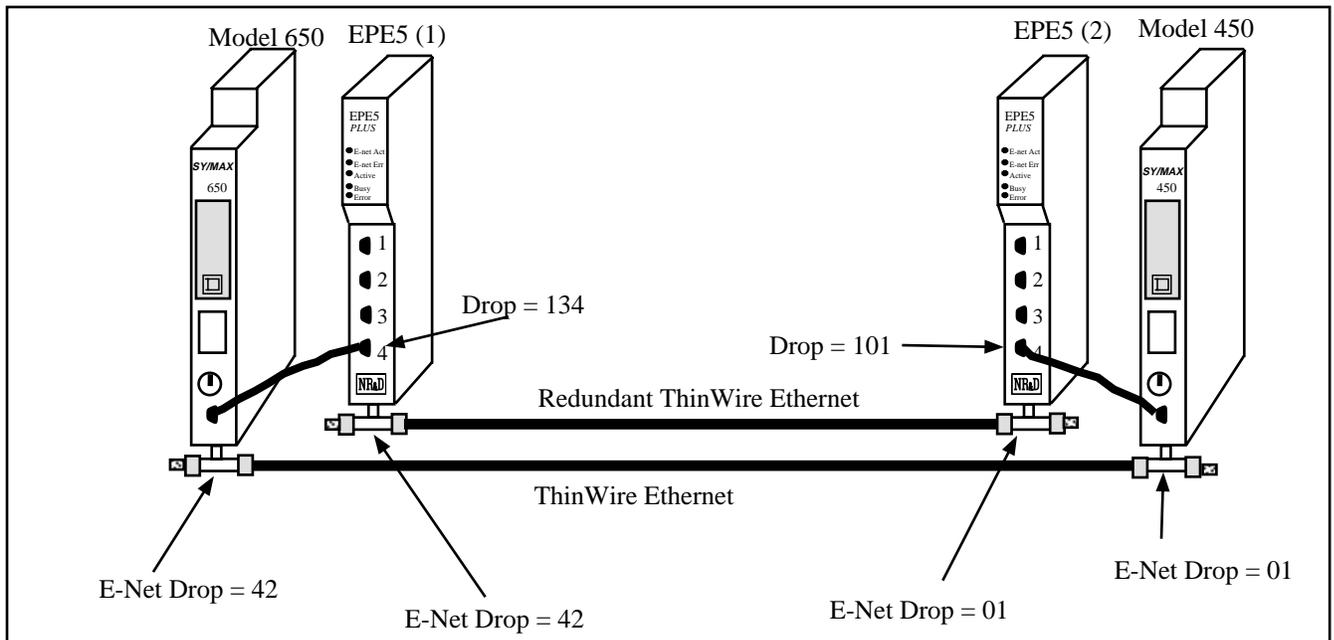


Figure 23-3 Redundant Ethernet Network

### 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 23-5) 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 23-4 displays the Edit screen for this example.

| EPE5 ETHERNET PORT EXPANDER        |        |        |        |        |                    |
|------------------------------------|--------|--------|--------|--------|--------------------|
| 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 23-4 Edit Port Parameters Example

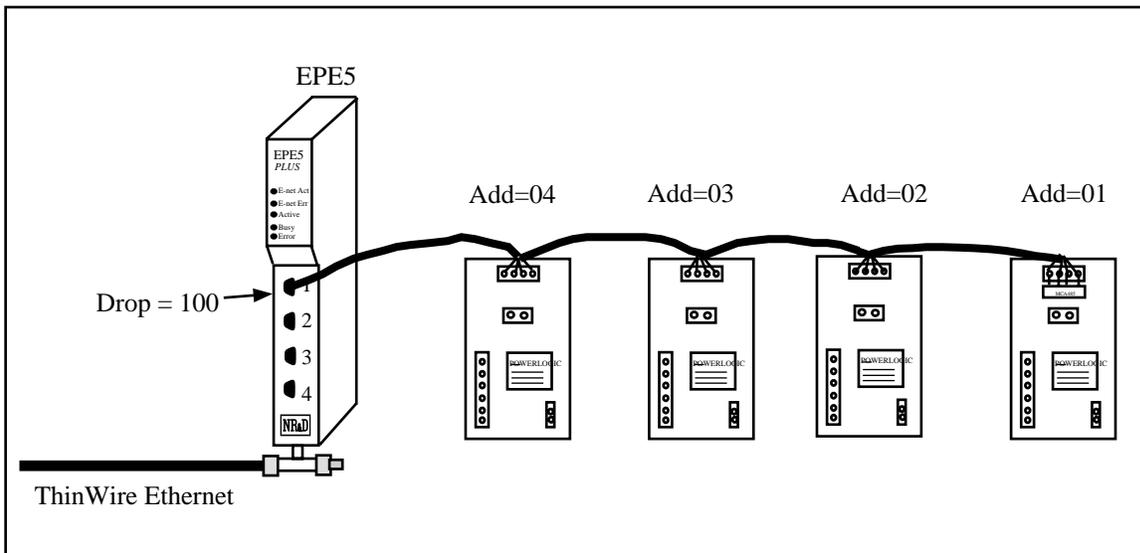


Figure 23-5 Auto-Scan Example

Figure 23-6 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.

```

Niobrara R&D      EPE5  ETHERNET  PORT  EXPANDER      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      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 23-6 Auto-Scan Table Example

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# Appendix A

## Ethernet Communication Overview

This Appendix is meant to provide a general background for common types of Ethernet Local Area Network communication.

### Hardware Overview

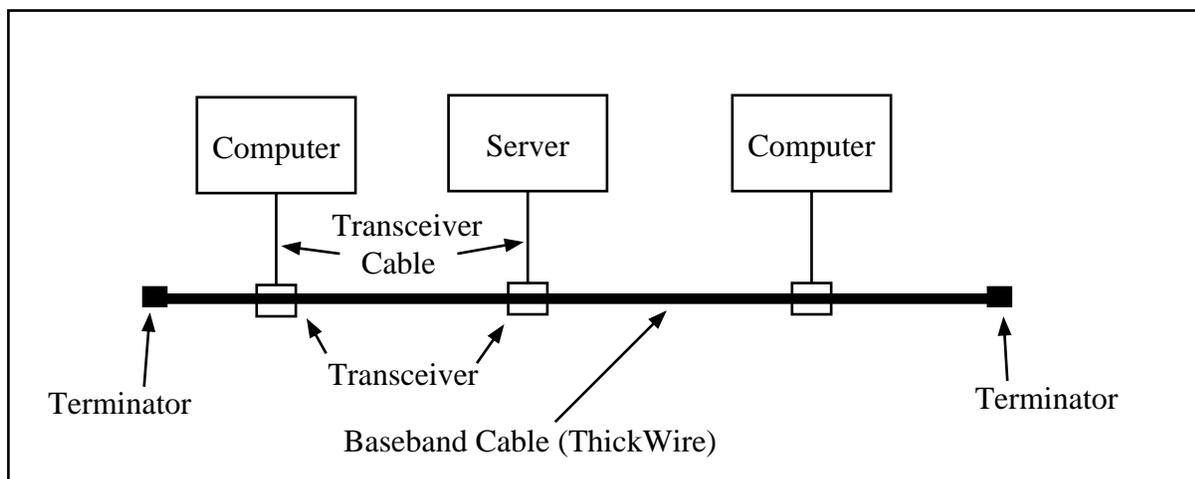
The IEEE 802.3 protocol may operate on a variety of wiring or cabling media. Networks may be comprised of standard baseband coaxial cable, ThinWire coaxial cable, and shielded and unshielded twisted pair cables.

#### **ThickWire (10Base5)**

The original IEEE 802.3 standard specified standard baseband and broadband coaxial cables. This cable is known as ThickWire and is referenced by 10Base5. These cables were optimized for the 10Mb/s maximum speed and maximum distances of Ethernet.

The coaxial cable system allows daisy-chaining of devices to form a network by the use of clamp on transceivers. Clamp on transceivers are used because the ThickWire cable is too stiff to bend near the computer to allow a TEE connection. Since the cable could not be brought to the transceiver, the transceiver was moved from the computer to the cable. The transceiver is connected to the controller by means of a Transceiver Cable. This Transceiver Cable consists of four twisted-pair wires and has a 15 pin connector on each end. The port on the controller is sometimes called an AUI port.

The ThickWire coax is joined with barrel connectors to increase its length up to 500 meters (1640 feet). Each end of the cable must have a terminator to prevent unwanted echoes.

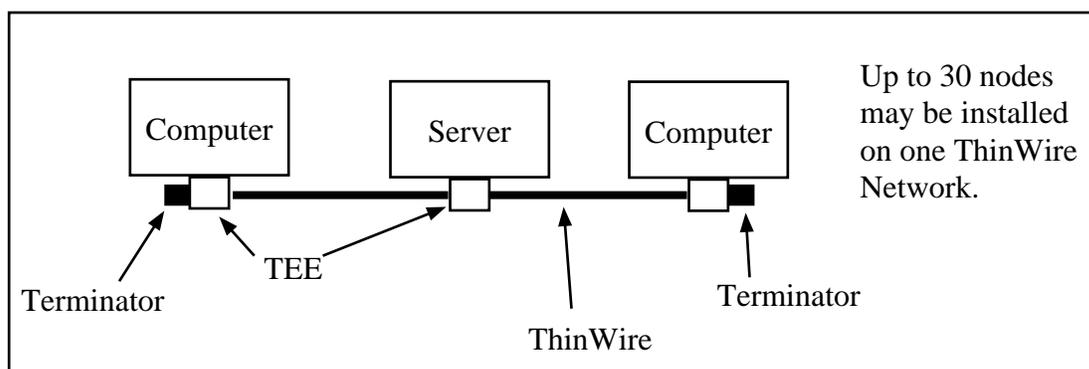


**Figure A-1 ThickWire Network**

### ThinWire (10Base2)

ThinWire coax, sometimes called "thin net" or "cheaper net" is used more commonly today. ThinWire offers the same speed capability as the standard baseband, but at a shorter maximum distance. ThinWire allows longer segment/distance lengths than twisted-pair and has lower EMI than unshielded twisted-pair. The maximum length of a ThinWire segment is 185 meters (607 feet). A maximum of 30 devices can be connected to a single segment by daisy-chained connections. When a ThinWire Ethernet repeater is used, up to 29 stations can be connected to each segment of ThinWire cable.

Like ThickWire, ThinWire allows daisy-chaining of devices to form a network. But ThinWire is flexible enough to bend near the Ethernet controller so the transceiver is mounted within the computer. Connection to the ThinWire is made with a TEE connector directly to the BNC connector on the controller.



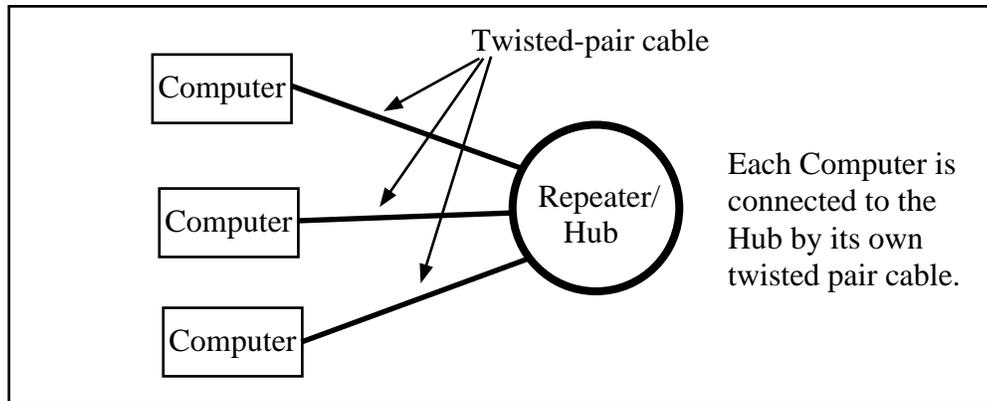
**Figure A-2 ThinWire Network**

This type of cable is used by Square D for its SY/NET 802.3 applications. The Model 650, 450, SFI-610 and Niobrara's EPE5 all support direct hardware connection to ThinWire.

### Twisted-pair (10BaseT)

Twisted-pair cabling is also used extensively for connecting Ethernet equipment together. The twisted-pair cable may be shielded or unshielded, such as telephone wire. ThickWire may be used in a star-

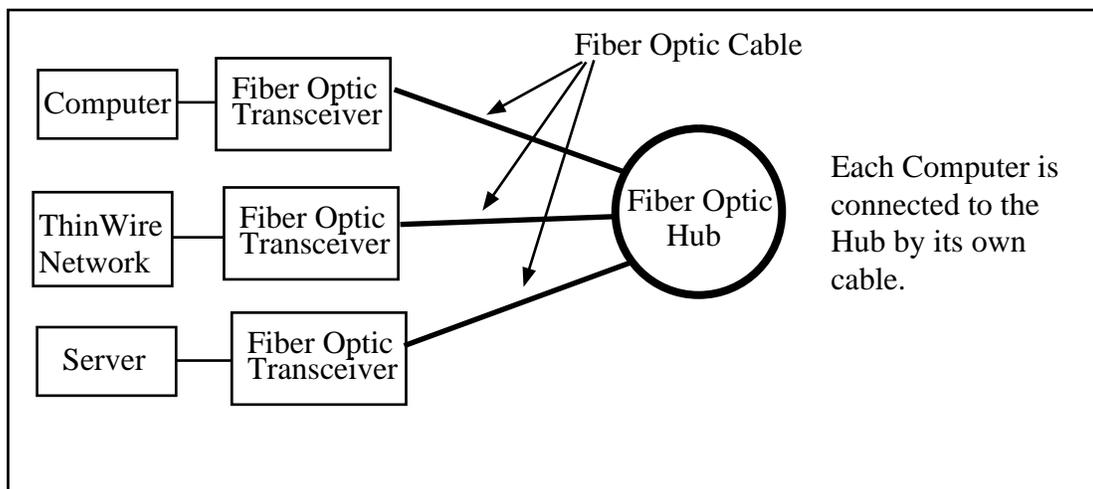
wired configuration only. Daisy-chaining is not allowed. For this reason, twisted-pair is primarily used for connecting work-stations to repeaters/hubs.



**Figure A-3 10BaseT Network**

### Fiber Optic

Fiber optic cables are being employed for network backbones in large systems. The high noise immunity, electrical isolation, long distances, and security features (Fiber optic cables are difficult to tap.) make the fiber optic backbone attractive. With the use of a fiber optic hub, star configurations may be constructed as shown in Figure .



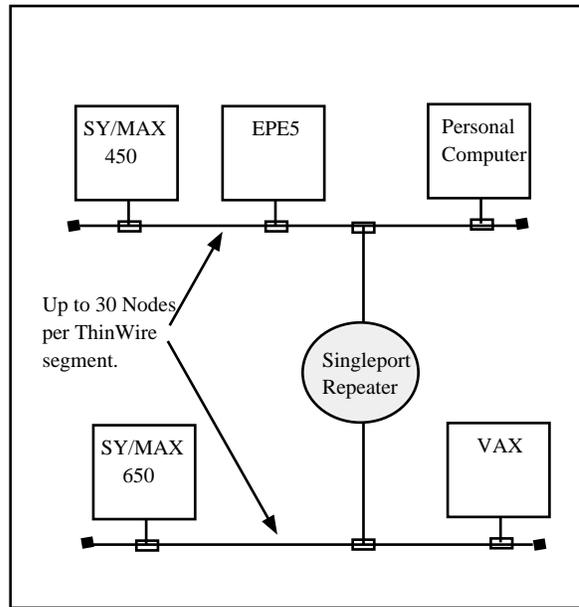
**Figure A-4 Fiber Optic Hub Network**

### Ethernet Repeaters

When more Ethernet Devices are needed on a given network than are allowed, it becomes necessary to use a repeater to extend the network. Repeaters are available in various configurations including Singleport Repeaters and Multiport Repeaters. Repeaters may have AUI connections, ThinWire ports, 10BaseT ports, and fiber optic ports. Multiport repeaters may be referred to as Hubs. See Figure .

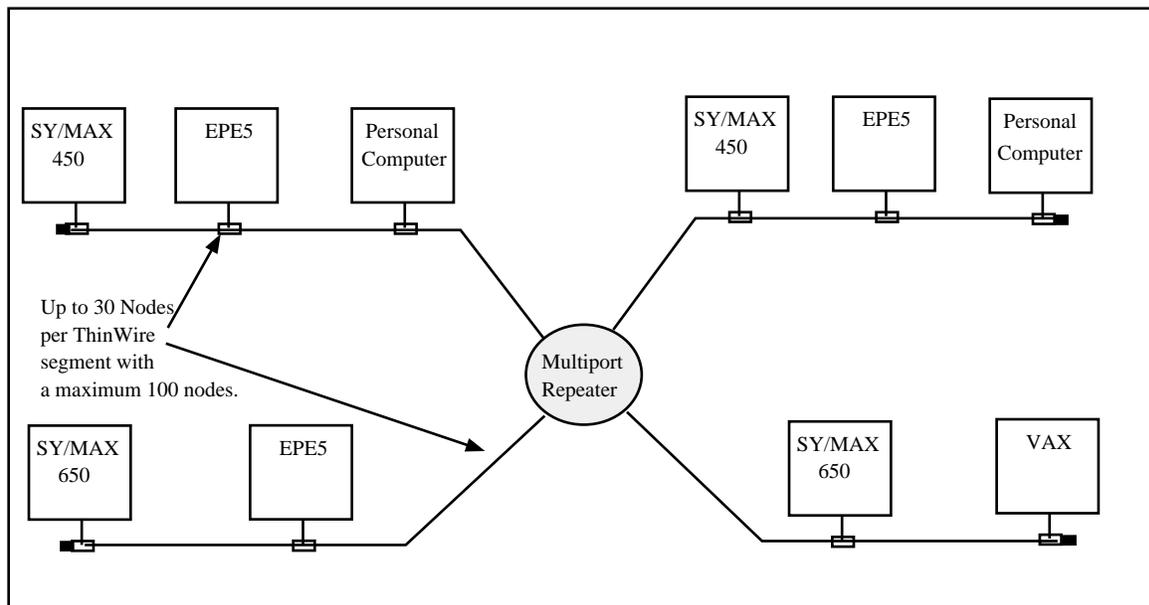
Repeaters have the ability to detect faults on each side, or leg, of the network and prevent that fault from interfering with traffic on the fault-free network. A fault may be made by disconnecting the network, removing the terminator, or broken equipment.

Singleport Repeaters offer a method for extending the LAN with a minimum of cost. A Singleport Repeater acts as its name implies; it repeats all traffic from one side of the repeater to the other.



**Figure A-5 ThinWire Singleport Repeater**

Multiport Repeaters provide the function of several Singleport repeaters in one convenient package. Multiport Repeaters are available with 6, 8, and more ports.



**Figure A-6 ThinWire Multiport Repeater**

There is a "Three Repeater Rule" which limits the number of repeaters a packet may travel through to its destination to three. This excludes special repeaters and bridges which re-time the packet.

### Ethernet Bridges

Ethernet bridges are specialized computers which allow separate LANs to be connected, typically across large distances. Unlike Repeaters, Bridges keep a record of all node addresses on each side of the bridge and isolate traffic to the appropriate side. This is useful in areas where high traffic might exist on one side of the bridge and the low traffic on the other side is not affected.

Bridges are often used to connect LANs across long distances and may include other media between the halves of the bridge. Micro wave, fiber optic, modems, etc. may be used to link the LANs together.

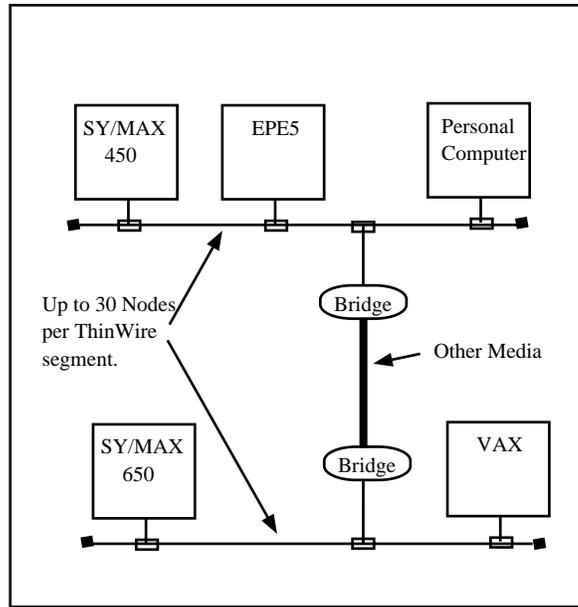


Figure A-7 ThinWire Bridge

## ThinWire Components

The ThinWire units are connected together 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:

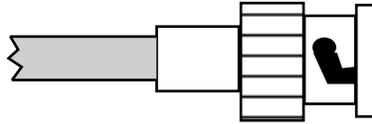
Table A-1 Ethernet Connectors and Cables

| NR&D Part Number | Square D Equivalent Part Number | Description                         |
|------------------|---------------------------------|-------------------------------------|
| EN1              | CC601                           | Ethernet Cable (ThinWire 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.

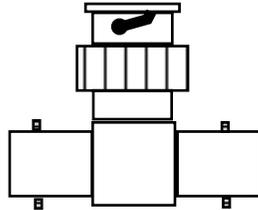
## Ethernet Cable End (EN611)



**Figure A-8 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.

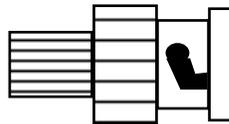
## Ethernet TEE Connector (EN612)



**Figure A-9 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.

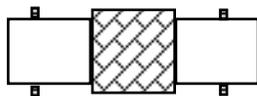
## Ethernet Terminator (EN613)



**Figure A-10 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.

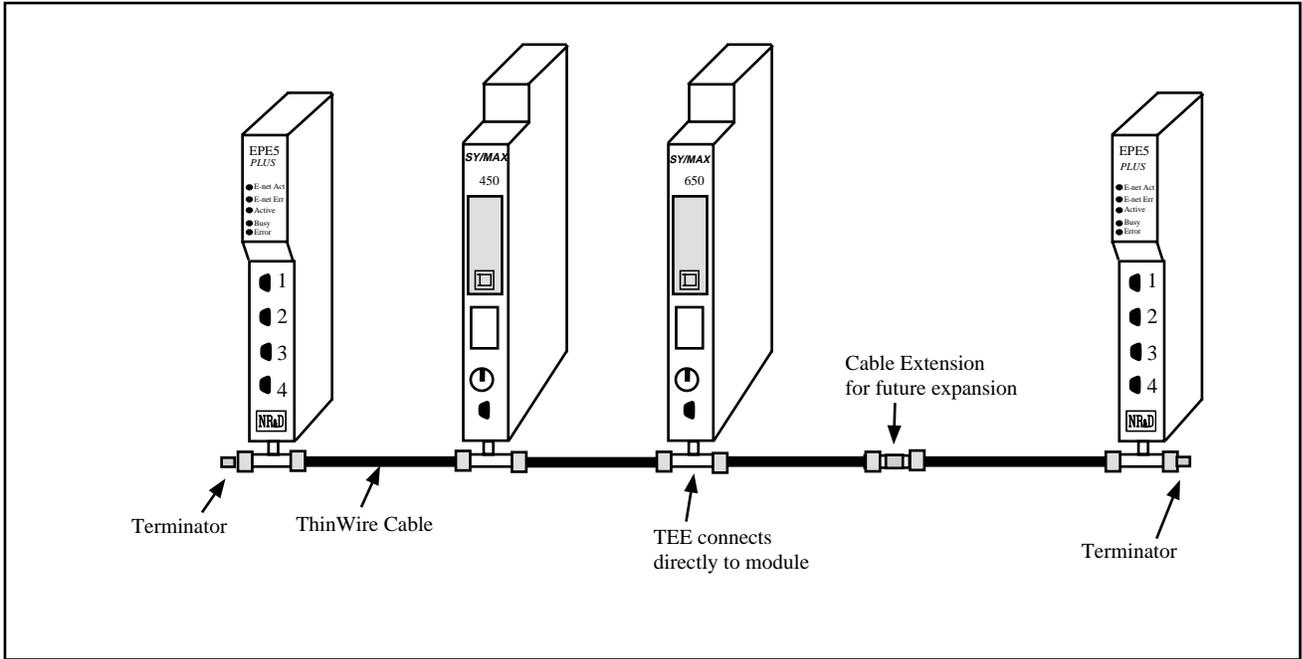
## Ethernet Cable Extension or Barrel (EN614)



**Figure A-11 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 typical Square D Ethernet thin wire network will be something like Figure 2-9.



**Figure A-12 ThinWire Ethernet network**

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

**Table A-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. |



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# Appendix B

## Serial Communication Overview

This Appendix is meant to provide a general background for common types of asynchronous serial communication.

### Hardware Overview

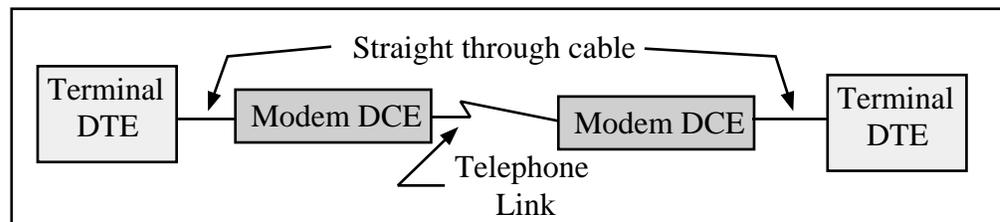
The need for information to be exchanged between independent devices has brought about the development of several serial communication standards. The most commonly encountered are RS-232, RS-422, RS-485, and 20mA current loop.

#### RS-232

RS-232 is intended for connecting two devices together for serial communication for short distances (50 feet or less) and low baud rates (19200 baud or less).

RS-232-C has two main classes of devices: DTE (Data Terminal Equipment) such as terminals and personal computers, and DCE (Data Communication Equipment) such as modems.

The original implementation of the RS-232 connection was for connecting terminals to modems as shown in Figure B-1. The standard connectors mounted on the equipment were DB25 females. Straight through cables with 25 pin male connectors were used to connect the DTE to DCE.



**Figure B-1 DTE to Modem connection**

Each pin on the DTE was connected to the same pin on the DCE. The most common pins and their definitions are listed below.

Pin 2: **TD** Transmit Data

This circuit is the path that serial data is sent from the DTE to the DCE.

Pin 3: **RD** Receive Data

This circuit is the path that serial data is sent from the DCE to the DTE.

**Pin 4: RTS** Request to Send

This circuit is the signal that indicates that the DTE wishes to send data to the DCE. In normal operation the RTS line will be OFF (MARK). Once the DTE has data to send it asserts RTS (SPACE) and waits for the DCE to assert CTS. RTS will remain asserted until the data is completely sent. In a full duplex channel, RTS may be asserted at initialization and left in that state.

**Pin 5: CTS** Clear to Send

This circuit is the signal that indicates that the DCE is ready to receive data from the DTE. In normal operation the CTS is not asserted. When the DTE asserts RTS, the DCE will do whatever is necessary to allow data to be sent. (This may mean raising the carrier and waiting until it is stabilized.) When the DCE is ready, it asserts CTS which allows the DTE to send data. When the DTE is finished sending data it will reset the RTS and the DCE will in turn reset its CTS.

Note: Most DTE must have CTS asserted before it will transmit.

**Pin 6: DSR** Data Set Ready

This circuit is the signal that informs the DTE that the DCE is active. It is normally asserted by the DCE at power-up and left that way.

Note: Most DTE must have DSR asserted to operate properly.

**Pin 7: SG** Signal Ground

This circuit is the ground to which all signals are referenced.

**Pin 8: DCD** Data Carrier Detect

This circuit is the signal that the DCE informs the DTE that it has an incoming carrier.

Note: Some DTE must have DCD asserted to operate properly. Also, some personal computer modems always assert DCD.

**Pin 20: DTR** Data Terminal Ready

This circuit provides the signal that informs the DCE that the DTE is alive and well. It is normally asserted by the DTE at power-up and left in that state.

Note: Most DCE must have DTR asserted to operate properly.

**Pin 22: RI** Ring Indicator

This circuit provides the signal from the DCE to indicate that the modem is ringing. The line is asserted by the DCE during each ring cycle.

The full pinout for the standard 25 pin connector is shown in Figure B-1.

With the down-sizing of computers it became necessary to move to a 9 pin port to save room. Only the most commonly used functions were kept for the 9 pin configuration. The TYPE A and TYPE B configurations are shown in Figures B-2 and B-3. The only difference is pins 2 and 3.

**Table B-1 25 pin RS-232 port**

| Pin | Name | DTE/DCE | Function                      |
|-----|------|---------|-------------------------------|
| 1   | CG   | <--->   | Frame Ground                  |
| 2   | TD   | --->    | Transmitted Data              |
| 3   | RD   | <---    | Received Data                 |
| 4   | RTS  | --->    | Request to Send               |
| 5   | CTS  | <---    | Clear to Send                 |
| 6   | DSR  | <---    | Data Set Ready                |
| 7   | SG   | <--->   | Signal Ground                 |
| 8   | DCD  | <---    | Data Carrier Detect           |
| 9*  |      | <---    | Positive DC Test Voltage      |
| 10* |      | <---    | Negative DC test Voltage      |
| 11* | QM   | <---    | Equalizer Mode                |
| 12+ | SDCD | <---    | Secondary Data Carrier Detect |
| 13+ | SCTS | <---    | Secondary Clear to Send       |
| 14+ | STD  | --->    | Secondary Transmitted Data    |
| 15# | TC   | <---    | Transmit Clock                |
| 16+ | SRD  | <---    | Secondary Receive Data        |
| 17# | RC   | <---    | Receive Clock                 |
| 18  | DCR  | <---    | Divided Clock Receiver        |
| 19+ | SRTS | --->    | Secondary Request to Send     |
| 20  | DTR  | --->    | Data Terminal Ready           |
| 21* | SQ   | <---    | Signal Quality Detect         |
| 22  | RI   | <---    | Ring Indicator                |
| 23* |      | <---    | Data Rate Selector            |
| 24* | SCTE | --->    | Data Rate Selector            |
| 25* |      | --->    | Busy                          |

In the above table, the character following the pin number means:

- \* rarely used
- + used only if secondary channel implemented
- # used only in synchronous interfaces

Although originally all DB25 RS-232 ports were female, most personal computers which have a DB25 RS-232 connector use a male connector. The female DB25 connector on a personal computer is most likely the parallel printer port and should never be connected to any RS-232 device.

As is indicated above, the 25 RS-232 standard has the option of 2 data channels, each with their own handshake lines, and the option of synchronous link. These functions are rarely used and have been left off of the newer 9 pin ports.

**Table B-2 Type A 9 pin RS-232 port**

| Pin | Name | Function            |
|-----|------|---------------------|
| 1   | DCD  | Data Carrier Detect |
| 2   | TD   | Transmitted Data    |
| 3   | RD   | Received Data       |
| 4   | DTR  | Data Terminal Ready |
| 5   | SG   | Signal Ground       |
| 6   | DSR  | Data Set Ready      |
| 7   | RTS  | Request to Send     |
| 8   | CTS  | Clear to Send       |
| 9   | RI   | Ring Indicator      |

**Table B-3 Type B 9 pin RS-232 port**

| Pin | Name | Function            |
|-----|------|---------------------|
| 1   | DCD  | Data Carrier Detect |
| 2   | RD   | Received Data       |
| 3   | TD   | Transmitted Data    |
| 4   | DTR  | Data Terminal Ready |
| 5   | SG   | Signal Ground       |
| 6   | DSR  | Data Set Ready      |
| 7   | RTS  | Request to Send     |
| 8   | CTS  | Clear to Send       |
| 9   | RI   | Ring Indicator      |

The TYPE B connection is the most common on 9 pin personal computer ports. These ports are usually male connectors.

Determining the type of RS-232 port with a voltmeter.

It is possible to determine the type of port with the use of a voltmeter using the following procedure:

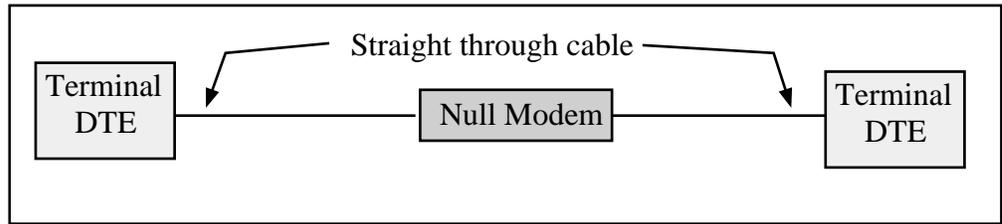
- 1 Set the voltmeter for DC volts, 30 volt range. The voltage being read likely be negative and be within the range of +3VDC to -15VDC.
- 2 Power up the equipment.
- 3 Place the negative probe (black) of the voltmeter on the SG pin of the port. (Pin 7 of a DB25 port or pin 5 of a DE9 port)
- 4 Place the positive probe (red) of the voltmeter on pin 2.
- 5 Write down that voltage.
- 6 Place the positive probe (red) of the voltmeter on pin 3.
- 7 Write down that voltage.

The TX voltage is within the range of -15V to -5V.

The RX voltage is within the range of -3V to +3V.

Therefore, if pin 2 is the more negative voltage of the two, the serial port is **TYPE A**. If pin 3 is the more negative voltage, the serial port is **TYPE B**.

Since almost every device that is not a modem is a DTE, it is quite common to connect DTE to DTE without a modem pair. A "null modem" connection has been established to simplify this situation. It simply reverses the transmit and receive connections from one side of the connector to another and jumpers some of the hardware handshake lines.



**Figure B-2 Null Modem connection**

The null modem is frequently a small enclosure with one male connector and one female connector. Sometimes the null modem is built into a single cable to connect the DTE device to another DTE device. In addition to the crossing of the transmit and receive pins, some additional connections to the hardware handshake pins is usually made the pinouts of null modems for 25 pin and 9 pin connections are shown below.

**Table B-4 DB25 Null Modem**

| Male Connector |       | Female Connector |
|----------------|-------|------------------|
| 1              | ————— | 1                |
| 2              | ————— | 3                |
| 3              | ————— | 2                |
| 4              | ————— | 5                |
| 5              | ————— | 4                |
| 6              | ————— | 20               |
| 8              | ————— | 6                |
| 20             | ————— | 8                |
| 7              | ————— | 7                |

**Table B-5 DE9 Null Modem**

| Male Connector |       | Female Connector |
|----------------|-------|------------------|
| 2              | ————— | 3                |
| 3              | ————— | 2                |
| 5              | ————— | 5                |
| 7              | ————— | 8                |
| 8              | ————— | 7                |
| 1              | ————— | 4                |
| 6              | ————— | 1                |
| 4              | ————— | 6                |

## Electrical characteristics of RS-232

The RS-232 interface is an Single-Ended driver with an open ended receiver. The driver asserts a voltage between -5V and -15V relative to the Signal Ground to represent the MARK state (Logic TRUE). The driver asserts a voltage between +5V and +15V relative to the Signal Ground to represent a SPACE state (Logic FALSE). The fact that there may be a 30 volt swing between MARK and SPACE conditions may lead to problems with the slew rate of the signal due to the capacitance of the cable. If the cable run is long and communication problems are occurring, try lowering the baud rate.

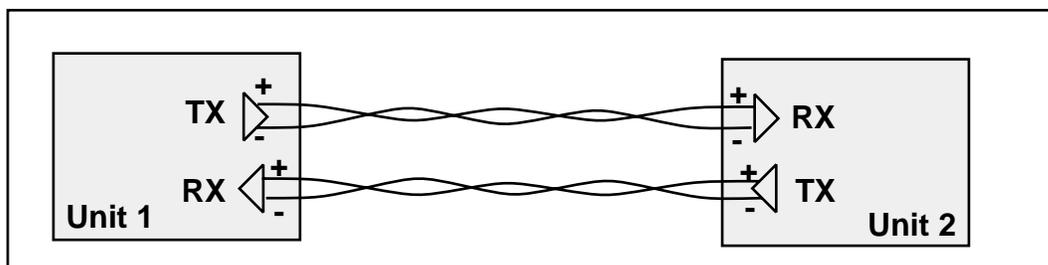
## RS-422

The RS-422 interface uses a closed ended driver and a closed ended receiver. The RS-232 interface is ground referenced. This can cause trouble in situations where a common mode induced noise may severely affect the signal by changing the reference. A better solution for noise immunity is to convert the ground referenced data at the transmission end into a differential signal and transmit this down a balanced, twisted-pair line. At the receiving end any induced noise voltage will appear equally on each line. If the receiver only looks at the differential signal, any induced common mode voltage will be rejected. This is the idea behind the RS-422 and RS-485 standards.

The RS-422 interface typically used in a point to point connection using a pair of wires from the transmitter of Unit 1 to the receiver of the Unit 2. Another pair of wires is from the transmitter of Unit 2 to the receiver of Unit 1. This connection allows for full duplex operation, i.e. the units can transmit messages while they are receiving messages. The Square D SY/MAX family of PLCs us RS-422 communication. Their standard pinout is as follows:

**Table B-6 SY/MAX DE9S RS-422 Pinout**

| Pin | Function | Description  |
|-----|----------|--|
| 1   | TX -     | Transmit Data from device. (Data OUT) (inverted)     |
| 2   | TX+      | Transmit Data from device. (Data OUT) (non-inverted) |
| 3   | RX-      | Receive Data (Data IN) (inverted)                    |
| 4   | RX+      | Receive Data (Data IN) (non-inverted)                |
| 5   | CTS-     | Clear to Send (inverted)                             |
| 6   | RTS-     | Request to Send (inverted)                           |
| 7   | CTS+     | Clear to Send (non-inverted)                         |
| 8   | RTS+     | Request to Send (non-inverted)                       |
| 9   | Shield   | Shield Ground. AC coupled to chassis.                |



**Figure B-3 RS-422 Setup**

Like RS-485, the RS-422 protocol may be used in a multidrop configuration as shown in Figure B-4. The RS-485 standard requires a minimum capability of 32 receivers on the network. The RS-422 standard places no minimum requirement and therefore is typically used in point to point or as the host of a RS-485 network.

Always connect the + terminals on the TX to the + terminals on the RX. Similarly, connect the - terminals on the TX to the - terminals on the RX.

**Note:** Occasionally the manufacture incorrectly labels the polarity of the connections. If the system is not working try exchanging the polarity of the TX pair and the RX pair on the host.

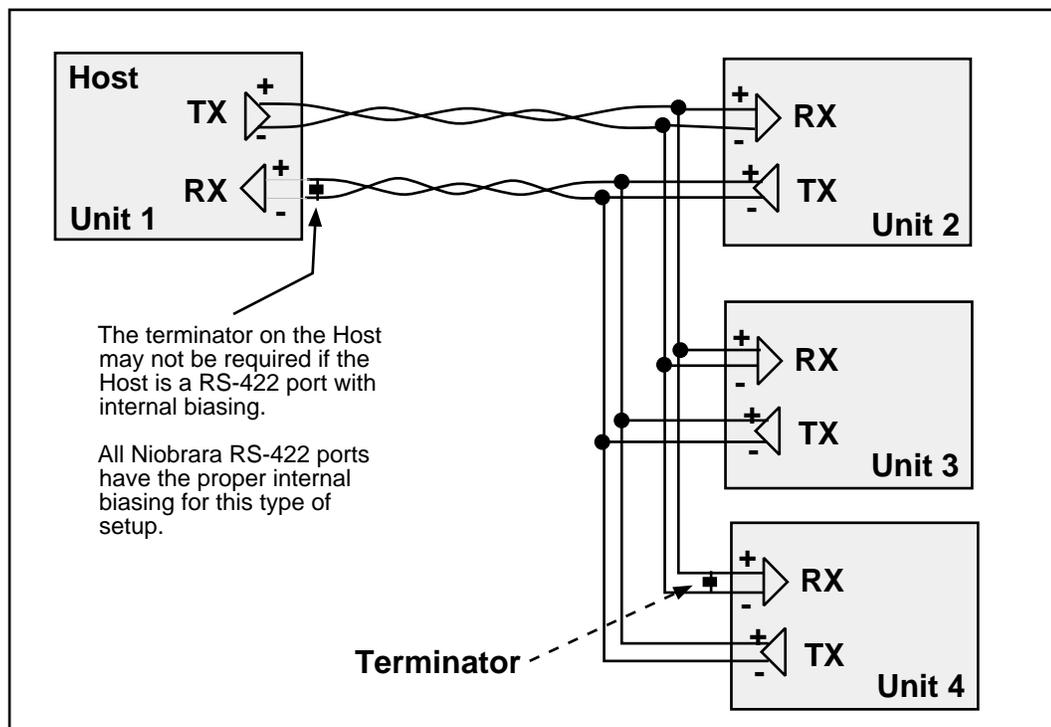
With the high noise immunity and low voltage swings, the RS-422 interface may have long runs of up to 10,000 feet.

Electrical Characteristics of RS-422.

The driver asserts a negative voltage across the receiver to represent a MARK state, a positive voltage to represent the SPACE state. The receiver triggers off of the transition through the zero voltage point.

### RS-485 (four wire)

The RS-485 interface is like the RS-422 interface with the exception that the transmitters are able to tri-state, i.e. float. This allows up to 32 transmitters to be connected to a host receiver and multiple receivers to be connected to a host transmitter. This technique is called multidropping and is shown in Figure B-4. Square D POWERLOGIC Circuit monitors use this type of RS-485 for communication.



**Figure B-4 RS-485 Four Wire Setup**

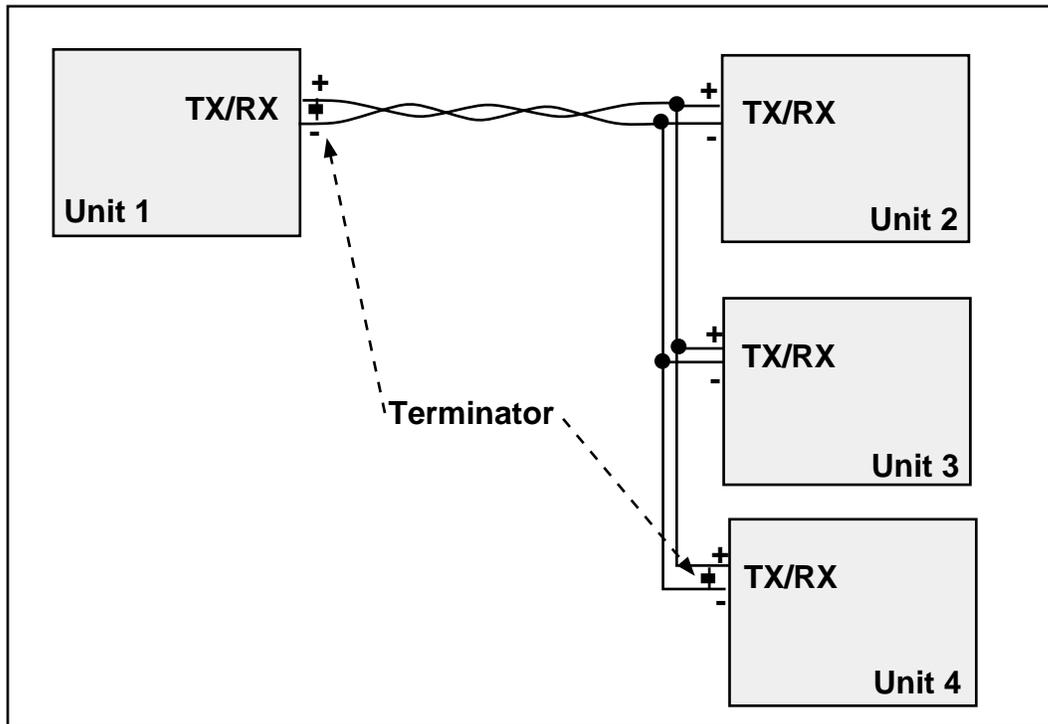
As shown in Figure B-4, it is possible to use a 4 wire RS-422 port to drive a 4 wire RS-485 multidrop network. If the RS-422 port does not have internal biasing on the RX pair it may be necessary to add a terminator to that end of the network. The terminator is a resistor correctly matched to the line which reduces reflections on the network.

### RS-485 (two wire)

Another version of the differential communication system is the RS-485 two wire network. The two wire system is a half-duplex connection where each unit transmits and receives on the same pair of wires. Only one transaction may occur on the network at one time as opposed to the four wire system where the units may transmit while they are receiving. The two wire system is inexpensive to install because only one twisted pair cable is needed. All the + terminals are connected together, all the - terminals are connected together. A terminating resistor is usually required on each end.

Since each unit can listen to the transmissions of every other unit on the network, peer to peer communication is available. The trade off is that the half-duplex connection has half of the throughput of the full duplex four wire system. A typical installation is shown in Figure B-5.

The Allen-Bradley® Data Highway is an example of a two wire RS-485 multidrop network.



**Figure B-5 RS-485 Two wire Multidrop Setup**

**Note:** Occasionally the manufacture incorrectly labels the polarity of the connections. If the system is not working try exchanging the polarity of the TX/RX pair on the unit.

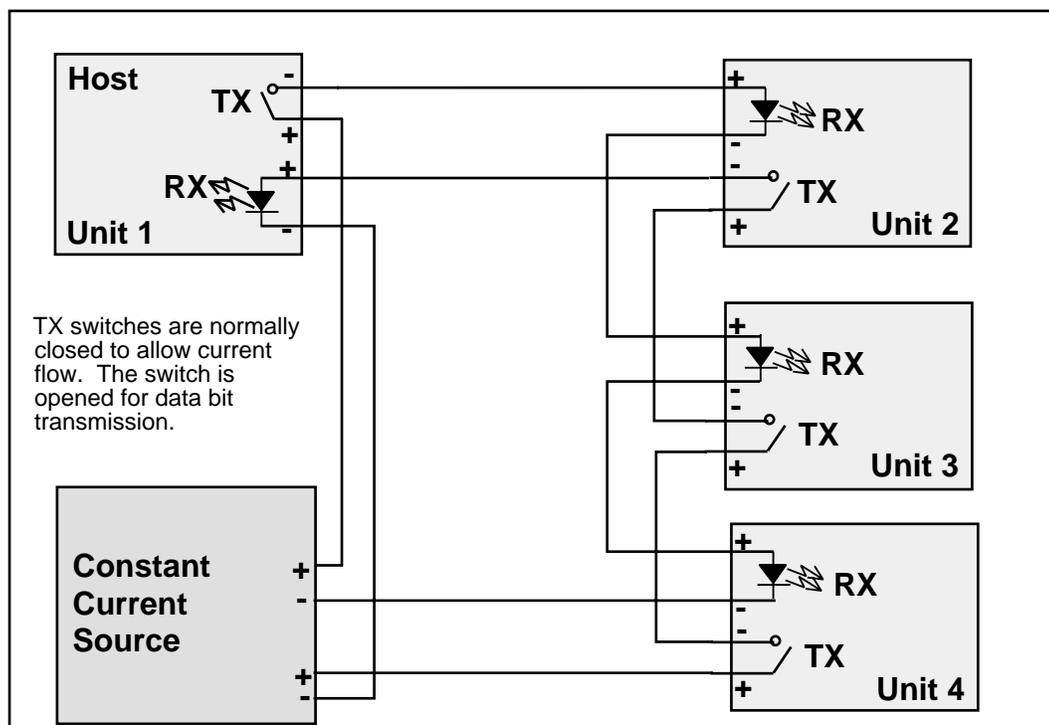
### 20mA Current Loop

The 20mA Current Loop is another multidrop configuration. The transmitting mechanism may be explained as simply opening a normally closed switch for the data bit transmission. The receiver is usually a optical isolator (LED/phototransistor) unit. Each loop is powered by a Constant Current Source. The source may be part of one of the units or may be a separate device as shown in Figure B-6.

As in other multidrop schemes, each unit watches the RX line for its messages with its address. The number of units on the network is dependent upon the addressing scheme as well as the voltage supply of the constant current source. Each RX receiver on the circuit will cause a voltage drop in the supply current. The series sum of these drops must be a value less than the available voltage from the current supply or none of the receivers will work.

To check, add up the voltage drops around the loop and make sure that the sum is less than the compliance voltage of the current source.

Some Red Lion Controls equipment such as the Apollo message centers use a 20mA current loop for serial communication.



**Figure B-6 20mA Current Loop (Full Duplex)**

A half-duplex 20mA current loop may be formed by connecting the a single current supply through all RX and TX connections in series.

## Hardware Handshaking

Sometimes it is necessary for the transmitting and receiving devices to signal each other to control the flow of data. This may be done with special characters in the software (see Software Handshaking on page 182.) or with physical connections to the hardware. This physical signaling system is known as hardware handshaking. The electrical characteristics of the handshaking lines are the same as the TX/RX lines of the system. It may be a single-ended, ground referenced signal in RS-232, or a differential pair in RS-422 or RS-485. The two most common types of hardware handshaking are: Request to Send (RTS) and Clear to Send (CTS).

**Request to Send (RTS)** is employed in two different modes: Request to Send (also known as Push to Talk) and Restraint.

**Request to Send (Push to Talk)** mode is used by the transmitting device to signal the receiving device that it has data to send. This is typically used in modem and radio modem setups. When the transmitting device has data to send, it asserts its RTS. When the modem is ready, it asserts the CTS of the transmitting device to allow it to transmit. The transmitting device will keep RTS asserted until it has sent all of its data.

Push to talk mode is the original mode of the RS-232 standard for connecting DTE to DCE. This mode of RTS usage is not commonly used in most serial communication situations and is usually restricted to modems and radios.

**Restraint** mode is used by the receiving device to signal the transmitting device that it is sending data too quickly for to be processed. When this situation occurs, the receiving device negates its RTS to signal the transmitting device to stop. When the receiving device has "caught up" it asserts its RTS line to signal the transmitting device to continue.

Restraint mode is the most common handshaking mode.

Sometimes if two RS-232 DTE devices are connected together, the DTR pin may be used as the restraint handshake line instead of RTS.

**Clear to Send (CTS)** is used to signal the transmitting device that the receiving device is ready to accept data. The transmitting device will not send data until its CTS is asserted.

In a typical hardware handshaking application RTS on the one device is usually connected to CTS on the other.

The vast majority of cases do not require active hardware handshaking. In this case it is common to jumper the RTS of each unit to its own CTS. This will allow each port to transmit at will.

## Software Overview

### Binary Representation of Data

With the implementation of an appropriate hardware system, a uniform system must be implemented to allow the data to be transferred.

In a synchronous serial system, each bit of data is transferred with a clock signal. This ensures that the receiving device "knows" when each bit is transferred so it can reconstruct the data. The throughput is determined by the number of data bits and the clock frequency. The data synchronization is accomplished by the transmission of a sync character which is an out-of-band character.

The more common type of serial communication is asynchronous. In an asynchronous system the character timing is determined by a local clock at each end. This clock usually runs at 16 times the baud rate. Each bit is to stay in its MARK or SPACE state for the time determined by the baud rate. Data is transmitted in packets of the following form: Start bit; Data Bits, Parity Bit, Stop Bits.

### Start Bit

The Start bit is always a SPACE bit and signifies the beginning of the data packet.

### Data Bits

Typically 7 or 8 bits. On rare occasions may be 5 or 6 bits. The if the data is logic true it is in the MARK state. If the data is false it is in the SPACE state. The data is transmitted LSB first.

### Parity Bit

The parity bit is a bit that follows the last data bit. Its determination is based upon the type of parity selected. The most common types are ODD, EVEN, NONE, MARK, and SPACE. These parity selections are calculated as follows.

**Odd:** The parity bit is set to the MARK state if the number of data bits in the MARK state are even. Therefore the total number of data bits in the MARK state plus the parity bit is an **ODD** number.

**Even:** The parity bit is set to the MARK state if the number of data bits in the MARK state are odd. Therefore the total number of data bits in the MARK state plus the parity bit is an **EVEN** number.

**None:** No parity bit. The stop bit comes immediately after the last data bit.

**Mark:** Always logic high. Like an additional stop bit. The mark parity bit is usually used in conjunction with 7 bit ASCII data.

**Space:** Always logic low. The space parity bit is usually used in conjunction with 7 bit ASCII data.

### Stop Bit

The Stop bit is always a MARK bit. There is always one stop bit, sometimes two stop bits, and on rare occasions 1.5 stop bits. The receiving device starts timing for the next start bit half way through the last

stop bit in the message. A message with two stop bits is the same as a message with one stop bit plus one extra character time worth of dead space between packets. Therefore a device set for 1 stop bit can also receive a message with 2 stop bits.

It is worth noting that the total number of bits in a packet is sometimes used to reference the type of communication. For instance, Square D SY/MAX packets have:

1 start bit + 8 data bits + 1 parity bit + 1 stop bit = 11 bits.

Most Hayes modems can only handle a 10 bit protocol. Now this may be:

1 start bit + 8 data + 0 parity + 1 stop = 10 bits  
 or 1 start bit + 7 data + 1 parity + 1 stop = 10 bits  
 or 1 start bit + 7 data + 0 parity + 2 stop = 10 bits

Since the Hayes modem is designed to handle only 10 bits per character, this explains why it is not possible to send an 11 bit protocol like SY/MAX across these modems. The bit count gets off when the 10th bit arrives at the modem and the modem expects a start bit instead of the stop bit. An 11 bit modem is required for this type of communication.

## Message Determination

With the above descriptions of an asynchronous serial packet, binary data may be sent from one device to another.

### Hexadecimal numbers

Binary representation is somewhat cumbersome to deal with so hexadecimal numbers are often used. Hexadecimal (hex) numbers are base sixteen numbers. There are 16 digits in hex, the ten decimal digits 0 through 9 plus the six letters A through F which represent the decimal numbers 10 through 15. The following is a table of the decimal numbers 0 through 31, their hexadecimal equivalent and their binary equivalent.

**Table B-7 Decimal, Hex, Binary**

| Dec | Hex | Binary | Dec | Hex | Binary    |
|-----|-----|--------|-----|-----|-----------|
| 0   | 0   | 0000   | 16  | 10  | 0001 0000 |
| 1   | 1   | 0001   | 17  | 11  | 0001 0001 |
| 2   | 2   | 0010   | 18  | 12  | 0001 0010 |
| 3   | 3   | 0011   | 19  | 13  | 0001 0011 |
| 4   | 4   | 0100   | 20  | 14  | 0001 0100 |
| 5   | 5   | 0101   | 21  | 15  | 0001 0101 |
| 6   | 6   | 0110   | 22  | 16  | 0001 0110 |
| 7   | 7   | 0111   | 23  | 17  | 0001 0111 |
| 8   | 8   | 1000   | 24  | 18  | 0001 1000 |
| 9   | 9   | 1001   | 25  | 19  | 0001 1001 |
| 10  | A   | 1010   | 26  | 1A  | 0001 1010 |
| 11  | B   | 1011   | 27  | 1B  | 0001 1011 |
| 12  | C   | 1100   | 28  | 1C  | 0001 1100 |
| 13  | D   | 1101   | 29  | 1D  | 0001 1101 |
| 14  | E   | 1110   | 30  | 1E  | 0001 1110 |
| 15  | F   | 1111   | 31  | 1F  | 0001 1111 |

Notice that it takes four binary digits makes one hex digit. Conversion from binary to hex is straight forward and explains why hex is so popular in PLCs. Since the most PLC devices use 16-bit registers it takes 4 hex digits to represent one register i.e. 1A2F. The first two characters "1A" make up the most significant byte (8 bits) and the last two characters make up the least significant byte.

## ASCII characters

ASCII is a set of 7-bit characters used in communication, computers and programmable logic controllers. The word ASCII is a acronym for American Standard Code for Information Interchange. ASCII is a way to interpret 7 bits (or 8 bits with a leading 0) as alphanumeric characters. There is an ASCII table following this section for your reference.

In ASCII, the small letter "p" is represented by the binary number 0111 0000. This is the hexadecimal number 70 or the decimal number 112.

Similarly, the capital letter "E" is represented by the binary number 0100 0101 which is the hexadecimal number 45 or the decimal number 69.

## Software Handshaking

It is common for communicating devices to need to exert control over each other. Typically the receiving device will need to force the transmitting device to stop and wait for it to catch up. This may be done at the hardware level (See Hardware Handshaking on page 179.) or at the software level using special characters. A common way for devices communicating with ASCII is to use the X-ON/X-OFF characters.

### X-ON

The X-ON character is the ASCII character DC1, which has the decimal value 17, hex value 11, and may be generated by pressing Ctrl+Q.

When a device receives an X-ON it starts sending data from the position at which it received an X-OFF character. The X-ON is only acted upon if the device is first halted with an X-OFF.

### X-OFF

The X-OFF character is the ASCII character DC3, which has the decimal value 19, the hex value 13, and the may be generated by pressing Ctrl+S.

When a device receives an X-OFF it stops sending data. It will remain in this state until an X-ON character is received. At this time, it will resume sending the data.

Obviously software handshaking is only useful when devices are sending characters for the handshake which are out of the normal range of data. Sometimes certain protocols get around this by specifying special escape sequences that the receiving device will recognize. This is done by methods such as sending that special character once if is to be recognized as a control character and twice if it is to be included as data.

**Table B-8 ASCII Table**

| Hex | Dec | Character | Description      | Abrv | Hex | Dec | Char. | Hex | Dec | Char. | Hex | Dec | Char. |
|-----|-----|-----------|------------------|------|-----|-----|-------|-----|-----|-------|-----|-----|-------|
| 00  | 0   | [CTRL]@   | Null             | NUL  | 20  | 32  | SP    | 40  | 64  | @     | 60  | 96  | '     |
| 01  | 1   | [CTRL]a   | Start Heading    | SOH  | 21  | 33  | !     | 41  | 65  | A     | 61  | 97  | a     |
| 02  | 2   | [CTRL]b   | Start of Text    | STX  | 22  | 34  | "     | 42  | 66  | B     | 62  | 98  | b     |
| 03  | 3   | [CTRL]c   | End Text         | ETX  | 23  | 35  | #     | 43  | 67  | C     | 63  | 99  | c     |
| 04  | 4   | [CTRL]d   | End Transmit     | EOT  | 24  | 36  | \$    | 44  | 68  | D     | 64  | 100 | d     |
| 05  | 5   | [CTRL]e   | Enquiry          | ENQ  | 25  | 37  | %     | 45  | 69  | E     | 65  | 101 | e     |
| 06  | 6   | [CTRL]f   | Acknowledge      | ACK  | 26  | 38  | &     | 46  | 70  | F     | 66  | 102 | f     |
| 07  | 7   | [CTRL]g   | Beep             | BEL  | 27  | 39  | '     | 47  | 71  | G     | 67  | 103 | g     |
| 08  | 8   | [CTRL]h   | Back space       | BS   | 28  | 40  | (     | 48  | 72  | H     | 68  | 104 | h     |
| 09  | 9   | [CTRL]i   | Horizontal Tab   | HT   | 29  | 41  | )     | 49  | 73  | I     | 69  | 105 | i     |
| 0A  | 10  | [CTRL]j   | Line Feed        | LF   | 2A  | 42  | *     | 4A  | 74  | J     | 6A  | 106 | j     |
| 0B  | 11  | [CTRL]k   | Vertical Tab     | VT   | 2B  | 43  | +     | 4B  | 75  | K     | 6B  | 107 | k     |
| 0C  | 12  | [CTRL]l   | Form Feed        | FF   | 2C  | 44  | ,     | 4C  | 76  | L     | 6C  | 108 | l     |
| 0D  | 13  | [CTRL]m   | Carriage Return  | CR   | 2D  | 45  | -     | 4D  | 77  | M     | 6D  | 109 | m     |
| 0E  | 14  | [CTRL]n   | Shift Out        | SO   | 2E  | 46  | .     | 4E  | 78  | N     | 6E  | 110 | n     |
| 0F  | 15  | [CTRL]o   | Shift In         | SI   | 2F  | 47  | /     | 4F  | 79  | O     | 6F  | 111 | o     |
| 10  | 16  | [CTRL]p   | Device Link Esc  | DLE  | 30  | 48  | 0     | 50  | 80  | P     | 70  | 112 | p     |
| 11  | 17  | [CTRL]q   | Dev Cont 1 X-ON  | DC1  | 31  | 49  | 1     | 51  | 81  | Q     | 71  | 113 | q     |
| 12  | 18  | [CTRL]r   | Device Control 2 | DC2  | 32  | 50  | 2     | 52  | 82  | R     | 72  | 114 | r     |
| 13  | 19  | [CTRL]s   | Dev Cont 3 X-OFF | DC3  | 33  | 51  | 3     | 53  | 83  | S     | 73  | 115 | s     |
| 14  | 20  | [CTRL]t   | Device Control 4 | DC4  | 34  | 52  | 4     | 54  | 84  | T     | 74  | 116 | t     |
| 15  | 21  | [CTRL]u   | Negative Ack     | NAK  | 35  | 53  | 5     | 55  | 85  | U     | 75  | 117 | u     |
| 16  | 22  | [CTRL]v   | Synchronous Idle | SYN  | 36  | 54  | 6     | 56  | 86  | V     | 76  | 118 | v     |
| 17  | 23  | [CTRL]w   | End Trans Block  | ETB  | 37  | 55  | 7     | 57  | 87  | W     | 77  | 119 | w     |
| 18  | 24  | [CTRL]x   | Cancel           | CAN  | 38  | 56  | 8     | 58  | 88  | X     | 78  | 120 | x     |
| 19  | 25  | [CTRL]y   | End Medium       | EM   | 39  | 57  | 9     | 59  | 89  | Y     | 79  | 121 | y     |
| 1A  | 26  | [CTRL]z   | Substitute       | SUB  | 3A  | 58  | :     | 5A  | 90  | Z     | 7A  | 122 | z     |
| 1B  | 27  | [CTRL][   | Escape           | ESC  | 3B  | 59  | ;     | 5B  | 91  | [     | 7B  | 123 | {     |
| 1C  | 28  | [CTRL]\   | Cursor Right     | FS   | 3C  | 60  | <     | 5C  | 92  | \     | 7C  | 124 |       |
| 1D  | 29  | [CTRL]]   | Cursor Left      | GS   | 3D  | 61  | =     | 5D  | 93  | ]     | 7D  | 125 | }     |
| 1E  | 30  | [CTRL]^   | Cursor Up        | RS   | 3E  | 62  | >     | 5E  | 94  | ^     | 7E  | 126 | ~     |
| 1F  | 31  | [CTRL]_   | Cursor Down      | US   | 3F  | 63  | ?     | 5F  | 95  | _     | 7F  | 127 | DEL   |



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## Appendix C

# NR&D on the Internet

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, anomomous ftp of our latest software, as well as E-mail to customer support and marketing.

Technical support questions may be E-mailed to [techsupport@niobrara.com](mailto:techsupport@niobrara.com).



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## Appendix D

# Ethernet Drop Number List

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

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

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

**Table D-1 Ethernet Drop Number Reference**

| <b>Ethernet Drop Number</b> | <b>Device Description</b> | <b>Device Location</b> |
|-----------------------------|---------------------------|------------------------|
| 00                          |                           |                        |
| 01                          |                           |                        |
| 02                          |                           |                        |
| 03                          |                           |                        |
| 04                          |                           |                        |
| 05                          |                           |                        |
| 06                          |                           |                        |
| 07                          |                           |                        |
| 08                          |                           |                        |
| 09                          |                           |                        |
| 10                          |                           |                        |
| 11                          |                           |                        |
| 12                          |                           |                        |
| 13                          |                           |                        |
| 14                          |                           |                        |
| 15                          |                           |                        |
| 16                          |                           |                        |
| 17                          |                           |                        |
| 18                          |                           |                        |
| 19                          |                           |                        |
| 20                          |                           |                        |
| 21                          |                           |                        |
| 22                          |                           |                        |
| 23                          |                           |                        |
| 24                          |                           |                        |
| 25                          |                           |                        |
| 26                          |                           |                        |
| 27                          |                           |                        |
| 28                          |                           |                        |
| 29                          |                           |                        |
| 30                          |                           |                        |
| 31                          |                           |                        |
| 32                          |                           |                        |
| 33                          |                           |                        |

| <b>Ethernet Drop Number</b> | <b>Device Description</b> | <b>Device Location</b> |
|-----------------------------|---------------------------|------------------------|
| 34                          |                           |                        |
| 35                          |                           |                        |
| 36                          |                           |                        |
| 37                          |                           |                        |
| 38                          |                           |                        |
| 39                          |                           |                        |
| 40                          |                           |                        |
| 41                          |                           |                        |
| 42                          |                           |                        |
| 43                          |                           |                        |
| 44                          |                           |                        |
| 45                          |                           |                        |
| 46                          |                           |                        |
| 47                          |                           |                        |
| 48                          |                           |                        |
| 49                          |                           |                        |
| 50                          |                           |                        |
| 51                          |                           |                        |
| 52                          |                           |                        |
| 53                          |                           |                        |
| 54                          |                           |                        |
| 55                          |                           |                        |
| 56                          |                           |                        |
| 57                          |                           |                        |
| 58                          |                           |                        |
| 59                          |                           |                        |
| 60                          |                           |                        |
| 61                          |                           |                        |
| 62                          |                           |                        |
| 63                          |                           |                        |
| 64                          |                           |                        |
| 65                          |                           |                        |
| 66                          |                           |                        |
| <b>Ethernet Drop Number</b> | <b>Device Description</b> | <b>Device Location</b> |

|    |  |  |
|----|--|--|
| 67 |  |  |
| 68 |  |  |
| 69 |  |  |
| 70 |  |  |
| 71 |  |  |
| 72 |  |  |
| 73 |  |  |
| 74 |  |  |
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| 81 |  |  |
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| 90 |  |  |
| 91 |  |  |
| 92 |  |  |
| 93 |  |  |
| 94 |  |  |
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| 99 |  |  |

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