# SPE4

Installation and Programming Manual

This Manual describes the SPE4-1 and SPE4-2 SY/MAX® Port Expander Module, its uses and set up. It also describes the use of the SPE4SW programming software.

Effective: 19 April, 2002

NR&D
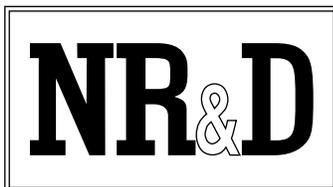
Niobrara Research and Development Corporation
P.O. Box 3418   Joplin, MO 64803

Telephone: (800) 235-6723 or (417) 624-8918
Facsimile: (417) 624-8920
Internet: http://www.niobrara.com

Contents

Appendix B NR&D on the Internet

Figures

Tables

1
Introduction

The Niobrara SPE4 is a SY/MAX® compatible communication switching and translating module mounted in and powered by the SY/MAX register rack. As a port expander, the SPE4 is capable of routing SY/MAX protocol messages between its five ports according to SY/MAX routing conventions. Applications for this function include:

- Interconnecting multiple SY/MAX 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 SPE4 is capable of:

- Changing baud rate and word structure
- 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
- Translating MODBUS messages to the SY/NET network.
- 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 SPE4 also provides 2048 processor equivalent mailbox registers accessible through any port. This function can be used to off-load communication from a processor by allowing attached devices to poll the mailbox in the SPE4 and letting the processor write new data as it changes. The SPE4-2D and -2S versions allow bi-directional access to the register rack backplane for these 2048 registers. Thus allowing external devices a high speed path to the PLC without being channeled through the PLC's communication port.

The SPE4 may be thought of as a SY/MAX packet routing machine. 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, Net-to-Net, and Plogic 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 SPE4 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 SPE4 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, perhaps instead of Gateway mode, that port is in SY/MAX mode and the device is an operator interface which requires data from a Model 400 and a Micro-1.

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.

The SPE4 is available in the following standard configurations:

- 4 RS-232 ports, 1 RS-422 port, the **SPE4-1S**

- 4 RS-422/485 (2 or 4 wire) ports, 1 RS-422 port, the **SPE4-1D**

Each of these hardware configurations is available in the PLUS versions:

- 4 RS-232 ports, 1 RS-422 port with rack addressable mailbox, the **SPE4-2S**

- 4 RS-422/485 (2 or 4 wire) ports, 1 RS-422 port with rack addressable mailbox, the **SPE4-2D**

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

SPE4

○ Active

○ Busy

● Error

PLUS

○
[connector] **1**
○

TX ○ ○ RX

○
[connector] **2**
○

TX ○ ○ RX

○
[connector] **3**
○

TX ○ ○ RX

○
[connector] **4**
○

TX ○ ○ RX

○
[connector] **0**
○

NR&D

Mode Indicators (LEDs)

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

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

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

PLUS Label - Identifies the module as either a SPE4-2S or SPE4-2D.

Ports 1-4

Male RS-232 (SPE4-1S, SPE4-2S)
Female RS-422 (SPE4-1D, SPE4-2D)

Serial communication ports for connection to peripheral devices. Ports 1-4 feature full RTS/CTS handshaking, and support all available modes.

Communication Indicators (LEDs)

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

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

Port 0

Female RS-422 communication port with limited mode and baud rate subsets. No RTS/CTS handshaking available. Provides +5VDC for connection to NR&D SC406 or SC902 Smart Cable.

Figure 1-1   SPE4 Front Panel

2
Installation

SPE4 Installation

1　Remove power from the register rack.

2　Mount the SPE4 module in an available slot in the register rack.

3　The SPE4 should receive its initial configuration by direct connection from an MS/DOS® personal computer COM: port (See Figure 2-1). 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 when connected to Ports 1 through 4**. 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.
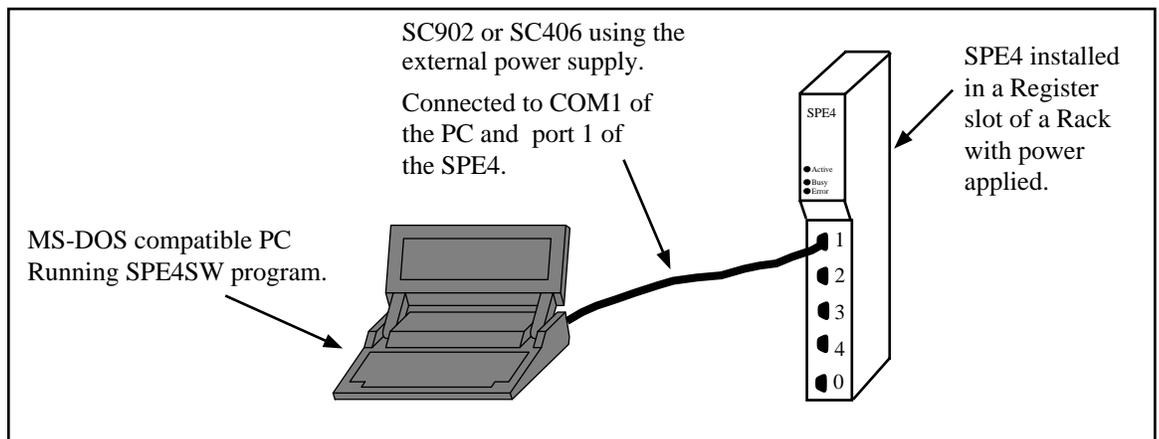
Figure 2-1　SPE4 Initial Configuration Setup

4　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 should flash periodically. The lights beneath ports 1-4 illuminate only when data is passing through the port.

5 (PLUS Modules only) 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.

SPE4SW Installation

1 The SPE4SW 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 SPE4SW file for installation and allow the INSTALL program to perform the decompression.

2 To manually install SPE4SW, run the PKUNZIP program with the following parameters:
> A:>PKUNZIP -d SPE4SW.ZIP C:\SPE4*.*

This will run PKUNZIP from the floppy, create the directory SPE4 on the c drive, expand all files from SPE4SW.ZIP into the \SPE4\ directory.

3 To start the SPE4SW after installation, perform the following:

> **> C:**

> **> CD \ SPE4**

> **> SPE4SW**

The screen should look like Figure 2-2.

4 If an error occurs in communicating with the SPE4, 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.

```
              S P E 4    P O R T   E X P A N D E R
Niobrara R&D                                              15Jun95
                   CONFIGURATION AND UTILITY SOFTWARE
oNline          oFfline            Utility         Setup         Quit







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


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

Figure 2-2   SPE4SW Startup Screen

5   Press S for Setup to configure the personal computer for the connection to the SPE4. The Setup
     menu should appear as in Figure 2-3.

```
              S P E 4    P O R T    E X P A N D E R
Niobrara R&D                                              15Jun95
                CONFIGURATION AND UTILITY SOFTWARE
oNline          oFfline          Utility          Setup          Quit
                                            ┌──────────────────────┐
                                            │Sy/Max communications │
                                            │Terminal emulator     │
                                            └──────────────────────┘



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 2-3   Setup Menu Screen

6   Press S for SY/MAX Setup. The SY/MAX setup window should appear as in Figure 2-4.

```
              S P E 4    P O R T    E X P A N D E R
Niobrara R&D                                              15Jun95
                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

    ┌────CONFIRM────────────────┐
    │  Write setup to startup file? │
    └───────────────────────────┘ R&D Corporation.  All rights reserved.
```

Figure 2-4   SY/MAX Setup Screen

```
                       S P E 4   P O R T   E X P A N D E R
Niobrara R&D                    SPE4-2 14JUN95 Port 0                    15Jun95
                      CONFIGURATION AND UTILITY SOFTWARE     Press F2 for help.
oNline          oFfline             Utility             Setup             Quit
                 PORT 0      PORT 1      PORT 2      PORT 3      PORT 4
Drop             0           1           2           3           4
Protocol         SY/MAX      SY/MAX      SY/MAX      SY/MAX      SY/MAX
Baud Rate        9600        9600        9600        9600        9600
Parity           EVEN        EVEN        EVEN        EVEN        EVEN
Data Bits        8           8           8           8           8
Stop Bits        1           1           1           1           1
Buffer Limit     16          16          16          16          16

Error Check      BCC
Route Appendix   NONE
Route Replacement OFF

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

Figure 2-5   oNline Edit Screen

7   For a direct connection as in Figure 2-1, the above settings should work. Refer to Chapter 17 on page 99 for additional information on the setup parameters.

8   Press Enter after selecting each parameter.

9   Press Y for Yes when prompted to save the setup to file.

10 Press N for oNline. The SPE4SW will attempt to communicate to the SPE4 and display the parameters of the module. If the setup parameters are correct, the screen should appear as in Figure 2-5. The Yellow Busy light should be flashing more quickly now and the TX/RX lights under Port 1 should both be flashing continuously.

11 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.

12 Attach one or more devices to the SPE4 ports. Refer to Chapters 19 and 20 for port and cable pinout diagrams. An RS-232 or RS-422 breakout box is useful in verifying the correct connection of input devices. The CTS Monitor Utility in SPE4SW is quite helpful in determining the status of the Clear To Send lines on Ports 1 through 4.

13 Use the SPE4SW program to configure port parameters for the devices attached.

3
Configuration

Each port of the SPE4 is independently configured for the desired drop number, baud rate, number of data bits, parity bit, protocol mode and other parameters.

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 SPE4SW provided with the module at no cost. SPE4SW must be used through a module data port configured as SY/MAX, Net-to-Net, Gateway, Modbus RTU, or Modbus ASCII. The computer running SPE4SW can be connected directly to the module, through a SY/NET network, or through modems.

The configuration 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. The Drop Number must fall within the range of 000 through 199. The drop number of each port in the SPE4 may be set independantly.

  The factory default Data Port Drop Numbers for Ports 0 through 4 of the SPE4 are 000, 001, 002, 003, and 004.

- **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, PNIM, RNIM Master, and RNIM Slave. The factory default value is SY/MAX mode. These modes are described later in this chapter.

- **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. Port 0 has a limited subset of the available baud rates.

- **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 16 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 SPE4 allows the option of choosing the checksum type for the SY/MAX, NET-TO-NET, PLOGIC, MULTIDROP, and PNIM protocols. The PNIM protocol must be set to CRC, all other modes default to the BCC. The CRC mode allows communication with the CRM-512 multimedia NIM, and SY/MATE PLUS ver. 2.x in PARITY = NONE setting. The CRC 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.

- **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 drop number 205 somewhere in the incoming packet. 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.

-

- **Driver Mode** - (Active on -xD units only) Peripheral, Share, Multidrop, and Modbus mode ports include settings to control the operation of the port in various multidrop configurations. These include Pt to Pt for point to point RS-422 operation (default), Four Wire for a multidrop slave, Half Duplex for a 4-wire master, and Two Wire for multidrop peer-to-peer operation. These settings only have effect on ports 1, 2, 3, and 4 of SPE4-1D and SPE4-2D boards Rev 2.1 and higher.

- **Auto-Transfer** - (PLUS units only) 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 SPE4 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 SPE4 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 SPE4 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 SPE4 is connected to port 101, the drop of port 0 of the SPE4 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 SPE4's local registers could be 000,101,1. Any drop on SY/NET could also reach the SPE4 with a route of 201,101,1 where 201 is the don't care originating drop.

SPE4 mailbox registers (PLUS Units ONLY)

The mailbox registers within an SPE4 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 SPE4. 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 SPE4.

    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.

RTS/CTS Handshaking

NOTICE: Port 0 does not feature active RTS/CTS handshake lines.

CTS Operation

In all modes, the CTS input of SPE4 ports one through four is available to restrain the SPE4 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 SPE4 while the peripheral catches up. CTS restraint cannot be held indefinitely with incoming data as the SPE4 has finite internal buffer capacity.

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

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

RTS Operation

The operation of the RTS pair depends on the mode of the port. In SY/MAX, Net-to-Net, POWERLOGIC, Idec, Gateway, and Transparent mode the RTS pair is used to restrain the attached device sending to the SPE4 and inform it that the SPE4'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 SPE4 wishes the attached device to stop sending to it in which the pair will go inactive (RTS+ less positive than RTS-) until the SPE4 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 SPE4 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 SPE4 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 8032, 8064, 8096, 8128, and 8160 set the number of PAD characters for Ports 0, 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 2040, 2072, 2104, 2136, and 2168 for Ports 0 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.

4
SY/MAX Mode

Mode 1: SY/MAX

Each of the SPE4's five 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 SPE4 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 SPE4 module, it is processed by the SPE4 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.
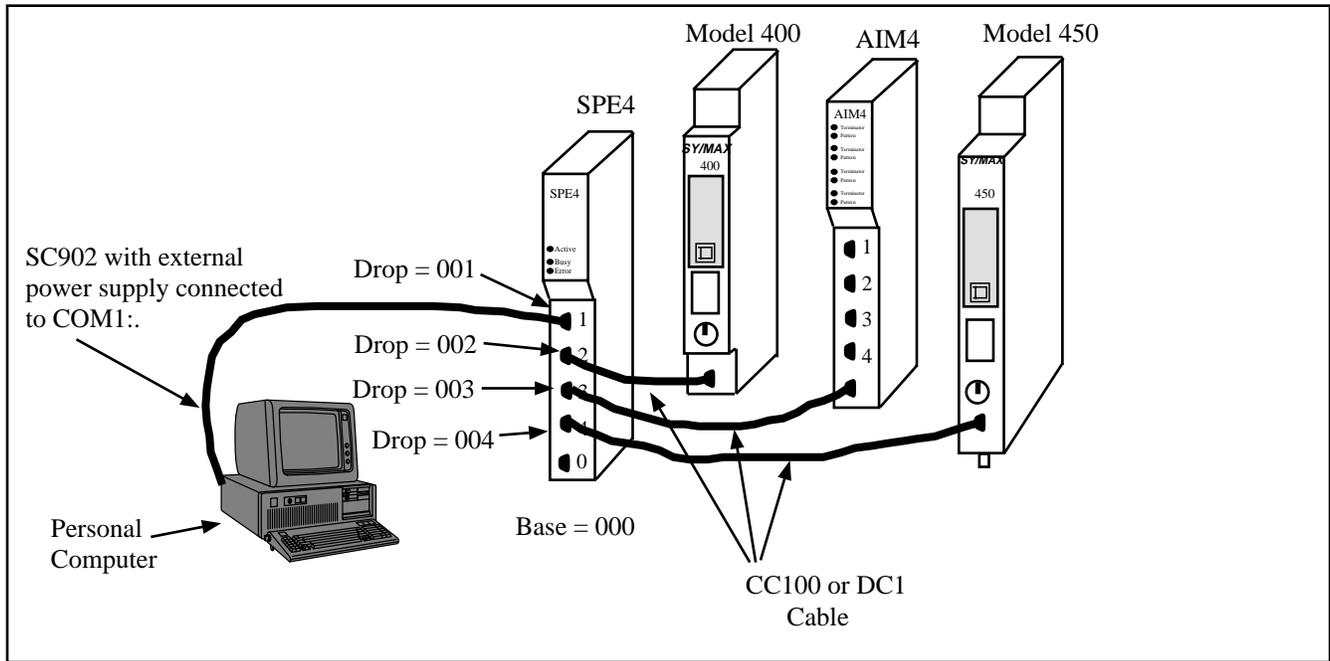
Figure 4-1 SY/MAX Mode Example

The Personal computer is connected to Port 1 of the SPE4 using a SC902 cable to its COM1: port. (The external power supply for the SC902 must be used.) The SPE4 has the setup shown in Table 4-1 below:

Table 4-1   SY/MAX Mode SPE4 Setup Example

Port	**Drop Number**	Mode	Baud Rate	Parity	Data	Stop	**Error Check**
0	000	SY/MAX	9600	E	8	1	BCC
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 2 of the SPE4 with a DC1 (CC100) type cable. The AIM4 Print/Prog port is connected to Port 3 of the SPE4 with a DC1 (CC100) cable. The Model 450 is connected to Port 4 of the SPE4 with a DC1 cable.

The personal computer may be used to program each of the processors as well as the AIM4 and SPE4. Table 4-2 gives the route required for the personal computer to reach each of the devices.

Table 4-2   SY/MAX Mode Personal Computer Route Examples

Origin	Target	Route
Personal Computer	Model 400	001, 002
Personal Computer	AIM4	001, 003
Personal Computer	Model 450	001, 004
Personal Computer	SPE4	NONE

Both of the processors can also use the SPE4 to share information between themselves, the SPE4, 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	002, 003
Model 400	Model 450	002, 004
Model 400	SPE4	NONE
Model 450	Model 400	004, 002
Model 450	AIM4	004, 003
Model 450	SPE4	NONE

As mentioned before, to access the registers in the SPE4 several routes are available. The routes listed above are all valid but are not all of the possibilities. If the message arriving at the SPE4 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 SPE4.

Table 4-4   SPE4 Equivalent routes for accessing internal registers

Origin	Target	Route	Route	Route
Personal Computer	SPE4	NONE	001, 204	001, 111
Model 400	SPE4	NONE	003, 204	002, 043
Model 450	SPE4	NONE	004, 204	004, 145

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

5
Net-to-Net Mode

Mode 2: Net-to-Net

If a data port of the SPE4 is connected to a NIM (CRM-510), a the RS-422 port of a SY/LINK board, or
to another SPE4 or EPE5 port, the following must be true:

- Both Ports must be configured for Net-to-Net Mode.

- Both Ports must have the same SY/NET Drop Number.

- Both Ports must be at the same baud rate.

- Both Ports must have the same parity.

- Both Ports must have the same error check.

It is critical for all of the above criteria to be met when connecting multiple SY/NETs together. The
SPE4 is considered to be its own SY/NET, so when it is connected to another SY/NET, the connection
must be made as Net-to-Net. The following examples demonstrate common NIM, SY/LINK, SPE4,
and EPE5 connections.

NIM Net-to-Net Example
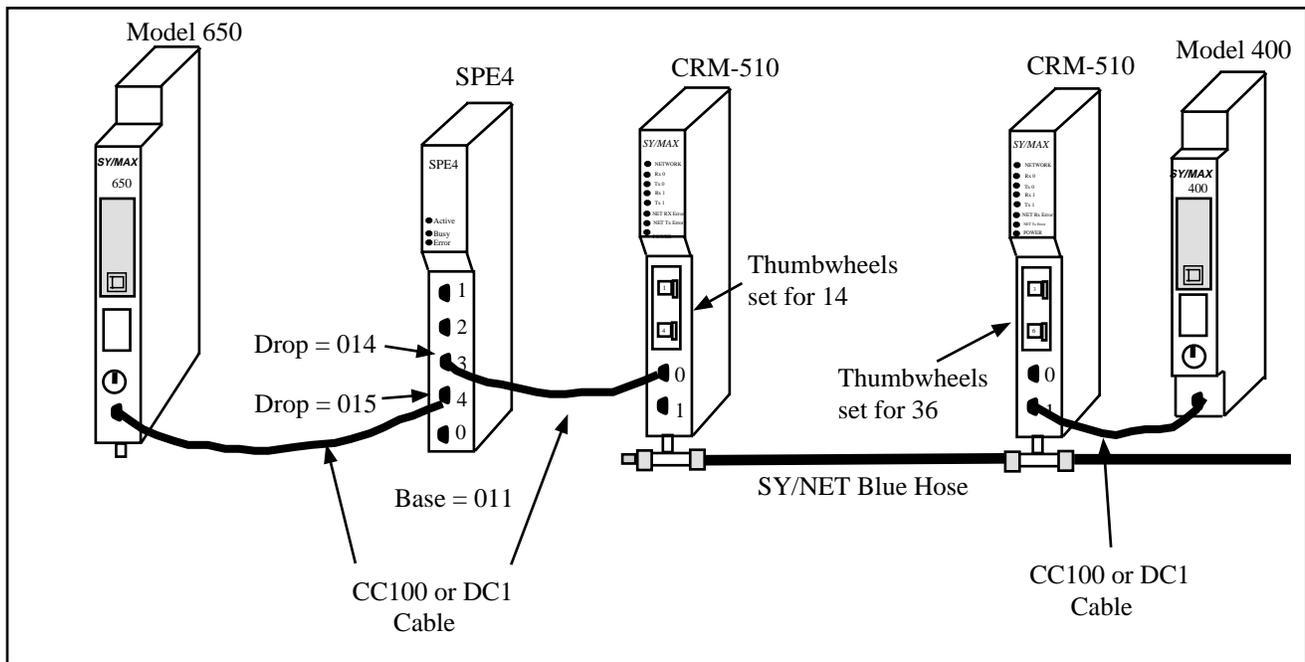
Figure 5-1   NIM Net-to-Net Example

Origin	Target	Route
Model 650	Model 400	015, 014, 136
Model 400	Model 650	136, 014, 015

Table 5-1   SPE4 Setup for NIM Net-to-Net Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	Error Check
0	011	SY/MAX	9600	E	8	1	BCC
3	014	Net-to-Net	9600	E	8	1	BCC
4	015	SY/MAX	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 SPE4, 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 SPE4 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.
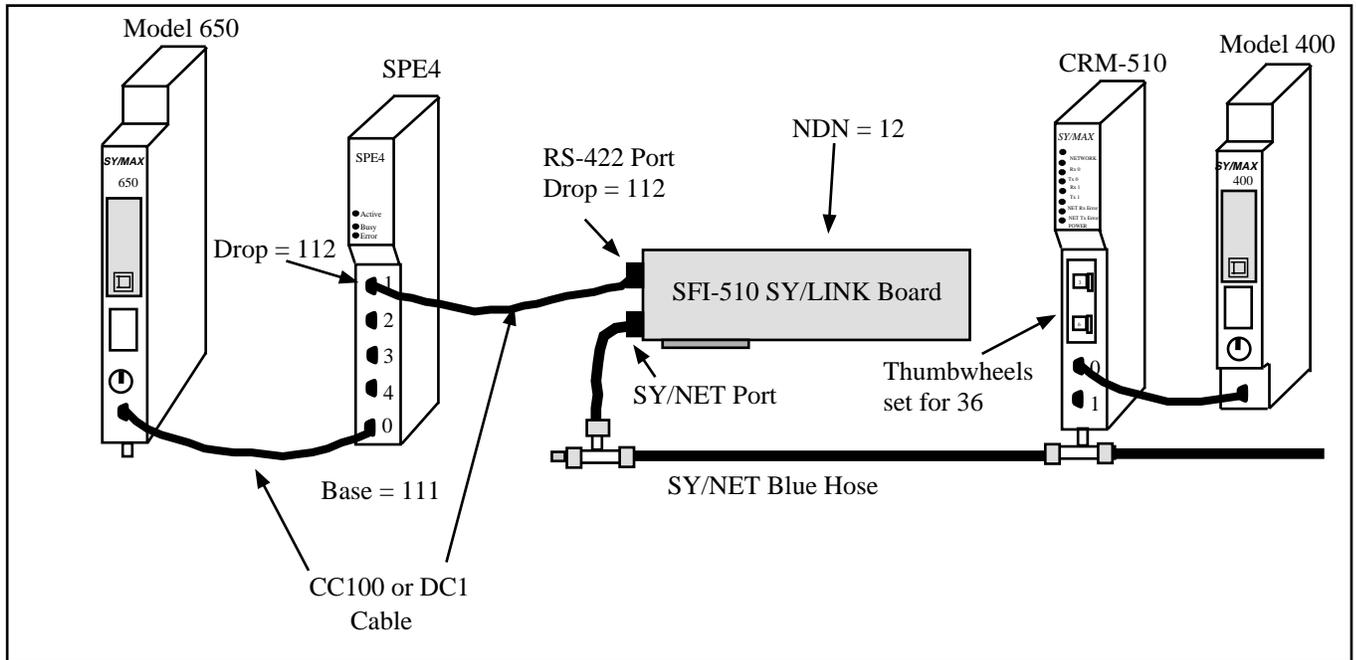
Figure 5-2   SY/LINK Net-to-Net Example

Table 5-2   SY/LINK Net-to-Net Routing Examples

Origin	Target	Route
Model 650	Model 400	111, 112 036
Model 650	SPE4 Mailbox	NONE
Model 650	SY/LINK Mailbox	111, 112, 012
Model 400	Model 650	036, 112, 111
SY/LINK	650	012, 112, 111
SY/LINK	400	012, 036
SY/LINK	SPE4 Mailbox	012, 112, 204

Table 5-3   SPE4 Setup for SY/LINK Net-to-Net Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	Error Check
0	111	SY/MAX	9600	E	8	1	BCC
1	112	Net-to-Net	9600	E	8	1	BCC

SPE4 Net-to-Net Example

When the five SY/MAX ports are not quite enough, an additional SPE4 may be added to enlarge the network. Both ports must have the same drop number and be in Net-to-Net mode. See Figure 5-3.

Additional throughput may be realized by increasing the baud rate to 19200 and setting the parity to NONE and the error check to CRC. Adding an additional connection between another pair of ports on the SPE4 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 the SPE4s. 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.
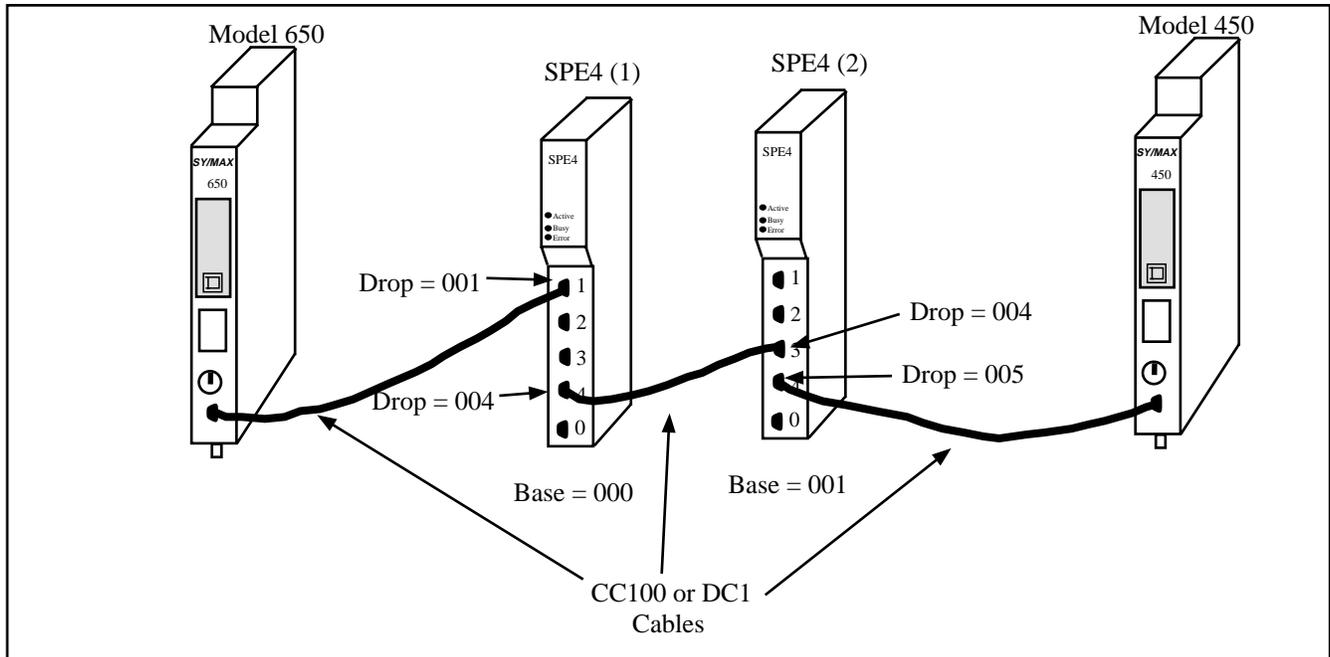
Figure 5-3   SPE4 Net-to-Net Example

Table 5-4   SPE4 Net-to-Net Routing Examples

Origin	Target	Route
Model 650	Model 400	001, 004, 005
Model 650	SPE4 (1) Mailbox	NONE
Model 650	SPE4 (2) Mailbox	001, 004
Model 450	Model 650	005, 004, 001
Model 450	SPE4 (1) Mailbox	005, 004
Model 450	SPE4 (2) Mailbox	NONE

Table 5-5   SPE4 (1) Setup for SPE4 Net-to-Net Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Error Check**
1	001	SY/MAX	9600	E	8	1	BCC
4	004	Net-to-Net	19200	N	8	1	CRC

Table 5-6   SPE4 (2) Setup for SPE4 Net-to-Net Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Error Check**
3	004	Net-to-Net	19200	N	8	1	CRC
4	005	SY/MAX	9600	E	8	1	BCC

EPE5 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 SPE4, the EPE5 ports are individually configurable for Drop Number. 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. The highest throughput (and better reliability) may be obtained by setting the parity to none and selecting the CRC error check.
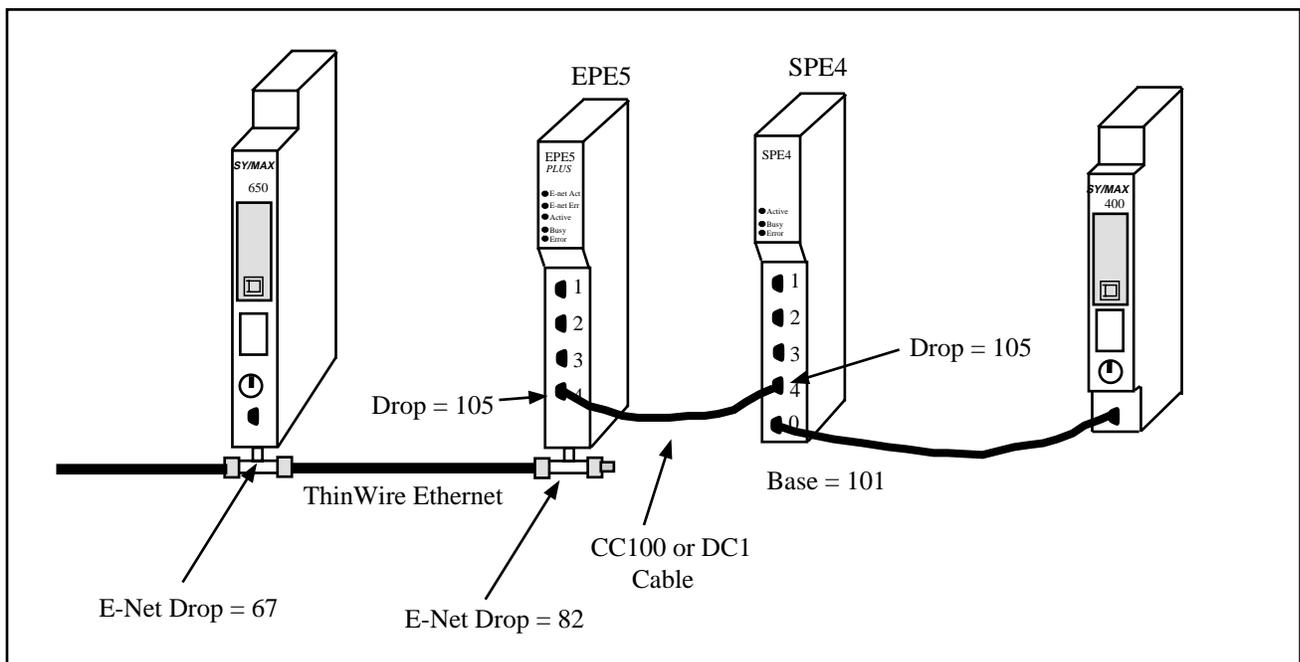
Figure 5-4 EPE5 Net-to-Net Example

Table 5-7   SPE4 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

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	BCC
4	105	Net-to-Net	19200	N	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	BCC
4	105	Net-to-Net	19200	N	8	1	CRC

<div align="right">

6

Peripheral Mode

</div>

Mode 3: Peripheral

An SPE4 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 in SPE4SW may be useful for testing peripheral mode ports.

RS-485 Driver Mode

Pt to Pt

Peripheral mode on ports 1-4 of a -1D or -2D modules offers 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 Peripheral port is the master on a 4-wire multidrop network.

Four Wire

Peripheral mode on ports 1-4 of a -1D or -2D modules offers the ability to operate on RS-485 networks in 4-wire and 2-wire modes. Four wire mode allows the transmit drivers to tri-state when CTS is not asserted. This allows the Peripheral port to act as a 4-wire slave on a multidrop network. This setting has no effect on Port 0 of any SPE4, any SPE4-1S, any SPE4-2S, or SPE4-1D and SPE4-2D REV 2.0 or earlier boards.

Half Duplex

Peripheral mode on ports 1-4 of a -1D or -2D modules 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.

This setting has no effect on Port 0 of any SPE4, any SPE4-1S, any SPE4-2S, or SPE4-1D and SPE4-2D REV 2.0 or earlier boards.

Two Wire

Peripheral mode on ports 1-4 of a -1D or -2D modules 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. This setting has no effect on Port 0 of any SPE4, any SPE4-1S, any SPE4-2S, or SPE4-1D and SPE4-2D REV 2.0 or earlier boards.

Peripheral Mode Example

In the following example, a SY/MAX processor sends network print rungs to an ASCII display and a printer.
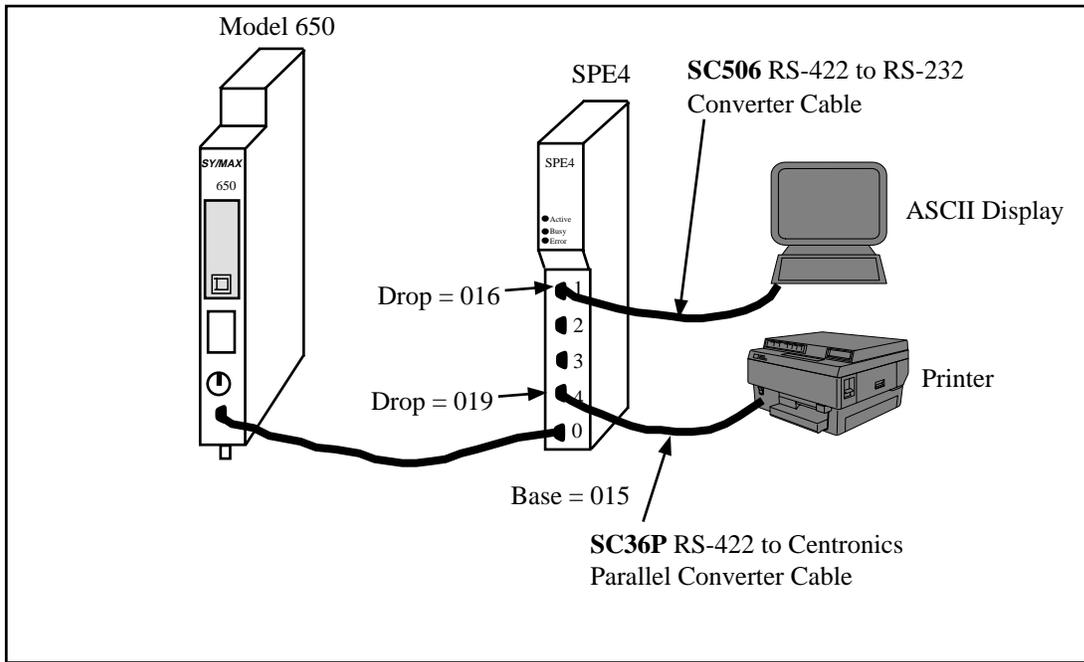
Figure 6-1   Peripheral Mode Example

Table 6-1   Peripheral Routing Examples

Origin	Target	Route
Model 650	ASCII Display	015, 016
Model 650	Printer	015, 019

Table 6-2   SPE4 Setup for Peripheral Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Error Check**
0	015	SY/MAX	9600	E	8	1	BCC
1	016	Peripheral	9600	N	7	1	NA
4	019	Peripheral	9600	N	7	1	NA

The Niobrara SC36P serial to parallel converter cable may be used to interface a Centronics compatible parallel printer to an SPE4 Peripheral (or other SY/MAX RS-422 port).

<div align="right">

7

Transparent and Share Modes

</div>

Modes 4,5: Transparent, Share

Transparent and Share modes are identical except for the behavior of the RTS pin (Transparent uses RTS in Restraint mode while Share uses RTS in Push-to-Talk mode.). 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 SPE4. 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 SPE4SW 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 termi-

nated 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.

Packet size limit

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

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

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

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

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.

RS-485 Driver Mode

Pt to Pt

Share mode on ports 1-4 of a -1D or -2D modules offers 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 Share port is the master on a 4-wire multidrop network.

Four Wire

Share mode on ports 1-4 of a -1D or -2D modules offers the ability to operate on RS-485 networks in 4-wire and 2-wire modes. Four wire mode allows the transmit drivers to tri-state when CTS is not asserted. This allows the Share port to act as a 4-wire slave on a multidrop network. This setting has no effect on Port 0 of any SPE4, any SPE4-1S, any SPE4-2S, or SPE4-1D and SPE4-2D REV 2.0 or earlier boards.

Half Duplex

Share mode on ports 1-4 of a -1D or -2D modules 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. This setting has no effect on Port 0 of any SPE4, any SPE4-1S, any SPE4-2S, or SPE4-1D and SPE4-2D REV 2.0 or earlier boards.

Two Wire

Share mode on ports 1-4 of a -1D or -2D modules 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. This setting has no effect on Port 0 of any SPE4, any SPE4-1S, any SPE4-2S, or SPE4-1D and SPE4-2D REV 2.0 or earlier boards.

TRANSPARENT Mode Example
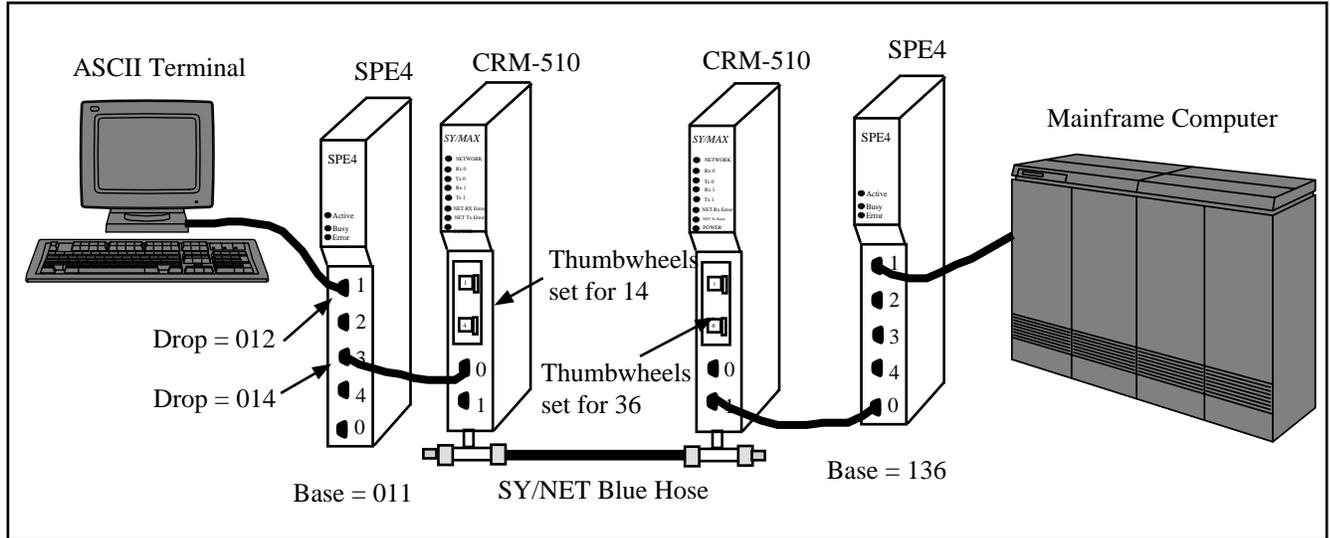
Figure 7-1   Transparent Mode Example

Table 7-1   Transparent Routing Examples

Origin	Target	Route
ASCII Terminal	Mainframe	012, 014, 136, 137
Mainframe	ASCII Terminal	137, 136, 014, 012

Table 7-2   SPE4 (1) Setup for TRANSPARENT Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	Error Check
1	012	Net-to-Net	9600	E	8	1	BCC
3	014	Transparent	9600	N	7	1	NA

Table 7-3   SPE4 (2) Setup for TRANSPARENT Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Error Check**
0	136	Net-to-Net	9600	E	8	1	BCC
1	137	Transparent	9600	N	7	1	NA

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 and have the same drop number as the NIM port.

If the Devices are RS-232 but the SPE4 ports are RS-422, the SC406 **or SC902** cable may be used to connect the external devices to the SPE4.

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.

<div align="right">

8
POWERLOGIC Modes

</div>

Mode 6: PLogic

The SPE4 can be used to route SY/MAX read and write messages originated by a PLC, computer, or SPE4 Gateway port to a POWERLOGIC network of one or more POWERLOGIC modules. The SPE4 handles the difficult task of allowing one communication process to be allowed for only one circuit monitor at a time, permitting multiple accessors to poll the units independently.

The route used should be the route from the accessor to the SPE4 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 SPE4. The SPE4 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 SPE4. But the network terminator should always be used. See the recommended cabling section at the end of this manual.

See pages **147** and **148** for more POWERLOGIC applications.

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 SPE4 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.

PLogic Mode Example
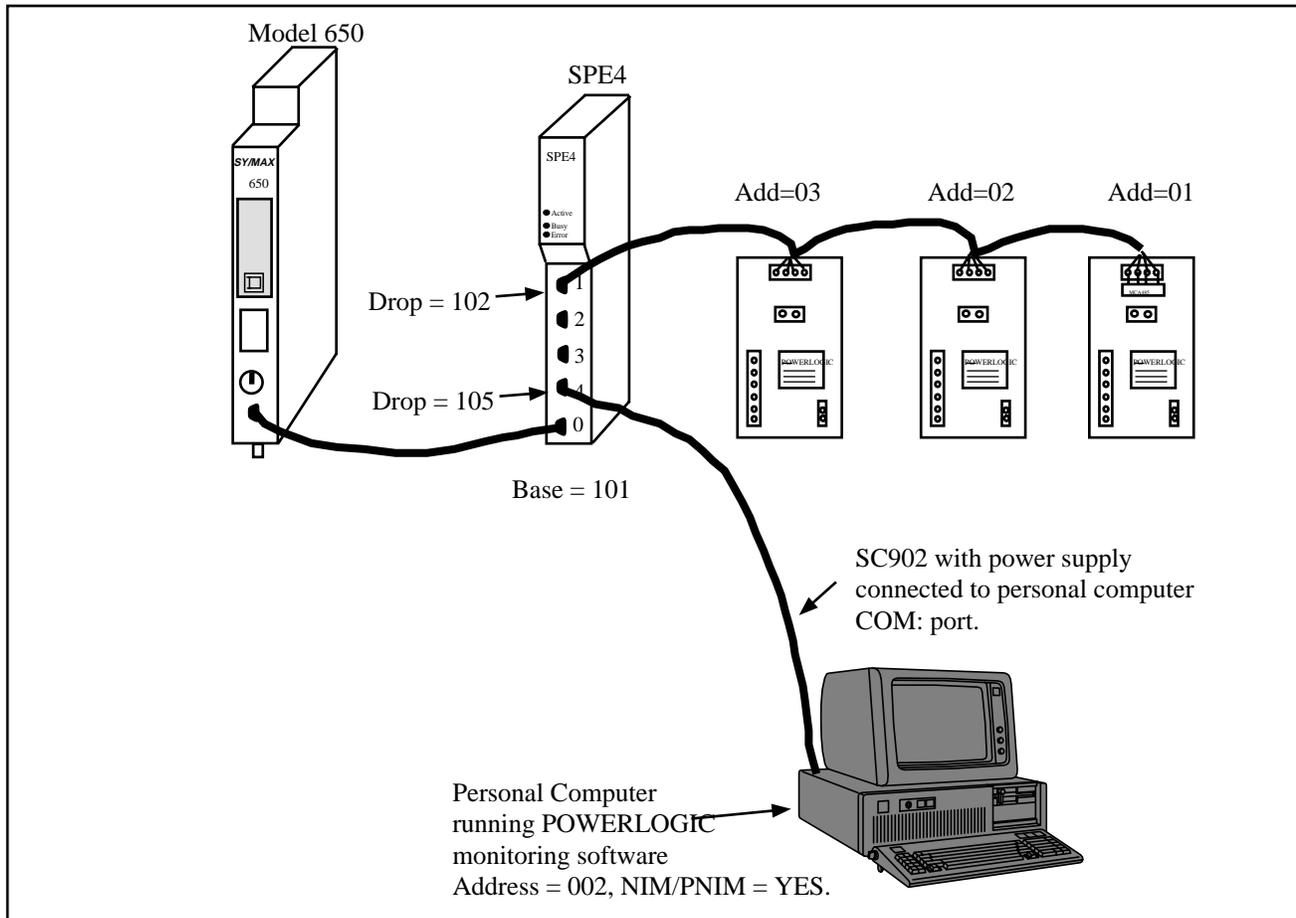
Figure 8-1 POWERLOGIC Example

Table 8-1 POWERLOGIC Routing Examples

Origin	Target	Route
Model 650	CM 1	101, 102, 001
Model 650	CM 3	101, 102, 003
Personal Computer	CM 1	002, 105, 102, 001
Personal Computer	CM 2	002, 105, 102, 002

Table 8-2   SPE4 Setup for POWERLOGIC Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	Error Check
0	101	SY/MAX	9600	E	8	1	BCC
1	102	PLOGIC	9600	E	8	1	BCC
4	105	SY/MAX	9600	E	8	1	BCC

The POWERLOGIC units are set up as 4-wire. The Personal Computer has an address of 2 and NIM/PNIM is set to yes.

Mode 11: PNIM

The SPE4 can be used to route SY/MAX read and write messages originated by a PLC, computer, or SPE4 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 SPE4 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 SPE4 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 SPE4 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 SPE4. The SPE4 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 SPE4. But the network terminator should always be used. See the recommended cabling section at the end of this manual.

PNIM Mode Example
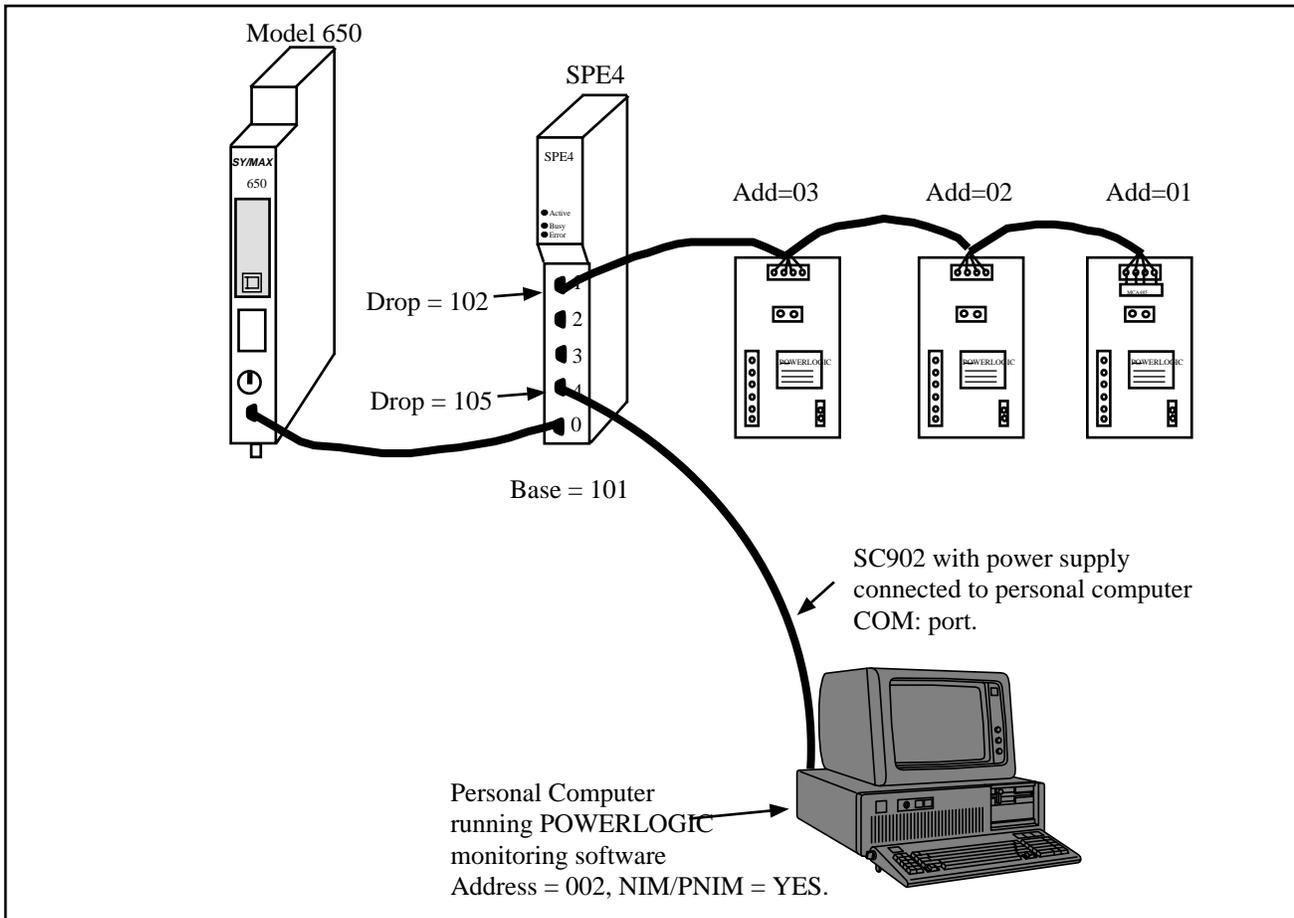
Figure 8-2   PNIM Mode Example

Table 8-3   PNIM Routing Examples

Origin	Target	Route
Model 650	CM 1	101, 102, 001
Model 650	CM 3	101, 102, 003
Personal Computer	CM 1	002, 105, 102, 001
Personal Computer	CM 2	002, 105, 015, 002

Table 8-4   SPE4 Setup for PNIM Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Error Check**
0	101	SY/MAX	9600	E	8	1	BCC
1	102	PNIM	9600	E	8	1	CRC
4	105	SY/MAX	9600	E	8	1	BCC

The POWERLOGIC units are set up as 4-wire. The Personal Computer has an address of 2 and NIM/PNIM is set to yes.

Mode 7: IDEC

Micro-1 and Model 50 Interfacing

The SPE4 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 SPE4 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 SPE4 port and one additional drop corresponding to the drop number of the Micro-1 or Model 50 processor within the ring network. The SPE4 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 SPE4 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 SPE4 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 SPE4 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

Programming IDEC Processors

A personal computer running SFW30 or SFW50 may be connected to SY/NET through a Transparent mode SPE4 or EPE5 port and routed to an IDEC port for processor programming. The Transparent Target route should include the route from the Transparent port to the IDEC port only. The SFW30 or SFW50 software provides the network drop for the processor.

For Micro-1 programming, set the Transparent port to 9600 baud, 8 data bits, EVEN parity, 1 Stop Bit, Time limit 100, Character limit 128, Control Char ON, and Echo OFF.

For Model 50 programming, set the Transparent port to 9600 baud, 8 data bits, NONE parity, 1 Stop Bit, Time limit 100, Character limit 128, Control Char ON, and Echo ON.

IDEC Mode Example
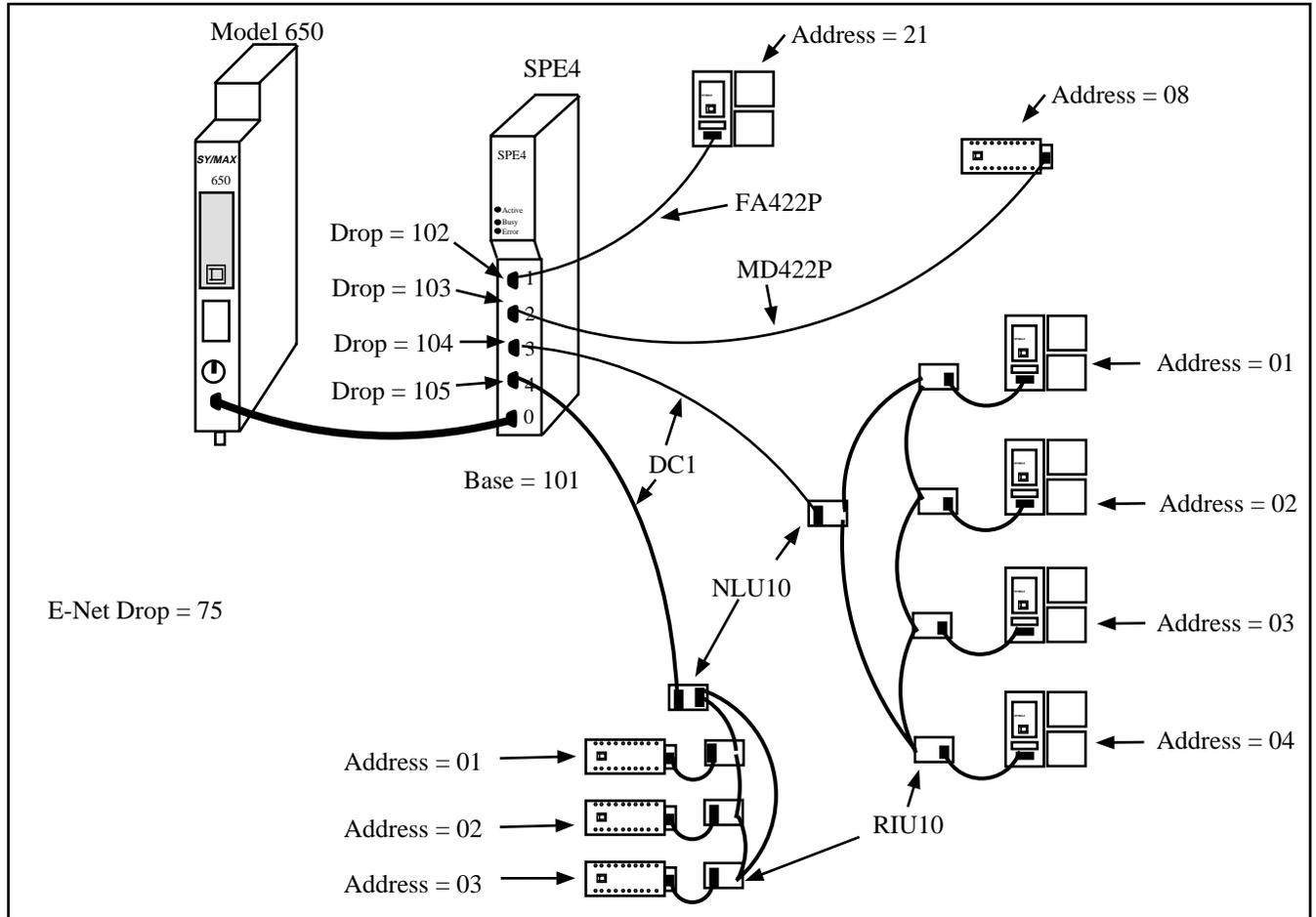
Figure 9-1 IDEC Mode Example

Table 9-3   IDEC Routing Examples

Origin	Target	Route
Model 650	Model 50 on Port 1	101, 102, 021
Model 650	Micro-1 on Port 2	101, 103, 008
Model 650	Model 50 (1) on Port 3	101, 104 001
Model 650	Model 50 (4) on Port 3	101, 104, 004
Model 650	Micro-1 (2) on Port 4	101, 105, 002
Model 650	Micro-1 (3) on Port 4	101, 105, 003

Table 9-4   SPE4 Setup for IDEC Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	Error Check
0	101	SY/MAX	9600	E	8	1	BCC
1	102	IDEC	9600	N	8	2	NA
2	103	IDEC	9600	E	8	1	NA
3	104	IDEC	9600	N	8	2	NA
4	105	IDEC	9600	E	8	1	NA

10
Gateway Mode

Mode 8: Gateway

ASCII Command Gateway Functions

To simplify access to SY/MAX devices such as PLCs, Niobrara's various modules, POWERLOGIC modules, and IDEC mode PLCs, the SPE4 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 SPE4 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 SPE4 or to a NIM connected to the Gateway SPE4 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 SPE4 module. The target route may be set by using SPE4SW (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 SPE4 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 within SPE4SW is useful for testing the gateway features.

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.

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.

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

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

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

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 SPE4 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...

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+++

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
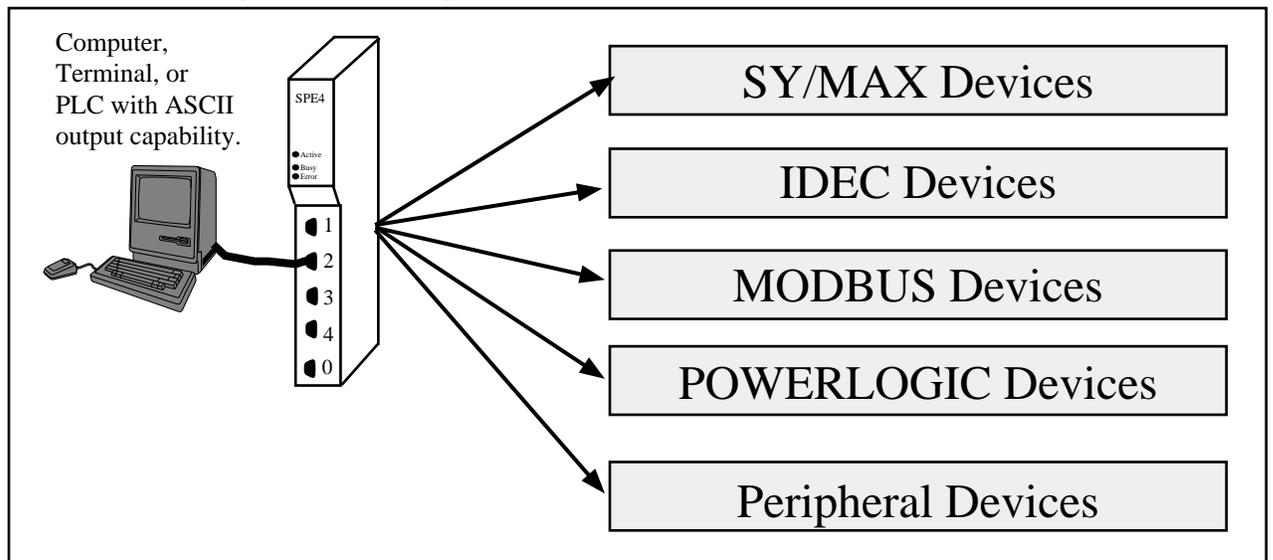
The Gateway mode simplifies access to SY/MAX devices, such as PLCs, NR&D's various modules, the SPE4 itself, and any other external mode of the SPE4 (IDEC, PLogic, MODBUS, etc.). A Gateway port accepts simple ASCII commands and translates them to properly formatted SY/MAX read, write, and print messages. Any device with an ASCII serial port may be used to communicate with SY/MAX devices

Packet size limit

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

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

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

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

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

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.

Table 10-1   Gateway Command List

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 SPE4'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
```

11
Multidrop Mode

Mode 9: Multidrop

The SPE4 multidrop port mode can be used to route packets between three or more SPE4 modules over a single communication medium such as an RS-485 pair or multidrop modems or radios. The Multidrop mode is best suited for an RS-485 network, if a radio or multidrop modem system is employed the RNIM mode should be considered. (See page 73) SPE4 ports one through four can be used in Multidrop mode, port zero cannot. An external device is required to interconnect more than two ports. In Multidrop mode, the SPE4 units on the line use a time division scheme to arbitrate access to the line. When an individual SPE4 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.

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 SPE4 port.

Multidrop mode is used to allow several SPE4s, or EPE5s, to communicate over a single medium such as a single frequency radio modem. The SPE4 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 SPE4 asserts RTS and waits for CTS from the modem before transmitting its packet. All other SPE4s or EPE5s monitor the incoming packets for their address and then route the packet accordingly.

Pt to Pt

Multidrop mode on ports 1-4 of a -1D or -2D modules offers 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

Multidrop mode on ports 1-4 of a -1D or -2D modules 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. This setting has no effect on Port 0 of any SPE4, any SPE4-1S, any SPE4-2S, or SPE4-1D and SPE4-2D REV 2.0 or earlier boards.

Two Wire

Multidrop mode on ports 1-4 of a -1D or -2D modules 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. This setting has no effect on Port 0 of any SPE4, any SPE4-1S, any SPE4-2S, or SPE4-1D and SPE4-2D REV 2.0 or earlier boards.

Multidrop Mode Example
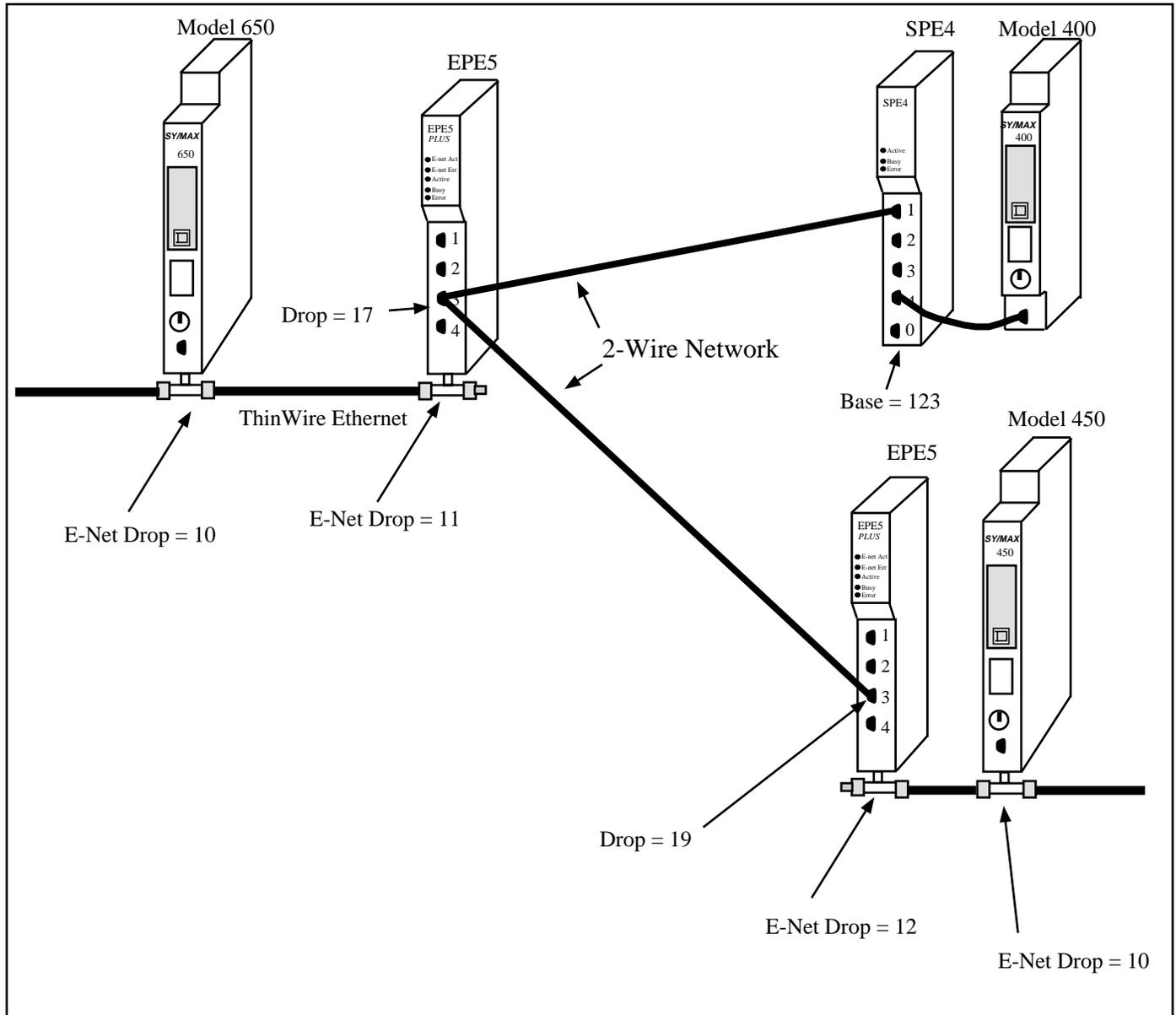
Figure 11-1 Multidrop Example

Each Multidrop port in the above example is set to TWO-WIRE mode for the Driver Mode.

Table 11-1   MULTIDROP Routing Examples

Origin	Target	Route
Model 650	Model 400	010, 011, 017, 124, 127
Model 650	Model 450	010, 011, 017, 019, 012, 010
Model 400	Model 650	127, 124, 017, 011, 010
Model 400	Model 450	127, 124, 019, 012, 010
Model 450	Model 650	010, 012, 019, 017, 011, 010
Model 450	Model 400	010, 012, 019, 124, 127

Table 11-2   EPE5 (1) Setup for MULTIDROP Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	Error Check
E-Net	11	SY/MAX	NA	NA	NA	NA	NA
3	17	MULTIDROP	19200	N	8	1	CRC

Table 11-3   SPE4 Setup for MULTIDROP Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	Error Check
1	124	MULTIDROP	19200	N	8	1	CRC
4	127	SY/MAX	9600	E	8	1	BCC

Table 11-4   EPE5 (2) Setup for MULTIDROP Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	Error Check
E-Net	12	SY/MAX	NA	NA	NA	NA	NA
3	19	MULTIDROP	19200	N	8	1	CRC

<div align="right">

12

Modbus Mode

</div>

NOTE: SPE4 modules with firmware of 05Jun95 or earlier MODBUS ports only acted as a RTU Master. Newer firmware units supply both Master and Slave functionality. Units with firmware of 22Nov95 or later Have the MODBUS mode renamed as Modbus Host. These units also include the new reversable Modbus Gate mode.

The Modbus protocol is implemented in a wide variety of products including Modicon PLCs, temperature controllers, flowmeters, intelligent valve systems, etc. The SPE4 provides a gateway translation from the SY/MAX protocol to/from Modbus RTU protocol with the Modbus Gate and Modbus Host modes. The SPE4 Modbus Gate mode provides 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.

Modbus Overview

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

The Modicon addressing method involves separate memory locations for input bits, output bits, input registers, and output registers. These different areas are denoted by the first character in the number that identifies the bit or register. Output bits (coils) are described by values in the range of 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 12-1.

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

---

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

Table 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. Untranslateable SY/MAX or Modbus messages should only be directed to a device of the same brand to avoid unpredictable results. SY/MAX, PLOGIC, PNIM, and IDEC serial ports will return an encapsulated error to encapsulated Modbus messages. Modbus Host and Modbus Gate serial ports will return an encapsulated error to encapsulated SY/MAX messages. Net-to-Net, RNIM, MULTIDROP, ETHERNET, SY/NET, and Modbus Plus ports forward all messages transparently.

SY/MAX to Modbus Translations

SY/MAX originated messages which can be reversibly translated are listed in Table 12-3.

Table 12-3　SY/MAX to Modbus Translations

SY/MAX Message	Modbus Message
Priority Read (0x20)	Read Holding Registers (3)
Non-Priority Read (0x00)	Read Holding Registers (3) 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

Modbus Message	SY/MAX Message
Read Coil Status (1)	Priority Read (0x20) with status register address 0xMN03 where M is the start bit modulo 16 and N is the bit count modulo 16
Read Input Status (2)	Priority Read (0x20) with status register address 0xMN05 where M is the start bit modulo 16 and N is the bit count modulo 16
Read Holding Registers (3) 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 0xfff) 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 slaves and networks of slaves to SY/NET. The Modbus Gate 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 SPE4 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 SPE4 Modbus Host or Gateway Slave port.

Register Calculations

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

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

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

> Example: A SY/MAX read is routed to a Modbus Host (Master) port of an SPE4. 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 SPE4. 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 SPE4 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 SPE4 MODBUS port must perform a translation to accomplish this task. The SY/MAX READ and WRITE messages support 16 bits per register address, so the translation to MODBUS coil address occurs in sections of 16 coils and occur on 16 bit boundaries. The MODBUS commands which are coil (bit) operations (1, 5, 15) are related to the REMOTE address specified in the READ or WRITE by the following formula:

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

The start address refers to the address of bit 1 of the SY/MAX register. Table 12-6 displays the SY/MAX bit relationship to the Modbus coils for the SPE4 Modbus Master.

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

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

Modbus Retries

If a Modbus packet is transmitted from the SPE4 port and a valid reply is not received from the Modbus device, the SPE4 will wait for the amount of time specified in the MODBUS RETRY timeout register for that port. The SPE4 will then rebroadcast the message and wait for a valid reply. The SPE4 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 Master Mode Example
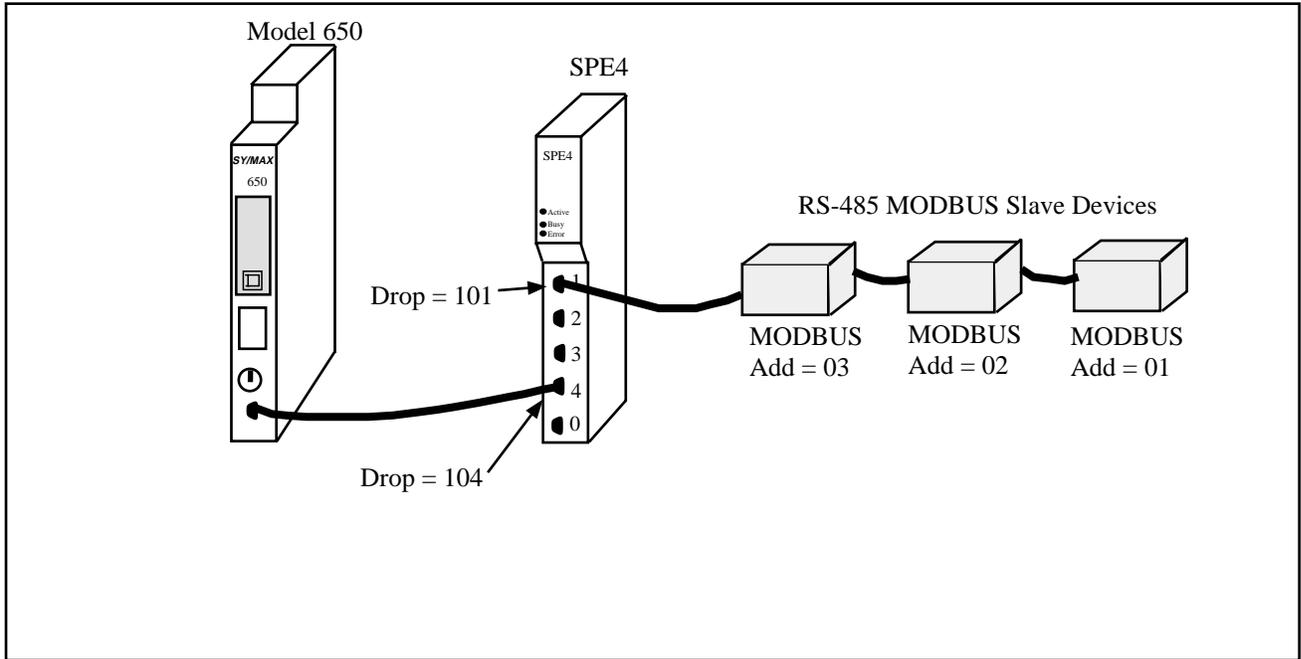
Figure 12-1 MODBUS Master Mode Example

Table 12-7   MULTIDROP Routing Examples

Origin	Target	Route
Model 650	MODBUS Slave 1	104, 101, 001
Model 650	MODBUS Slave 3	104, 101, 003

Table 12-8   SPE4 (1) Setup for MULTIDROP Master Connection

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Error Check**
1	101	MODBUS Gate	9600	E	8	1	NA
4	104	SY/MAX	9600	E	8	1	BCC

If the MODBUS peripherals are equipped for 4-wire RS-485 operation, up to 32 units may be connected to a single SPE4 RS-422 port. Set the Options bits for that Modbus port for Multidrop False and FULL Duplex. (In the SPE4SW Edit screen, set the Driver Mode = Pt to Pt.)

If a 2-wire RS-485 network is required, set the Options bits for that port for Multidrop TRUE and HALF Duplex. (In the SPE4SW Edit mode, set the Driver Mode for Two Wire.)

Modbus Slave Operation

The SPE4 Modbus Slave operation allows a Modbus Master to read and write data into SY/MAX devices via SY/NET. The SPE4 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 SPE4 port. Each SPE4 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 SPE4 ports connected in a multidrop fashion are able to respond to all 255 Modbus addresses.
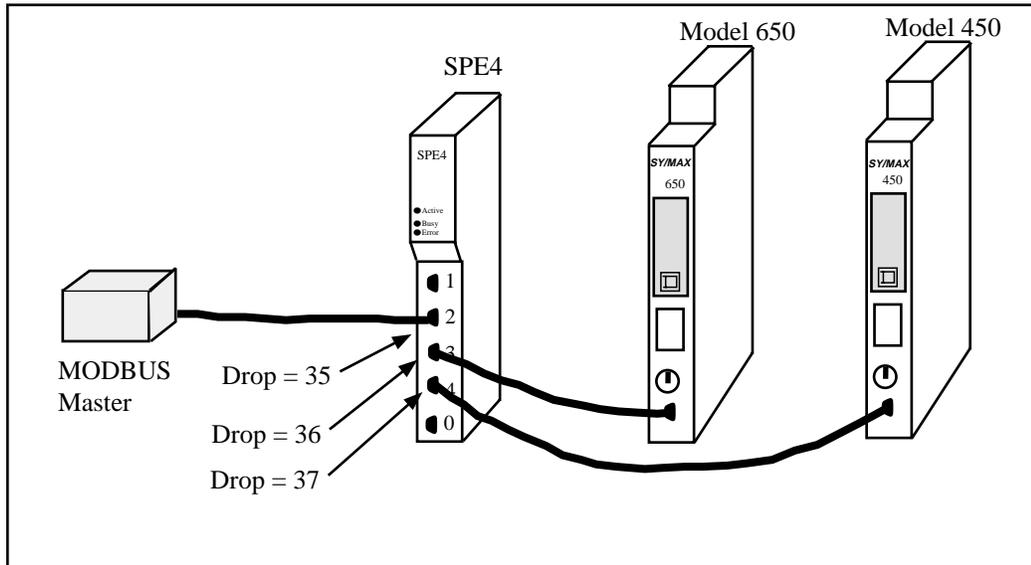
Figure 12-2 OTHER Modbus Slave Example

Table 12-9   Modbus Slave Example Setup

Origin	Target	Modbus Address	SY/MAX Route in the Modbus Address Table
Modbus Master	Model 650	1	035, 036
Modbus Master	Model 450	2	035, 037
Modbus Master	SPE4 Mailbox	3	035, 204

Table 12-10 Modbus Example Configuration

Port	Drop #	Mode	Baud Rate	Parity	Data	Stop	**Error Check**
2	35	MODBUS Gate	9600	E	8	1	NA
3	36	SY/MAX	9600	E	8	1	BCC
4	37	SY/MAX	9600	E	8	1	BCC

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.

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 12-11 displays the currently used PLC IDs from Modicon.

Table 12-11 Modicon PLC ID Values

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

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

Non-Priority Random Access Reads

The POWERLOGIC softwares all make extensive use of the SY/MAX Non-Priority Random Access Read message. This is a highly efficient use of the SY/MAX protocol and can provide excellent throughput for gathering large amounts of non-contiguous data. 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 module is now capable of translating SY/MAX Random Access Reads to multiple Modbus Plus Reads of MB+ devices on the local network.

NOTE: Port 0 will not support the RNIM protocol as it requires active handshake line operation.

The RNIM mode provides compatibility with the Square D CRM-560 RNIM. Two modes of RNIM operation are RNIM Master (Mode 12) and RNIM Slave (Mode 13). The RNIM protocol provides remote network access to SY/MAX devices using a half-duplex connection via radio/microwave/fiber optic/telephone links with the addition of a modem device. For a twisted pair RS-485 link, it is recommend that the MULTIDROP Mode be used rather than RNIM. (See page 59.) 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)

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.
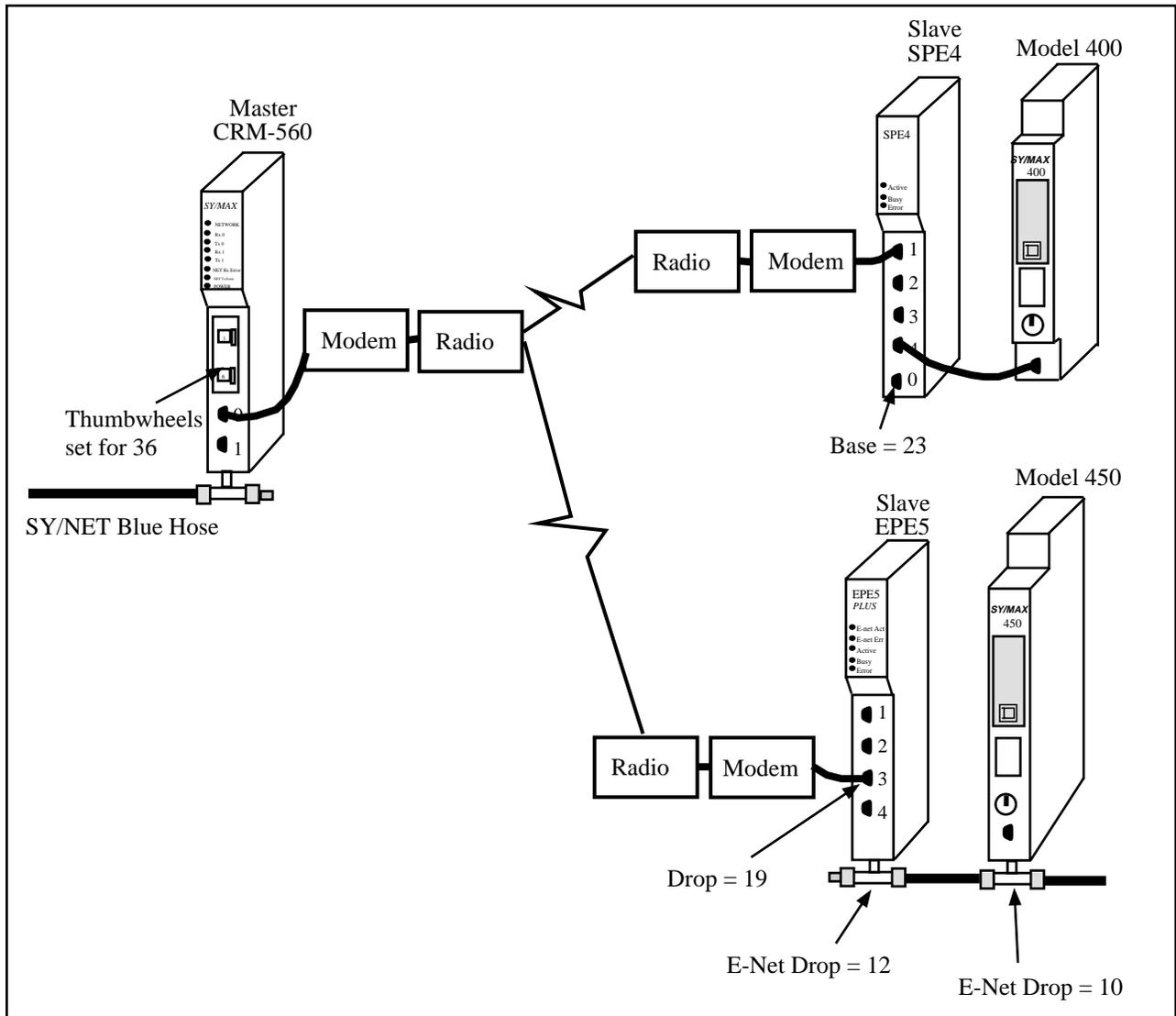
Figure 13-1 NORMAL RNIM Example

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 SPE4 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 SPE4 RNIM Slave does not include this restriction. The SPE4 will respond to any BID if it has a message in its Command buffer.

NOTE: The SPE4 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 (SPE4 Master).

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

Automatic BID Operation (100 + n)

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

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

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

1   A value is written to the Bid address register.

2   A BID is sent to that address - 100.

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

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

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

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

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

Automatic BID Operation (200 + n)

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

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

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

1   A value is written to the Bid address register.

2   A BID is sent to that address - 200.

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

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

5   Flow returns to step 2.

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

Automatic BID Operation (300 + n)

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

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

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

1   A value is written to the Bid address register.

2   A BID is sent to that address - 300.

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

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

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

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

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

Data Store and Forward Operation

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

The STORE and FORWARD feature of the RNIM Slave is used by simply including the drop number of the repeater Slave plus 100 in the route.
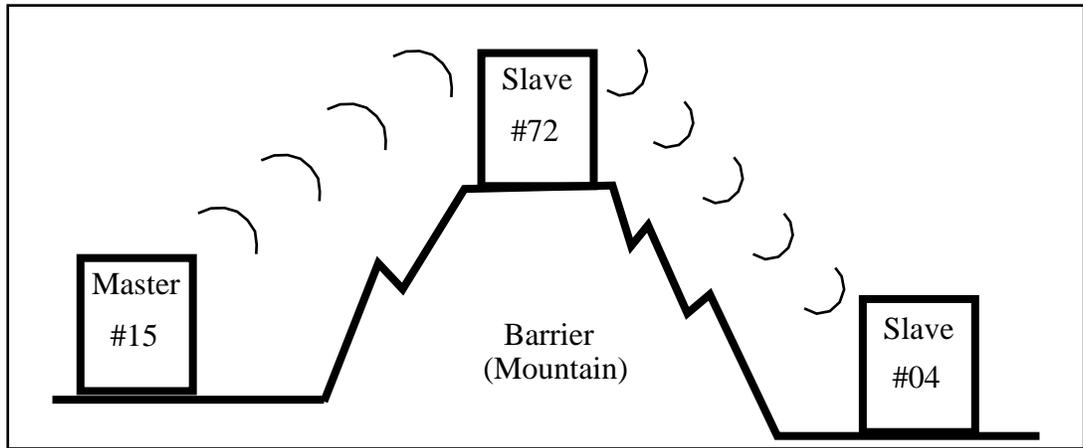
Figure 13-2 RNIM Repeater Example

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 SPE4, the Broadcast Operation implementation varies. The SPE4 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 SPE4.

Table 13-1   Broadcast Route Values

	Slave Drop #	CRM-560 Slave Port	SPE4 Response	Broadcast Route Value
General Broadcast	00-99	#1 Twin-ax	Internal Internal	254 253
Partial Broadcast	90-99	#1 Twin-ax	Internal Internal	252 251
	80-89	#1 Twin-ax	Internal Internal	250 249
	70-79	#1 Twin-ax	Internal Internal	248 247
	60-69	#1 Twin-ax	Internal Internal	246 245
	50-59	#1 Twin-ax	Internal Internal	244 243
	40-49	#1 Twin-ax	Internal Internal	242 241
	30-39	#1 Twin-ax	Internal Internal	240 239
	20-29	#1 Twin-ax	Internal Internal	238 237
	10-19	#1 Twin-ax	Internal Internal	236 235
	00-09	#1 Twin-ax	Internal Internal	234 233

If it is desired to route a broadcast message to all SPE4 RNIM Slaves with Drop numbers in the fifties and send a broadcast message our all of the other SY/MAX mode ports on the SPE4, 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 SPE4 are adjustable. Table 13-2displays the control registers in the SPE4 and the equivalent registers in the Square D CRM-560. The SPE4 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 SPE4.

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 SPE4 also uses this value as the BID timeout.
21	8044	8076	8108	8140	BID address number	00 to 99 Single BID. 100 to 199 Automatic BIDs. 200 to 299 Continuous Single BIDs 300 to 399 Continuous Automatic BIDs.
22	8045	8077	8109	8141	Number of Retries (when no ACK received)	CRM-560 defaults to 3 on power-up.
23	8062	8094	8126	8158	Master Disable	Set bit 9 in the SPE4/EPE5 options register to disable the Master. Set the CRM-560 register to decimal 123 to disable the Master.
25	8058	8090	8123	8155	Pause Time (10mS units)	CRM-560 defaults to 15 seconds on power-up.
26	8059	8091	8124	8156	Message Count (between Pause Time)	CRM-560 defaults to 4 on power-up.
NA	8060	8092	8125	8157	BID Reply Interval	This value determines the amount of time between successive automatic BIDs.
NA	2103	2135	2167	2199	Number of messages in Command Buffer	Read Only Statistic that displays the number of queued messages waiting in the Command buffer.

Mode 13: RNIM Slave

Several operational parameters of the RNIM Master in the SPE4 are adjustable. Table 13-3 displays the control registers in the SPE4 and the equivalent registers in the Square D CRM-560. The SPE4 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 SPE4.

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 SPE4 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 -1D or -2D modules offer 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. This setting has no effect on Port 0 of any SPE4, any SPE4-1S, any SPE4-2S, or SPE4-1D and SPE4-2D REV 2.0 or earlier boards.

Two Wire

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. 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.   This setting has no effect on Port 0 of any SPE4, any SPE4-1S, any SPE4-2S, or SPE4-1D and SPE4-2D REV 2.0 or earlier boards.

RTS/CTS Operation

It is important to note that the RTS/CTS operation of the SPE4 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 SPE4 will wait for the attached device to assert CTS. This true handshaking feature of the SPE4 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 SPE4 handshake sequence is as follows:

1   The SPE4 asserts the Request to Send (RTS) signal when it has data to send.

2   The SPE4 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 SPE4 will just wait for CTS to be asserted.

14

Chevron Mode

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

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

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

The following restrictions apply to the Chevron mode:

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

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

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

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

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

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

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

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

- RNIM BIDding and automatic BIDding is permitted and operates like a normal RNIM Master port.
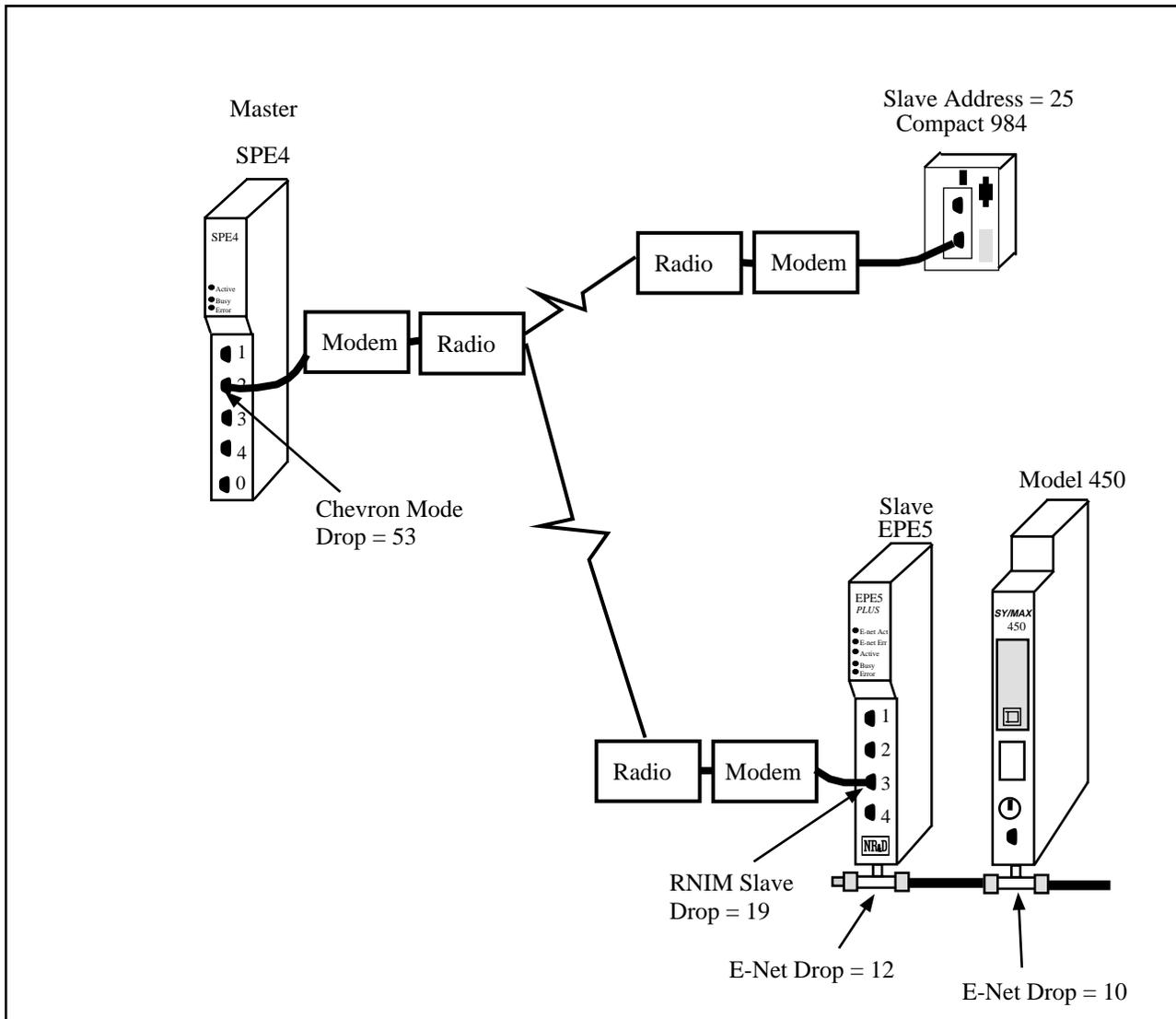
Figure 14-1 Chevron Radio Example

An example application of the Chevron mode is displayed in Figure 14-1. The Master SPE4 on the left has Port 2 in Chevron mode with a drop number of 53. This port is connected via radio modems to another EPE5 and a Compact 984 PLC. The remote EPE5 has its Port 3 set for RNIM Slave with a drop number of 19. The Compact 984 is configured for RTU mode with and address of 25.

To route to the Model 450, the portion of the route from the Master SPE4 would be:
                        ..., 53, 19, 12, 10

while the route to the Compact 984 from the Master SPE4 would be:
                        ..., 53, 125

Notice that the Modbus device was accessed by adding 100 to its slave address.
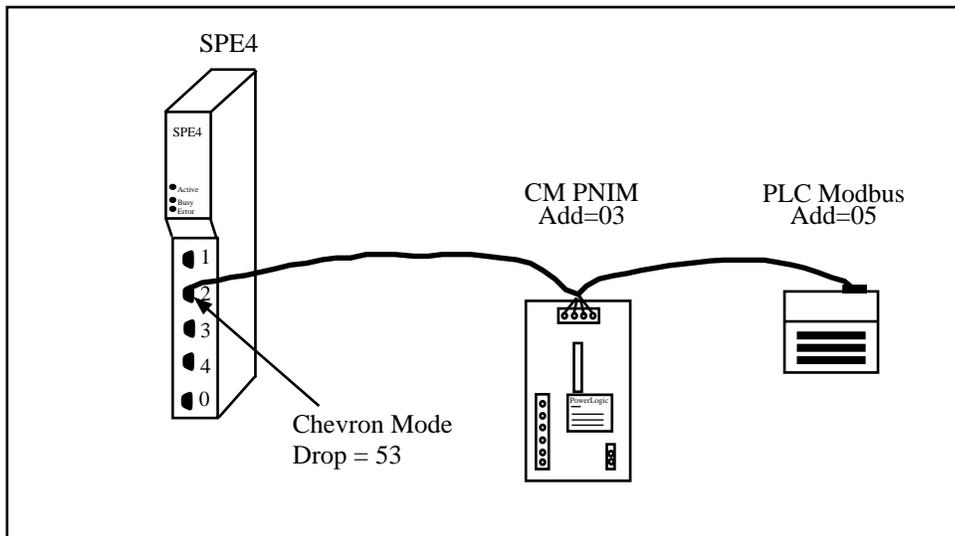
Figure 14-2 Chevron POWERLOGIC Example

An example application of the Chevron mode is displayed in Figure 14-2. The SPE4 has Port 2 in Chevron mode with a drop number of 53. This port is wired with a 4-wire RS-485 cable to a POWERLOGIC Circuit Monitor and a Momentum PLC. The CM is configured for PNIM Address 03 while the PLC is at Modbus RTU Address 05. All three devices are configured for the same baud rate, paritye, data bits, and stop bits (9600,EVEN,8,1). The PLC has its 9-pin port confgured for RS-485.

The setup for the CHEVRON port is as follows:

Table 14-1   POWERLOGIC CHEVRON Example

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

To route to the CM, the portion of the route from the Master SPE4 would be:

..., 53, 03

while the route to the Momentum PLC from the Master SPE4 would be:

..., 53, 105

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

15
Dual Slave Mode

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

There are a few limitations imposed by the Dual Mode:

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

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

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

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

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

SMS Example

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

NOTE: The "Communications Wiring" setting within SMS must be set for "SyMax to NIM/PNIM" Do not choose "PowerLogic/Modbus/Jbus (4-Wire)" because the SY/MAX routing will not work.
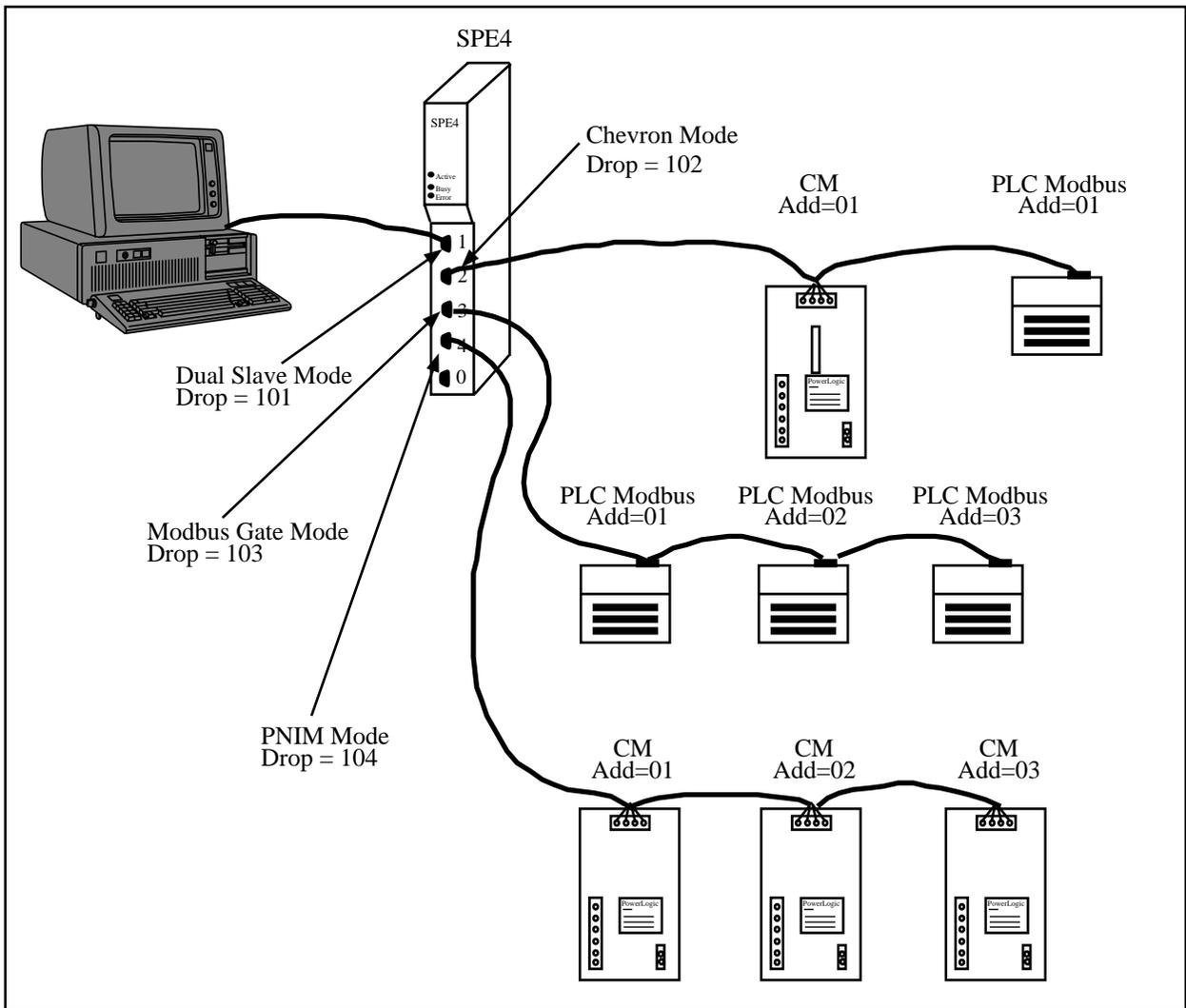
Figure 15-1 Dual Slave SMS Example

An example application of the Dual Slave mode is displayed in Figure 15-1. The SPE4 has Port 1 in Dual Slave Mode with the SMS computer connected through an NR&D SC902 cable. Port 2 is in Chevron mode with a Circuit Monitor and a Momentum PLC. Port 3 is in Modbus Gate Mode with three Momentum PLCs. Port 4 is in PNIM mode with three Circuit Monitors.

Table 15-1   POWERLOGIC Example DUAL SLAVE Port

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

Table 15-2   POWERLOGIC Example DUAL SLAVE Port Modbus Routing

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

Table 15-3   POWERLOGIC Example CHEVRON Port

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

Table 15-4   POWERLOGIC Example Modbus Gate and PNIM Ports

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

Table 15-5   POWERLOGIC Example SMS Communications Connection - Serial

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

Table 15-6   POWERLOGIC Example SMS Setup Devices/Routing

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

PLC Programming Example
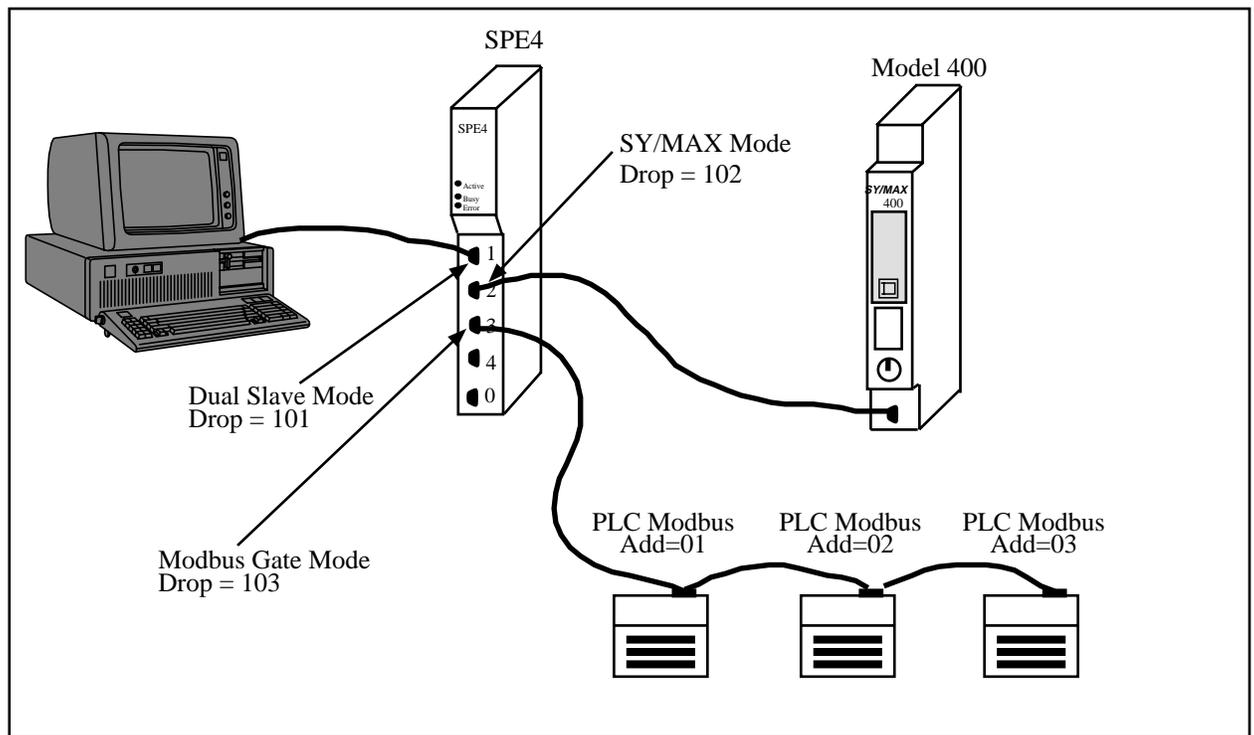
Figure 15-2 Dual Slave SMS Example

Another example application of the Dual Slave mode is displayed in Figure 15-2. The SPE4 has Port 1 in Dual Slave Mode with the PLC Programming computer connected through an NR&D SC902 cable. Port 2 is in SY/MAX mode with a Model 400 PLC. Port 3 is in Modbus Gate Mode with three Momentum PLCs. This setup allows the computer to run either the SY/MATE programming software or a Modicon programming software (Modsoft, ProWorks, Concept) without changing the cabling or SPE4 port setup.

Table 15-7   PLC Programming Example DUAL SLAVE Port

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

Table 15-8   PLC Programming Example DUAL SLAVE Port Modbus Routing

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

Table 15-9   PLC Programming Example SY/MAX and Modbus Gate Ports

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

Table 15-10 PLC Programming Example SY/MATE Settings

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

Table 15-11 PLC Programming Example Modsoft Settings

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

16

Auto-transfer and Auto-Scan

The SPE4-2x PLUS units have 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 SPE4's internal mailbox registers. The WRITE messages move information from the SPE4's mailbox registers to an external device.

NOTICE: The Auto-transfer and Auto-Scan features are **NOT** avaliable on the non-PLUS SPE4 modules including the SPE4-1D and SPE4-1S.

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 SPE4 port is the Master.

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 SPE4 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 SPE4'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 SPE4'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 SPE4'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 SPE4 includes its own Auto-Scan table. 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 SPE4 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 SPE4'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 SPE4 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 SPE4. 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 SPE4. 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 mes-

sage has a successful reply and cleared if the scan entry is disabled or an error occurs in the reply. The first Status register is for Scan entries 1 through 16, the second register is for entries 17 through 32 , and the third Status register is for entries 33 through 48.

Auto-Scan Watchdog

The Auto-Scan feature includes a watchdog option that can turn off autoscan entries in specific ports when a user-specified timer expires. This option is only available in firmware revision 19JUN01, or later. Two registers control this option: 8189 and 8190. Register 8190 is the bitmask register. The first (least significant) five bits control each of the ports. Bit one (LSB) controls port 0, bit two controls port 1, etc. When any of these bits is set high, the corresponding port is affected by the watchdog timer. The timer register, 8189, can be set by any outside device. The decimal value written will indicate the time in 10 ms increments. The time will immediately begin to count down to 0, unless a new number is rewritten to the timer register. If the timer reaches 0, all autoscans on the specified ports will be discontinued, and the status bits, if any, will be set to zero. Since this option is designed to take effect in the event of a communications loss, the affected ports will also be shut down in the event of a power cycle. When the SPE4 reboots, register 8189 will be reset to 0.

Auto-Scan Watchdog Example
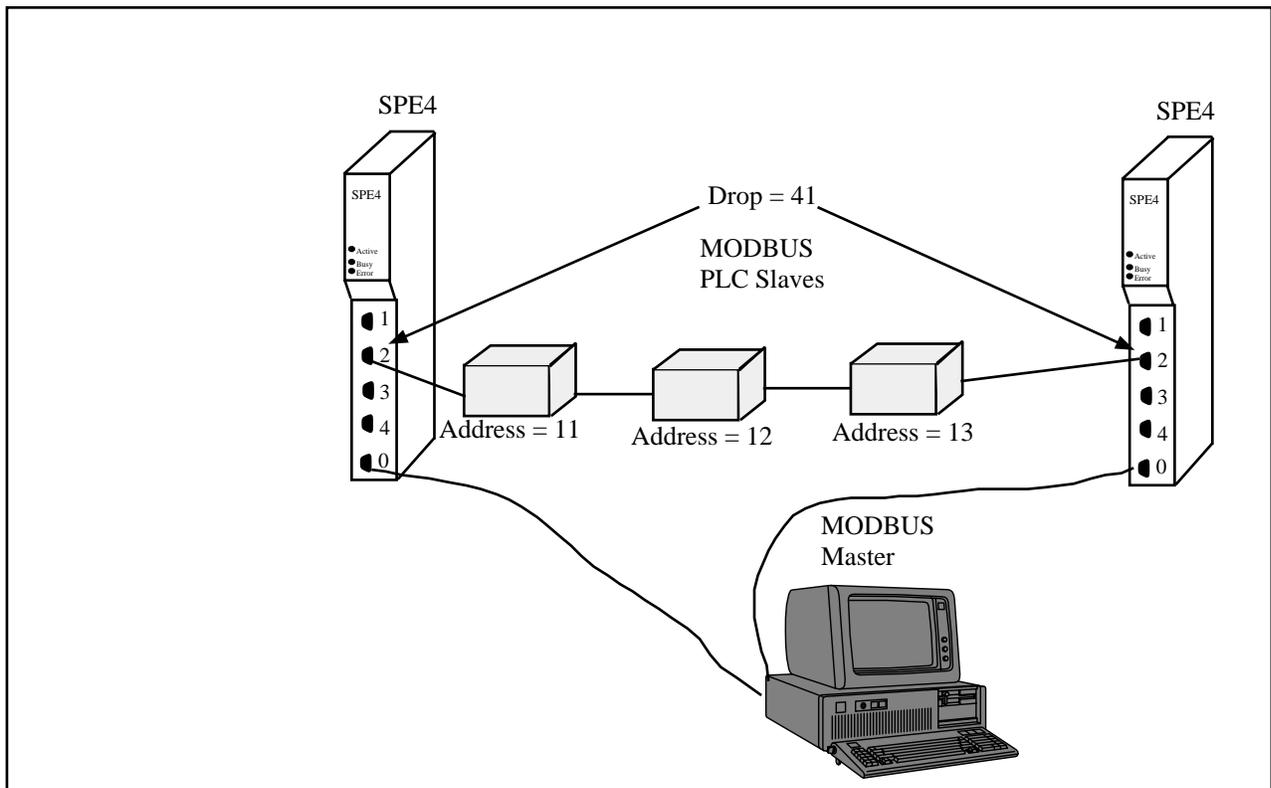
Figure 16-1 **Auto-Scan Watchdog Example**

In this example, an HMI package is monitoring registers that have been Auto-Scanned by SPE4 I. The HMI is constantly writing a decimal value of 500 to register 8189. The HMI is also monitoring the status register for the Auto-Scans. If the value of the status register is ever zero, or if the HMI loses communication to SPE4 I, the HMI must wait five seconds, then begin continuously writing decimal 500 to SPE4 II. Waiting five seconds will allow the timer in SPE4 I to run out, and there will be no conflicting queries on the serial line. As can be seen in the tables below, the Auto-Scan tables for both SPE4's are exactly the same, so only one should be Auto-Scanning at any given time.

Note: Since the Auto-Scan table uses the same routing registers as the Modbus Routing table, the programmer must be careful to select slave ID's that will be higher than the last entry in the Auto-scan table. Otherwise, the SPE4 not Auto-Scanning would reply to the master's queries.

Table 16-1 Auto-Scan Entries for both SPE4's

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

17

Configuration Software SPE4SW

SPE4SW

The SPE4SW software program is provided free of charge to SPE4 users. This software is used to configure the operational parameters of the SPE4. SPE4SW can be operated in either online or offline modes.

SPE4SW uses the SY/MAX protocol for the configuration; thus allowing remote service of the SPE4 through SY/NET, and other SY/MAX devices such as Niobrara's 2496X modems. Full support for the SY/LINK SFI-510 Network Interface Card and SFI-610 Ethernet card is also provided.

In online mode, SPE4SW 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 SPE4 module and are effective immediately.

In offline mode, SPE4SW allows a copy of the configuration to be uploaded from the SPE4 to an image in offline memory. The offline copy can be edited without affecting the SPE4 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 SPE4 need not be connected to perform most offline operations. The offline copy of the configuration parameters may be downloaded to an SPE4 module at any time.

Because the SPE4 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 SPE4SW is shown in Figure 17-1 on page 100. 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.

Figure 17-1 SPE4SW Startup Screen

If offline mode is selected, a second menu appears as shown in Figure 17-2 on page 100. 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 SPE4 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 SPE4. 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 SPE4, not the offline copy. Likewise, changes made in offline mode have no effect on a connected SPE4 until they are explicitly sent to it using the "Send memory to SPE4" function.

SPE4SW also contains several convenient utilities for general use, a SY/MAX Register Viewer, a Terminal Emulator, a Statistics Viewer, and a CTS monitor. The Register Viewer, Statistics Viewer, and CTS monitor use the same setup as the oNline and oFfline functions. The Terminal Emulator has its own setup characteristics.

Figure 17-2 SPE4SW 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 SPE4SW 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.

```
                    S P E 4   P O R T   E X P A N D E R
Niobrara R&D                                              15Jun95
                    CONFIGURATION AND UTILITY SOFTWARE
oNline              oFfline            Utility         Setup        Quit
  ┌─────────────────────┐
  │Edit port parameters │
  │edit Modbus routing  │
  └─────────────────────┘




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 17-3 SPE4SW oNline Edit Screen

The oFfline (and oNline) Edit Parameters screen is presented as a matrix of parameters, see Figure 17-3 . Each column represents one of the ports of the SPE4. The lower half of the screen will change to present the available parameters for each protocol mode. The parameters are described below.

Drop Number

This value determines the route drop number of the port. Port 0 is the only port that may have its drop number modified. The drop numbers of the rest of the ports are based from the drop number of Port 0. The drop numbers for the Ports must fall within the range 000 through 199. The default drop number for the Port 0 is 0. The default drop numbers for Ports 1 through 4 are: 1, 2, 3, 4.

Protocol

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. Note: Port 0 does not support Multidrop mode.

Baud Rate

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

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

Set to 7 or 8 to match the data bits transmitted by the connected device. The default value is 8.

Stop Bits

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

Buffer Limit

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. 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:

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 drop 205 will have the Route Appendix inserted 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 routes stripped 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 SPE4 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 Master Only) This value expressed in units of n/100 seconds determines the delay time between retries for failed transmissions from a MODBUS mode port. The default value is 100. This value is only in use when the port is operating as a Modbus Master. When the port is acting as a Modbus Slave, the timeout is determined by the connected Modbus Master and this value is ignored.

Register Bias

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

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

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

Transfer Interval

(Auto-transfer, Auto-Scan) This value determines the periodic interval between Auto-transfer or 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 SPE4 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 SPE4 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.

See **Example 1 : POWERLOGIC Remote Rack Interface** on page **147** for an Auto-transfer application.

Pt to Pt

(Peripheral, Share, Multidrop, Modbus, RNIM) Ports 1-4 of a -1D or -2D modules offers 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 Peripheral port is the master on a 4-wire multidrop network.

Four Wire

(Peripheral, Share, Modbus, RNIM) Ports 1-4 of a -1D or -2D modules offers the ability to operate on RS-485 networks in 4-wire and 2-wire modes. Four wire mode allows the transmit drivers to tri-state when CTS is not asserted. This allows the port to act as a 4-wire slave on a multidrop network. This setting has no effect on Port 0 of any SPE4, any SPE4-1S, any SPE4-2S, or SPE4-1D and SPE4-2D REV 2.0 or earlier boards.

Half Duplex

(Peripheral, Share, Multidrop, RNIM) Ports 1-4 of a -1D or -2D modules 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. This setting has no effect on Port 0 of any SPE4, any SPE4-1S, any SPE4-2S, or SPE4-1D and SPE4-2D REV 2.0 or earlier boards.

Two Wire

(Peripheral, Share, Multidrop, Modbus, RNIM) 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. 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.   This setting has no effect on Port 0 of any SPE4, any SPE4-1S, any SPE4-2S, or SPE4-1D and SPE4-2D REV 2.0 or earlier boards.

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 to a printer or text file. Pressing the F1 key will produce a window similar to Figure 17-4.
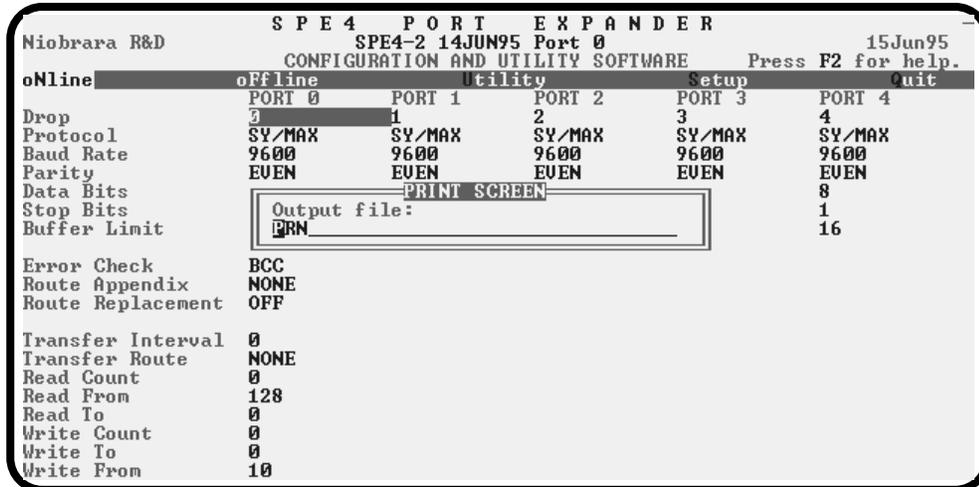
Figure 17-4 F1 Print Screen

The new window prompts for an output filename. The default is PRN which prints to the DOS default printer. If a valid DOS filename is typed into the field, SPE4SW 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 17-5. Pressing any key will return to the previous location
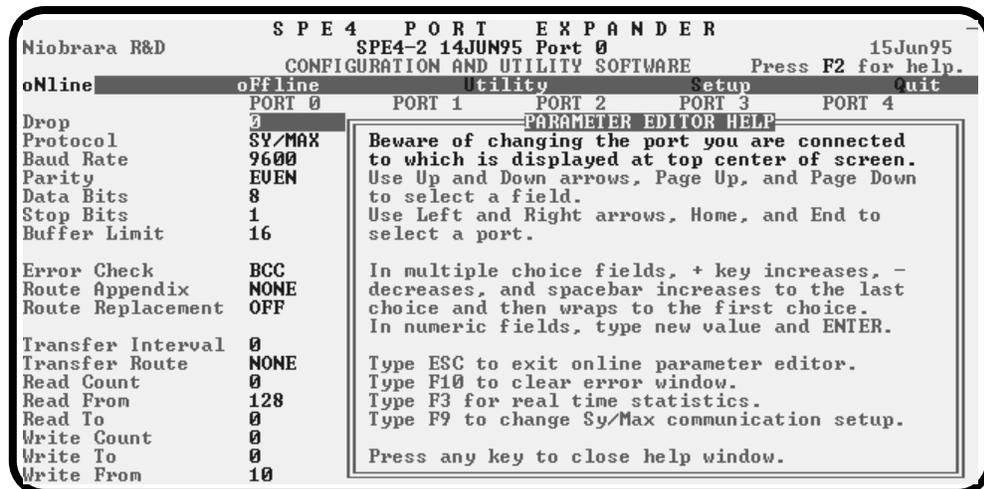
Figure 17-5 F2 Help Window

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. For additional statistical information, press Page Down.

The Statistics Registers are quite helpful for debugging an application. Each port has a group of 32 registers which are incremented when a specific action occurs, see Figure 17-6.

```
              S P E 4    P O R T    E X P A N D E R
Niobrara R&D              SPE4-2 14JUN95 Port 0              15Jun95
                        ═Statistics╕                        for help.
oN1│        PORT 0 DROP 0              │Count│ Register│     Quit
   │  Valid packets received, ACK sent    411    2049   RT 4
Dro│  Incoming packet lost because no buffer  0    2050
Pro│  Invalid packets received, NAK sent    0    2051   /MAX
Bau│  Packets generated internally          0    2052   00
Par│  Internal generations failed (No buffer) 0   2053   EN
Dat│  Packets sent and ACK received        411    2054
Sto│  Transmit not ACKed, packet lost        0    2055
Buf│  Transmit retries                       0    2056
Dri│  Packets lost because unrouteable       0    2057
Rea│  Illegal operation requests             0    2058
Wri│  Priority reads performed locally       0    2059
Ret│  Priority writes performed locally      0    2060
Reg│  Non-priority reads performed         399    2061
Tra│  Non-priority writes performed         12    2062
Tra│  Receiver parity or framing             0    2063
Rea│  Characters transmitted             31886    2064
Rea│  Characters received                 8034    2065
Rea│
Wri│  Type + or - to change port.  Z to zero.
Wri│  Page Down for more data.  ESC to exit.
Wri│
```

Figure 17-6 Statistical Screen (page 1)

Below is a list of the currently active registers for Ports 0 through 4 and the conditions which cause them to be incremented. For a complete table of these registers see page 125. When one of the error registers is incremented, the RED ERROR light on the module will be lit for one second.

- **Receipt of a packet on the port. In SY/MAX mode, the packet was valid.** This register is incremented when a packet is received from an external source connected to the port.

- **Incoming packet rejected (SY/MAX) or lost (other) because no available 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. 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. 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.

- **Invalid SY/MAX packet received and negative acknowledge 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.

- **Message 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 message failed because no available buffer.** Check CTS wiring. Check the Auto-transfer interval and possibly slow it down. (increase the value)

- **Packet transmitted (SY/MAX packet acknowledged by recipient).** A valid transmission has occurred to the attached device.

- **Transmission failed (SY/MAX retries exhausted).** 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).

- **Transmission retry.** Incremented when a negative acknowledgment or the failure of a positive acknowledgment has occurred after a transmission.

- **Message lost because of unrecognized or illegal drop or bad route.** Check the route of the sending devices routed to the port.

- **Illegal operation request for local command or translation.** Check the command being sent to the port. Effective in Gateway, MODBUS, IDEC modes.

- **Priority read received and 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.

- **Priority write received and performed.** 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 read received and 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 write received and 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.

- **Character receive error (parity, framing, etc.).** Check the baud rate, parity, data bits, and stop bits.

- **Characters Transmitted.** Incremented when a character (byte) of information is transmitted from the port.

- **Characters Received**. Incremented when a character (byte) of information is received to the port.

```
                 S P E 4    P O R T    E X P A N D E R
Niobrara R&D               SPE4-2 14JUN95 Port 0                      15Jun95
                             Statistics                             for help.
oN1          PORT 0 DROP 0                    Count  Register         Quit
        Transmit percent of capacity            55    2064      RT 4
Dro     Receive percent of capacity             17    2065
Pro     Last route received                     24    2076      /MAX
Bau                                            178    2076      00
Par                                              3    2077      EN
Dat                                              6    2077
Sto                                            ---    2078
Buf                                            ---    2078
Dri                                            ---    2079
Rea                                            ---    2079
Wri
Ret
Reg
Tra
Tra
Rea
Rea     Buffers currently in use                 1    2080
Rea
Wri     Type + or - to change port.  Z to zero.
Wri     Page Up for more data.  ESC to exit. .
Wri
```

Figure 17-7 Statistical Screen (Page Down)

- **Transmit percent of capacity.** Displays the percentage of the theoretical maximum throughput for the settings for the port. The number displayed is a timed average that is reset when the z or 0 is pressed, or when the screen is entered by pressing page down, or an external resetting of the characters transmitted statistical register. The calculation is based upon the baud rate, data bits, stop bits, parity bit, and the characters transmitted values in the module. Due to the latency between the SPE4SW polling the SPE4, it may be possible for values greater than 100 percent to be displayed shortly after clearing the timer. Since the value is averaged from the time of resetting of the characters transmitted register, a more accurate average is obtained by letting the average run for a few moments.

The percent throughput should not be allowed to approach 100 percent during normal operation. Continuous running near 100 percent does not allow for the possibility of extra messages to be routed through that port and consequently buffers will begin to back up, eventually resulting in lost messages. Use the **percent** and **buffers currently in use** statistics registers together to fine tune your system.

- **Receive percent of capacity.** Displays the percentage of the theoretical maximum throughput for the settings for the port. The number displayed is a timed average that is reset when the z or 0 is pressed, or when the screen is entered by pressing page down, or an external resetting of the characters received statistical register. The calculation is based upon the baud rate, data bits, stop bits, parity bit, and the characters received values in the module. Due to the latency between the SPE4SW polling the SPE4, it may be possible for values greater than 100 percent to be displayed shortly after clearing the timer. Since the value is averaged from the time of resetting of the characters received register, a more accurate average is obtained by letting the average run for a few moments.

  The percent throughput should not be allowed to approach 100 percent during normal operation. Continuous running near 100 percent does not allow for the possibility of extra messages to be routed through that port and consequently buffers will begin to back up, eventually resulting in lost messages. Use the **percent** and **buffers currently in use** statistics registers together to fine tune your system.

- **Last route received.** Displays the route of the last packet received from an external source on that port. Each of the eight possible drop numbers are displayed. If the route is shorter than the maximum eight drops then the fields following the last drop in the route are filled with ---. If no route is received, all fields will be ---. These values may change quickly if a port is receiving packets from multiple routes.

- **Messages in Queue.** Displays the number of messages waiting in queue to be transmitted from the port. This value will usually be 0 or 1, but may climb if the port is experiencing a bottleneck such as a low baud rate connection, high retry rate, non-responding devices, or it is a single-threaded port with multiple simultaneous accessors.

- **Buffers Currently in use.** Displays the number of buffers currently in use by the particular port. This number should remain below 3 in normal operation. If this number increases to near the buffer limit, messages may be lost when all buffers are used. When the Buffers in use climbs, check the route for a bottle neck in the communication path and if necessary, slow down the polling from that port.

MODBUS Routing

SPE4 ports in MODBUS mode are capable of operating as a MODBUS RTU Slave as well as a Master. As a Slave, the SPE4 port will respond to Modbus messages based upon a look-up table. If the entry in the look-up table is non-empty, the SPE4 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 SPE4 port will ignore the message. Each SPE4 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.

```
                    S P E 4   P O R T   E X P A N D E R
Niobrara R&D              SPE4-2 14JUN95 Port 0                    15Jun95
                    CONFIGURATION AND UTILITY SOFTWARE
oNline          oFfline              Utility            Setup           Quit
        MODBUS ROUTING FOR PORT 2, BASE DROP = 1
              DROP   DEVICE   ROUTE
               1     OTHER    12,13,1
               2     OTHER    12,204
               3     OTHER    12,14
               4     MODBUS   12,11,4
               5     OTHER    NONE
               6     OTHER    NONE
               7     OTHER    NONE
               8     OTHER    NONE
               9     OTHER    NONE
              10     OTHER    NONE
              11     OTHER    NONE
              12     OTHER    NONE
              13     OTHER    NONE
              14     OTHER    NONE
              15     OTHER    NONE
              16     OTHER    NONE
                         Use arrows to select field. Home to edit base drop.
                         Use PgUp and PgDown to select port. Escape to exit.
```

Figure 17-8 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 17-8 displays an example of this screen. This screen allows the editing of the table for each SPE4 port, the range of Modbus address that the table covers, and the entries for each of the covered addresses.

Port Number

Each SPE4 serial port has its own Modbus Slave look-up table. The Page Up and Page Down keys are used to select the SPE4 port table for editing.

Base Drop

The SPE4 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.

NOTE: On firmware 22Nov95 and later, this field is ignored by the SPE4.

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 SPE4 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 (SPE4 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 include per port. Figure 17-9 displays an example of the Auto-Scan edit screen.


```
               S P E 4    P O R T    E X P A N D E R
Niobrara R&D                                                        06Feb96
                   CONFIGURATION AND UTILITY SOFTWARE
oNline          oFfline            Utility           Setup          Quit
Port 2   Drop 12               SCANNING AUTO TRANSFER        Status 31..33
  ENTRY  LOCAL REMOTE COUNT DIRECTION  ROUTE (from Modbus Slave table)
      1      1     1    10    READ     12,1
      2     11     1    10    READ     12,2
      3     21     1    10    READ     12,3
      4            0     0    READ     NONE
      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 17-9 Edit Auto-Scan Table

Local

This value determines the mailbox register in the SPE4 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 throug 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 SPE4's mailbox. WRITE operations copy data from the SPE4'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 SPE4 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 .SPE 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 .SPE 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 .SPE 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.

```
            S P E 4    P O R T    E X P A N D E R
Niobrara R&D                                              15Jun95
                 CONFIGURATION AND UTILITY SOFTWARE
oNline           oFfline             Utility        Setup       Quit




                  ┌──────LOAD OFFLINE FROM DISK──────┐
                  │ File to read:                    │
                  │ ▉PC400..                         │
                  └──────────────────────────────────┘
[ parent ][L:       ]
 CAGMON   [M:       ]
 IPC400
 IPC650
 TXQUANT
[A:       ]
[B:       ]
[D:       ]
[E:       ]
[F:       ]
[H:       ]
[I:       ]
```
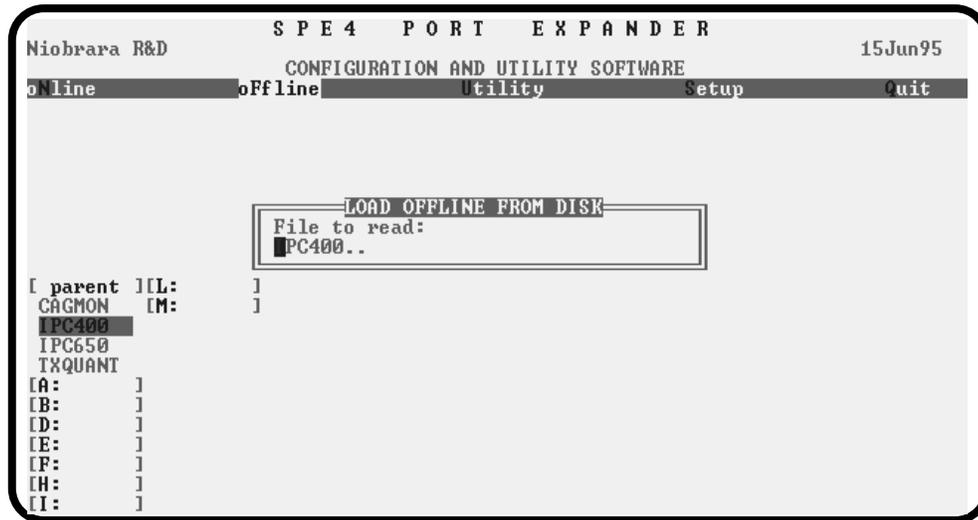
Figure 17-10oFfline Read from Disk to Memory

"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 SPE4.

"Send memory to module"

This function will send the configuration in memory to the SPE4 module by way of the SY/MAX setup parameters. In order to send the configuration to the SPE4 it is necessary for the personal computer to communicate with the SPE4. 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 SPE4 module to the offline memory for editing, printout, or saving on disk. "Send memory to the SPE4"

This function transfers all five ports' configuration parameters from offline memory to the SPE4. This function can be used to load configuration back into the SPE4 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 SPE4 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

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.

```
                    S P E 4     P O R T     E X P A N D E R
Niobrara R&D              SPE4-2 14JUN95 Port 0                    15Jun95
                    CONFIGURATION AND UTILITY SOFTWARE
REGSTR   HEX    UNSIGN   SIGNED        BINARY          STAT
    1    007B     123      123    0000 0000 0111 1011  E000
    2    0123     291      291    0000 0001 0010 0011  E000      NR&D Sy/Max
    3    ABCD   43981   -21555    1010 1011 1100 1101  E000      Register Viewer
    4    152D    5421     5421    0001 0101 0010 1101  E000
    5    0000       0        0    0000 0000 0000 0000  A000    Press F2 for Help
    6    0000       0        0    0000 0000 0000 0000  A000
    7    0000       0        0    0000 0000 0000 0000  A000
    8    0000       0        0    0000 0000 0000 0000  A000
    9    0000       0        0    0000 0000 0000 0000  A000
   10    0000       0        0    0000 0000 0000 0000  A000
   11    0000       0        0    0000 0000 0000 0000  A000
   12    0000       0        0    0000 0000 0000 0000  A000
   13    0000       0        0    0000 0000 0000 0000  A000
   14    0000       0        0    0000 0000 0000 0000  A000
   15    0000       0        0    0000 0000 0000 0000  A000
   16    0000       0        0    0000 0000 0000 0000  A000
   17    0000       0        0    0000 0000 0000 0000  A000
   18    0000       0        0    0000 0000 0000 0000  A000
   19    0000       0        0    0000 0000 0000 0000  A000
   20    0000       0        0    0000 0000 0000 0000  A000
```

Figure 17-11 View Registers

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

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

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

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

This register viewer is highly useful in that it allows easy editing of the data in the register being viewed. By pressing 0..9 in the decimal fields or 0..9, or A..F in the hex field, an editing mode is en-

tered. New data may be entered at this time. Pressing the Enter key or moving to a new field with the arrow keys will cause the new data to be written to the edited register. If the curser is located in the REGISTER column the block of registers being viewed may be adjusted by entering a new register number. To edit the binary values, press HOME when on the binary field. Move the cursor to the desired bit and enter a '0' or a '1' and press enter to accept.

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

The STAT field displays the status register associated with the data register. The STATUS field is a read only display and can not be modified by the Register Viewer. Two common values are E000 and A000. A000 is the hex representation that the PLC recognizes as a PLC OUTPUT register. E000 is for a PLC INPUT register. This allows easy recognition of registers used by the SPE4 as inputs and used by the PLC as outputs.

The SPE4-1 units do not have the ability to have their mailbox registers rack addressed, so the STAT field has no meaning. For the SPE4-1 units, the STAT field simply displays the value of the associated data register in hex.

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 17-12.

```
Type contrl-End to exit terminal.  Type F7 to begin capture to a file.
Type F9 to change terminal communication setup.
To send hex sequence, type INSERT key, enter hex codes, type ENTER.
<00><0D>
r1,20<0D>
123 291 43981 5421 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0<0D>
r1,1<0D>
123<0D>
w2,234<0D>
<0D>r1,3<0D>
123 234 43981<0D>
b1,1<0D>
1<0D>
c1,1<0D>
<0D>b1,1<0D>
0<0D>
s1,1<0D>
<0D>r1,2<0D>
123 234<0D>
Enter hex codes to send: 10 05 31 32
<10><05>12█
```

Figure 17-12 Terminal Emulator

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

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

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

Statistics Viewer

The Statistics Viewer provides the same window as pressing F3 while oNline. See **F3 Statistic Viewer** on page **109** for more information.

CTS Monitor

The CTS monitor provides the state of the Clear to Send line for Ports 1, 2, 3, and 4. In order for the module to transmit, the CTS must be ON. If CTS is OFF, check the wiring at the port and possibly jumper the CTS to the RTS lines.


```
                      S P E 4    P O R T    E X P A N D E R
Niobrara R&D                SPE4-2 14JUN95 Port 0                      15Jun95
                      CONFIGURATION AND UTILITY SOFTWARE
oNline              oFfline              Utility              Setup         Quit




                                   ┌─CTS MONITOR─┐
                                   │Port 1 CTS ON│
                                   │Port 2 CTS ON│
                                   │Port 3 CTS ON│
                                   │Port 4 CTS OFF│
                                   │Any key to exit│
                                   └─────────────┘
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 17-13 CTS Monitor Screen

SETUP

The setup menu accesses the setup parameters for the personal computer to enable it to communicate with the SPE4 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 three groups: the personal computer's COM: port, the SY/LINK SFI-510 Network Interface Card, and the SFI-610 Ethernet Interface Card.

Personal Computer COM: port

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

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

Sy/Max COM: is the default and most likely will be the one used. In this mode the personal computer will communicate through one of its COM: ports as though it were a SY/MAX device such as a PLC. The full SY/MAX protocol is supported including routing so SY/MAX COM: may be used through SY/MAX mode ports on NIMs and SPE4s with appropriate routing. This mode is to be used when a direct connection from the personal computer COM: port is made to the SPE4. 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 SPE4.

Net-to-Net COM: is used when connecting to a NIM, SY/LINK, SPE4, 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. The first drop number in the route should be that of the Gateway port. Make sure that the Highlight and Echo fields are OFF and the Control Char. is ON.

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 SPE4.

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 SPE4 has a default baud rate of 9600 and if a direct connection is made to the SPE4 this is the setting that should be made on the personal computer. If the baud rate of the port of the SPE4 has been changed this value may need to be adjusted.

```
          S P E 4   P O R T   E X P A N D E R
Niobrara R&D                                         15Jun95
               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

      ═CONFIRM═
    Write setup to startup file?
                           R&D Corporation.  All rights reserved.
```

Figure 17-14 SY/MAX Setup Screen

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

Stop bits - The stop bits are normally set to 1 but may be adjusted to 2 for some particular application. The communication ports of the SPE4 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 SPE4. Other choices are ODD and NONE.

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

SY/LINK Connection

SPE4SW 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.
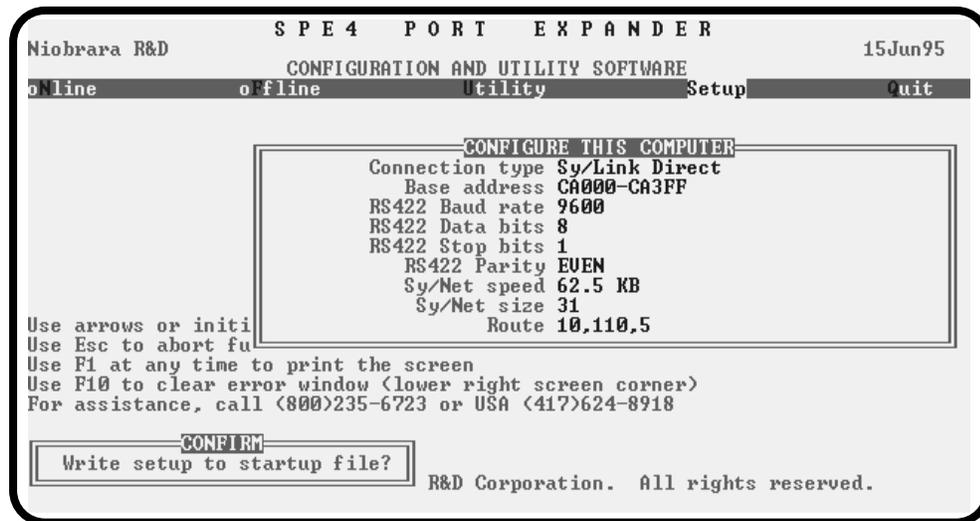
Figure 17-15 SY/LINK Setup Screen

Connection type - The RS-422 port may be set to SY/MAX or Net-to-Net modes. For a direct connection to the SPE4 from the RS-422 port of the SY/LINK card choose the Sy/Link Direct mode.   If an indirect connection from the RS-422 port of the card is made through other Net-to-Net ports choose Sy/Link Net-to-Net. If the RS-422 port is not used and the connection is make through the SY/NET network to another NIM, the choice does not matter.

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

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

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

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

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

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

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

Route - The first drop in the route defines the network address of the SY/LINK board. Since the personal computer is connected to the SY/LINK card through the edge connector of the card, port 0, the drop number must start with 0. The remaining two digits of that drop should be selected not to match any other device on the SY/NET. For instance, there are three NIMs on the network addressed 01, 02, and 03. It seems logical to make the SY/LINK card be at address 04 so the first drop in the route field will be 004. The next drop will be that of the NIM port connected to the SPE4, or another Net-to-Net port. If Sy/Link Direct was selected and the SPE4 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

SPE4SW provides support for the Square D SFI-610 Ethernet card for the personal computer. The SFI-610 must be installed and initialized using SFI610.EXE before SPE4SW is started. The only operational parameter to be configured for the SFI-610 is the Route. The first drop in the route must be the drop number assigned to the SFI610 during its configuration. The remaining drops determine the path to the SPE4.

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 SPE4 SY/MAX connection and COM2 to be used for a terminal emulator connection.

```
         S P E 4   P O R T   E X P A N D E R
Niobrara R&D                                            15Jun95
              CONFIGURATION AND UTILITY SOFTWARE
oNline          oFfline          Utility       Setup        Quit

                    CONFIGURE TERMINAL EMULATOR
                            Port COM1:
                       Baud rate 9600
                       Data bits 8
                       Stop bits 1
                          Parity EVEN




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



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

Figure 17-16 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

SPE4SW 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.SPE into an SPE4, then quits. It is assumed that the SPE4 is connected to the computer and the rest of SPE4SW setup is correct.

>SPE4SW 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 SPE4SW.STP in the batch file before calling SPE4SW.

The SPE4 configuration is controlled by writing to a set of processor equivalent registers local to the SPE4 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 SPE4SW 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 SPE4 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 SPE4SW program is a convenient interface to the module's registers.

Module Register Overview

Table represents an overview of the local registers present within the SPE4. Notice that only registers 1..2048 may be rack addressed by the PLC. All other registers must be read or written through the data ports.

Table 18-1   Module Register Overview

Register	Legal Values	Function	
1..2048	any	Mailbox registers for user applications	
2048..2208		Statistics Registers	(See Table 18-4 on Page 125)
3265..3999		Auto-Scan Tables	
4000..7199		Modbus Slave Address Look-up Tables	
2009..8000		Reserved for future use, do not modify	
8001	4	-1 Parameter register version number	(read only)
	2004 (hex)	-2 PLUS Parameter register version number	(read only)
8002	0..195	Drop number of port 0	
8003		Reserved for future use, do not modify	
8004..8163	Register Dependent	Port Control Registers	(See Table 18-8 on Page 129)
8164..8175		Reserved for future use, do not modify	
8176...8188	Register Dependent	Module Identification	(See Table 18-21 on Page 136)

Mailbox Registers

The SPE4 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, for PLUS units, these registers may be rack addressed by the PLC; therefore each of the 5 ports may read and write values directly to the PLC without using the PLC's COMM port.

The mailbox registers correspond to to the registers in the PLC by the following formula:
PLC Register = Rack Start Address + Mailbox Register - 1

The direction of data flow is determined by the SPE4. 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 SPE4 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 SPE4 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 SPE4 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 18-1. 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 SPE4 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.
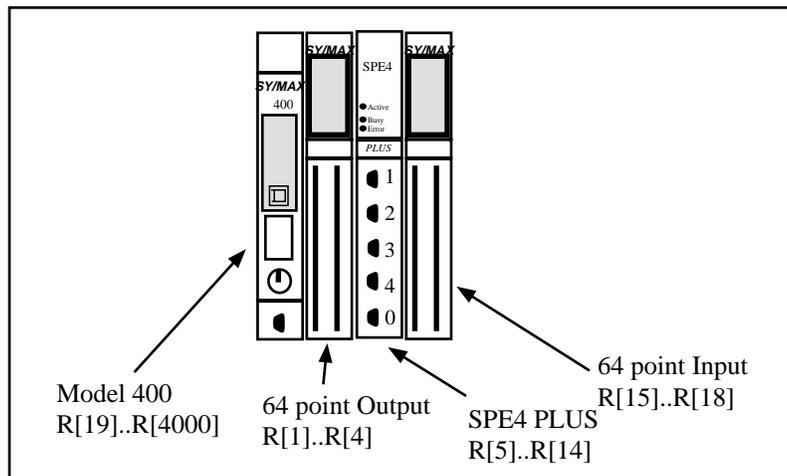
Figure 18-1 Mailbox Setup Example

The rack addressed registers within the SPE4 PLUS mailbox will correspond to the PLC registers in the Model 400 as follows:

Table 18-2   Mailbox Example Register List

PLC Register #	SPE4 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 SPE4 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 SPE4 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 SPE4. 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 18-3 after each register has been written at least once.

Table 18-3   Mailbox Example Register List after External Writes

PLC Register #	SPE4 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	SPE4
11	7	E000	SPE4
12	8	E000	SPE4
13	9	E000	SPE4
14	10	E000	SPE4

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. These are displayed in Table 18-4.

Table 18-4   Ports 1 through 4 Statistics Registers

Port 0	Port 1	Port 2	Port 3	Port 4	Incremented when the following occurs:
2049	2081	2113	2145	2177	Receipt of a packet on the port. In SY/MAX mode, packet was valid.
2050	2082	2114	2146	2178	Incoming packet rejected (SY/MAX) or lost (other) because no available buffer.
2051	2083	2115	2147	2179	Invalid SY/MAX packet received and negative acknowledge sent.
2052	2084	2116	2148	2180	Message generated internally. (translation, Auto-transfer)
2053	2085	2117	2149	2181	Internal message generation failed because no available buffer.
2054	2086	2118	2150	2182	Packet transmitted (SY/MAX packet acknowledged by recipient.)
2055	2087	2119	2151	2183	Transmission failed (SY/MAX retries exhausted).
2056	2088	2120	2152	2184	Transmission retry.
2057	2089	2121	2153	2185	Message lost because of unrecognized or illegal drop or bad route.
2058	2090	2122	2154	2186	Illegal operation request for local command or translation.
2059	2091	2123	2155	2187	Priority read received and performed upon this port.
2060	2092	2124	2156	2188	Priority write received and performed upon this port.
2061	2093	2125	2157	2189	Non-Priority read received and performed upon this port.
2062	2094	2126	2158	2190	Non-Priority write received and performed upon this port.
2063	2095	2127	2159	2191	Character receive error (parity, framing, etc.)
2064	2096	2128	2160	2192	Characters (BYTES) transmitted
2065	2097	2129	2161	2193	Characters (BYTES) received.
2066	2098	2130	2162	2194	Reserved for future use.
2067	2099	2131	2163	2195	Reserved for future use.
2068	2100	2132	2164	2196	Reserved for future use.
2069	2101	2133	2165	2197	Reserved for future use.
2070	2102	2134	2166	2198	Reserved for future use.
2071	2103	2135	2167	2199	Messages queued for single-threaded output.
2072	2104	2136	2168	2200	Number of bytes transmitted between SY/MAX checksum and ack returned.
2073	2105	2137	2169	2201	Reserved for future use.
2074	2106	2138	2170	2202	Reserved for future use.
2075	2107	2139	2171	2203	Reserved for future use.
2076	2108	2140	2172	2204	Route of last message received. Drops 1 and 2.
2077	2109	2141	2173	2205	Route of last message received. Drops 3 and 4.
2078	2110	2142	2174	2206	Route of last message received. Drops 5 and 6.
2079	2111	2143	2175	2207	Route of last message received. Drops 7 and 8.
2080	2112	2144	2176	2208	Buffers in use.

Auto-Scan Table Registers

Each serial port has registers reserved for up to 48 entries in the Auto-Scan table. Registers 3265 through 3999 along with the Modbus Slave Address Tables are used to define the Auto-Scan table.

Table 18-5   Auto-Scan Configuration Registers

Port 0 Register	Port 1 Register	Port 2 Register	Port 3 Register	Port 4 Register	Data Bytes		Description
					MSB	LSB	
3265	3410	3555	3700	3845			Status Pointer
3266	3411	5281	5921	6561	Flag	Count	Drop 1 Flags/Count
3267	3412	5282	5922	6562			Drop 1 Local Pointer
3268	3413	5283	5923	6563			Drop 1 Remote Pointer
3269	3414	5284	5924	6564	Flag	Count	Drop 2 Flags/Count
3270	3415	5285	5925	6565			Drop 2 Local Pointer
3271	3416	5286	5926	6566			Drop 2 Remote Pointer
...	...	...	...	...	...	...	...
3409	3554	5915	6555	7195			Drop 48 Remote Pointer

Modbus Slave Address Tables

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

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

The table registers occupy addresses in the 4000 through 7199 range in the SPE4.

Table 18-6   Modbus Slave Address Table

Port 0 Register	Port 1 Register	Port 2 Register	Port 3 Register	Port 4 Register	Data Bytes		Modbus Drop Numbers
					MSB	LSB	
4000	4640	5280	5920	6560	Modbus Bit 9	Number of Drops	Address Base + 1
4001	4641	5281	5921	6561	Drop 1	Drop 2	
4002	4642	5282	5922	6562	Drop 3	Drop 4	
4003	4643	5283	5923	6563	Drop 5	Drop 6	
4004	4644	5284	5924	6564	Drop 7	Drop 8	
4005	4645	5285	5925	6565	Modbus Bit 9	Number of Drops	Address Base + 2
4006	4646	5286	5926	6566	Drop 1	Drop 2	
4007	4647	5287	5927	6567	Drop 3	Drop 4	
4008	4648	5288	5928	6568	Drop 5	Drop 6	
4009	4649	5289	5929	6569	Drop 7	Drop 8	
...	...	...	...	...	...	...	...
4645	5275	5915	6555	7195	Modbus Bit 9	Number of Drops	Address Base + 128
4646	5276	5916	6556	7196	Drop 1	Drop 2	
4637	5277	5917	6557	7197	Drop 3	Drop 4	
4638	5278	5918	6558	7198	Drop 5	Drop 6	
4639	5279	5919	6559	7199	Drop 7	Drop 8	

The Modbus address base register is in the normal setup register area. (Table 18-7)

Table 18-7   Modbus Address Base Register

SPE4 Port	Modbus Address Base Register
0	8030
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 -1D 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 SPE4. Each Port of the SPE4 uses 32 registers to control its operational parameters.

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 18-8.

Table 18-8   Port Configuration Registers

Port 0	Port 1	Port 2	Port 3	Port 4	Legal Values	Function (NOTE: Auto-Transfer only on PLUS Models)
8004	8036	8068	8100	8132	0..14	Baud Rate (See Table 18-15 on Page 133)
8005	8037	8069	8101	8133	0,1	Data Bits (See Table 18-16 on Page 133)
8006	8038	8070	8102	8134	0,1,2	Parity Bits (See Table 18-17 on Page 133)
8007	8039	8071	8103	8135	0,1	Stop Bits (See Table 18-18 on Page 133)
8008	8040	8072	8104	8136	1..10	Protocol Mode (See Table 18-19 on Page 134)
8009	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 (Port 0 does not support Mode 12, 13)
8010	8042	8074	8106	8138	0..32767	Time limit (Modes 4, 5, and 8)
					0..32767	MODBUS mode retry timeout
					0..65535	RNIM CTS Delay (Port 0 does not support Mode 12, 13)
8011	8043	8075	8107	8139	0..32767	Multidrop window interval (Port 0 does not support Mode 9)
					0..32767	Auto-transfer Interval
					0..65535	RNIM Message Response Timeout (Port 0 does not support Mode 12, 13)
8012	8044	8076	8108	8140	0..200	Priority in Multidrop mode (Port 0 does not support Mode 9)
					1..2048	Auto-transfer Read Destination Register (Mailbox)
					0..65535	RNIM BID Address (Port 0 does not support Mode 12, 13)
8013	8045	8077	8109	8141	0..200	Number of nodes in Multidrop mode (Port 0 does not support Mode 9)
					1..2048	Auto-transfer Write Source Register (Mailbox)
					0..65535	RNIM Number of Retries (Port 0 does not support Mode 12, 13)
8014	8046	8078	8110	8142	0..8	Number of drops in target route (Modes 4,5,8 and Auto-transfer)
8015	8047	8079	8111	8143	0..255	Target Route Drop 1 (Modes 4,5,8 and Auto-transfer)
8016	8048	8080	8112	8144	0..255	Target Route Drop 2 (Modes 4,5,8, and Auto-transfer)
8017	8049	8081	8113	8145	0..255	Target Route Drop 3 (Modes 4,5,8, and Auto-transfer)
8018	8050	8082	8114	8146	0..255	Target Route Drop 4 (Modes 4,5,8, and Auto-transfer)
8019	8051	8083	8115	8147	0..255	Target Route Drop 5 (Modes 4,5,8, and Auto-transfer)
8020	8052	8084	8116	8148	0..255	Target Route Drop 6 (Modes 4,5,8, and Auto-transfer)
8021	8053	8085	8117	8149	0..255	Target Route Drop 7 (Modes 4,5,8, and Auto-transfer)
8022	8054	8086	8118	8150	0..255	Target Route Drop 8 (Modes 4,5,8, and Auto-transfer)
8023	8055	8087	8119	8151	1,2,3,4	MODBUS equivalent READ command
8024	8056	8088	8120	8152	5,6,15,16	MODBUS equivalent WRITE command
8025	8057	8089	8121	8153	2..16	Buffer Limit

(Continued on the Next Page.)

Port 0	Port 1	Port 2	Port 3	Port 4	Legal Values	Function (NOTE: Auto-Transfer only on PLUS Models)
8026	8058	8090	8122	8154	0..128	Auto-transfer Read Count
					0..65535	RNIM Pause Time (Port 0 does not support Mode 12, 13)
8027	8059	8091	8123	8155	0..128	Auto-transfer Write Count
					0..65535	RNIM Message Count (Port 0 does not support Mode 12, 13)
8028	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)
8029	8061	8093	8125	8157	0..32767	MODBUS Host Offset (Register Bias)
8030	8062	8094	8126	8158		Options (See Table 18-20 on Page 134)
8031	8063	8095	8127	8159	0..127	Modbus Slave Address Base
8032	8064	8096	8128	8160	0..65525	PAD Count in SY/MAX, N-T-N or CTS Delay in 10mS units for Modbus
8033	8065	8097	8129	8161	0..65535	Modbus RTU inter-character timeout in mS. (default is 4 chars.)
8034	8066	8098	8130	8162		Reserved for future use, do not modify
8035	8067	8099	8131	8163		Reserved for future use, do not modify

Some Modes of operation require several setup registers. The following tables provide a convenient reference to the registers used in these modes.

Table 18-9   Control Registers for Transparent, Share, and Gateway Modes

Port 0	Port 1	Port 2	Port 3	Port 4	Legal Values	Function
8009	8041	8073	8105	8137	0..256	Packet Size Limit
8010	8042	8074	8106	8138	0..32767	Time Limit
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
8030	8062	8094	8126	8158		Options

Table 18-10 Control Registers for Multidrop Mode

Port 0	Port 1	Port 2	Port 3	Port 4	Legal Values	Function
NA	8043	8075	8107	8139	0..32767	Multidrop window Interval
NA	8044	8076	8108	8140	0..200	Priority in Multidrop mode
NA	8045	8077	8109	8141	0.200	Number of nodes in Multidrop

Table 18-11 Control Registers for MODBUS Host Mode

Port 0	Port 1	Port 2	Port 3	Port 4	Legal Values	Function
8010	8042	8074	8106	8138	0..32767	MODBUS Host Retry Timeout
8023	8054	8087	8118	8151	1,2,3,4	MODBUS Host READ command
8024	8055	8088	8119	8152	5,6,15,16	MODBUS Host WRITE command
8029	8061	8093	8125	8157	0..32767	MODBUS Host Offset (Register Bias)

Table 18-12 Control Registers for Auto-transfer

Port 0	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 18-13 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 SPE4 also uses this value as the BID timeout.
21	8044	8076	8108	8140	BID address number	01 to 99 Single BID. 100 to 199 Automatic BIDs. 200 to 299 Continuous Single BIDs 300 to 399 Continuous Automatic BIDs.
22	8045	8077	8109	8141	Number of Retries (when no ACK received)	CRM-560 defaults to 3 on power-up.
23	8062	8094	8126	8158	Master Disable	Set bit 9 in the SPE4/EPE5 options register to disable the Master. Set the CRM-560 register to decimal 123 to disable the Master.
25	8058	8090	8123	8155	Pause Time (10mS units)	CRM-560 defaults to 15 seconds on power-up.
26	8059	8091	8124	8156	Message Count (between Pause Time)	CRM-560 defaults to 4 on power-up.
NA	8060	8092	8125	8157	BID Reply Interval	This value determines the amount of time between successive automatic BIDs.
NA	2103	2135	2167	2199	Number of messages in Command Buffer	Read Only Statistic that displays the number of queued messages waiting in the Command buffer.

Table 18-14 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 SPE4 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.

Table 18-15 Baud Rate Values

Baud Register	Baud Rate	Notes
0	50	Not Available on Port 0
1	75	Not Available on Port 0
2	110	Not Available on Port 0
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	Not Available on Port 0

Table 18-16 Data Bits Values

Data Register	Data Bits
0	7
1	8

Table 18-17 Parity Values

Parity Register	Parity
0	None
1	Odd
2	Even

Table 18-18 Stop Bits Values

Stop Register	Stop Bits
0	1
1	2

Table 18-19 Port Mode Values

Mode Valuer	Protocol	Notes:
1	SY/MAX	Connect to SY/MAX devices.
2	Net-to-Net	Connect to NIMs, other SPE4s.
3	Peripheral	Connect to Printers, Displays.
4	Transparent	
5	Share	Mode 4 with Push to Talk RTS.
6	PLogic	Use with POWERLOGIC CMs.
7	Idec	Model 50, Micro-1
8	Gateway	
9	Multidrop	Not available on Port 0.
10	MODBUS Host	MODBUS RTU Master/Slave
11	PNIM	Use with Altivar Motor Drives.
12	RNIM Master	Not available on Port 0..
13	RNIM Slave	Not available on Port 0.
14	MODBUS Gate	MODBUS RTU Master/Slave

Table 18-20 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 not 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	Reserved.	Reserved.
7	Multidrop False (TX driver enabled)	Multidrop True (TX driver dependent on CTS)
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.	Reserved.
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 is reserved in the SPE4. In EPE5 and MEB modules it 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 serial ports on Ethernet modules.

- 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.

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 18-21 provides an overview of these registers.

Table 18-21 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 SPE4-1 has a Firmware revision of 21JUN94, Registers 8177..8186 would have the values in Table 18-22.

Table 18-22 Module ID Example

Register	Values (hex)	Packed ASCII Values
8177	5350	SP
8178	4534	E4
8179	2D31	-1
8180	2032	2
8181	314A	1J
8182	554E	UN
8183	3934	94
8184	4520	O
8185	2020	
8186	2020	

<div align="right">

19

</div>

<div align="right">

Connector Pinouts

</div>

RS-422/485 data port with Handshake Lines

Table 19-1 gives the pinout for the DE9S (female) connector with slide lock posts . This connectors found on Ports 1, 2, 3, and 4 on the SPE4-1D and SPE4-2D. (See Figure 19-1) These ports are configured just as those on a Square D NIM. The RTS and CTS pairs are active and CTS must be asserted before the port will transmit. The function of RTS varies with the mode of operation and may operate in Restraint or Push-to-Talk fashion. The state (enabled or tri-stated) of the Transmit pair also varies with the Driver mode of the port.

Table 19-1   RS-422/485 port pinout.

Pin	Name	Direction	Description
1	TX-	OUT	Transmit data (inverted) from SPE4 to external device.
2	TX+	OUT	Transmit data (non-inverted) from SPE4 to external device.
3	RX-	IN	Receive data (inverted) from external device to SPE4.
4	RX+	IN	Receive data (inverted) from external device to SPE4.
5	CTS +	IN	Must be more negative than pin 7 to allow SPE4 to transmit.
6	RTS +	OUT	Driven more negative than pin 8 when SPE4 is ready to receive data.
7	CTS-	IN	Must be more positive than pin 5 to allow SPE4 to transmit.
8	RTS-	OUT	Driven more positive than pin 6 when SPE4 is ready to receive data.
9	Shield		AC coupled to chassis
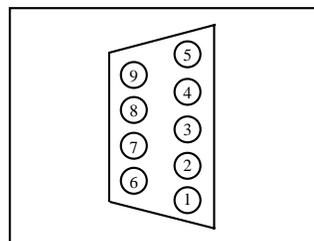
**Figure 19-1 DE9S Female Connector**

RS-422 Port 0

Table 19-1 gives the pinout for the DE9S (female) connector with slide lock posts. This connector is found on Port 0 on the SPE4-1D, SPE4-2D, SPE4-1S, and SPE4-2S. (See Figure 19-1) This port is configured just as those on a PLC. The RTS and CTS pairs are inactive and instead contain +5VDC and GND. This power may be used to power an SC406 or SC902 programming cable.

Table 19-2   Port 0 Pinout

Pin	Name	Direction	Description
1	TX-	OUT	Transmit data (inverted) from SPE4 to external device.
2	TX+	OUT	Transmit data (non-inverted) from SPE4 to external device.
3	RX-	IN	Receive data (inverted) from external device to SPE4.
4	RX+	IN	Receive data (inverted) from external device to SPE4.
5	+5VDC		+5VDC power for NR&D SC406 and SC902 power.
6	+5VDC		+5VDC power for NR&D SC406 and SC902 power.
7	GND		Logic ground and +5V return.
8	GND		Logic ground and +5V return.
9	Shield		AC coupled to chassis

RS-232 data ports

These ports are DE9P (Male) with screw lock posts.   The pin position is displayed in Figure 19-2. Ports 1, 2, 3, and 4 on the SPE4-1S and SPE4-2S have these type of ports. The pinout is the same as most 9-pin personal computer RS-232 ports and is shown in Table 19-3. The CTS pin must be pulled high to transmit and this may be accomplished by jumping it to RTS or DTR. The function of RTS varies with the port mode and may function in Push-to-Talk or Restraint fashion.
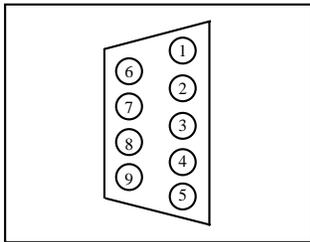
Figure 19-2 RS-232 Port Connector

Table 19-3   RS-232 Port Pinout

| Pin	Name	Direction	Description
1	CD		Carrier Detect. No connection in the SPE4.
2	RXD	IN	Receive Data. From external device to SPE4.
3	TXD	OUT	Transmit Data. From SPE4 to external device.
4	DTR	OUT	Data Terminal Ready. Pulled up to +10 VDC internally.
5	SG		Signal Ground.
6	DSR		Data Set Ready. No connection in the SPE4.
7	RTS	OUT	Request to Send.
8	CTS	IN	Clear to Send. Must be pulled high to transmit.
9	RI		Ring Indicator. No connection in the SPE4.

20

Recommended Cabling

RS-422/485 Cables

SPE4 RS-422 to SY/MAX RS-422 port (Without Handshaking)


```
            DE-9P                                    DE-9P

              1  ———————————  pair 1  ———————————  3
              2  ———————————  pair 1  ———————————  4
              3  ———————————  pair 2  ———————————  1
              4  ———————————  pair 2  ———————————  2
              5  ┐                                ┌  5
              6  ┘                                └  6
              7  ┐                                ┌  7
              8  ┘                                └  8
              9  ———————————  shield  ———————————  9
```
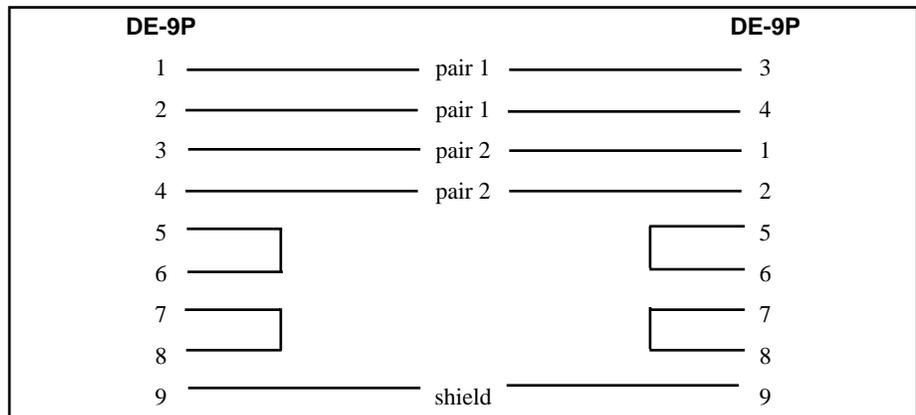
This is a Niobrara **DC1** cable. This cable is used for connecting an SPE4 port to a Square D PLC such as a Model 300, 400, 500, 600, 700 etc. This cable is also use for connecting EPE5 ports to NIMs, SY/LINK RS-422 ports, DLOGs, AIM4 Print/Prog ports, other SPE4s, EPE5s, IBSMs, RM14Ks, 2496Xs, CAM500s, and other SY/MAX ports that do not require active handshake lines.

SPE4 RS-422 to SY/MAX RS-422 port (With Handshaking)

```
  DE-9P                                              DE-9P

    1 ——————————————— pair 1 ——————————————— 3
    2 ——————————————— pair 1 ——————————————— 4
    3 ——————————————— pair 2 ——————————————— 1
    4 ——————————————— pair 2 ——————————————— 2
    5 ——————————————— pair 3 ——————————————— 6
    6 ——————————————— pair 4 ——————————————— 5
    7 ——————————————— pair 3 ——————————————— 8
    8 ——————————————— pair 4 ——————————————— 7
    9 ——————————————— shield ——————————————— 9
```
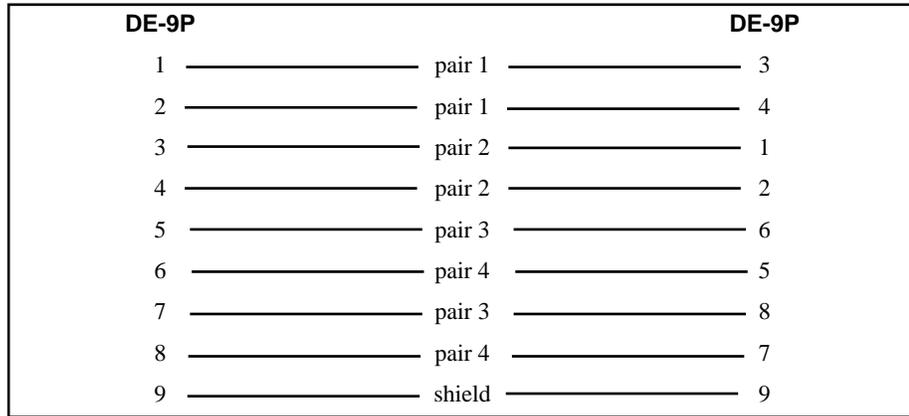
This is a DC2 cable and it is used for connecting the SPE4 to devices that require active handshaking. These devices include: modems, other NIMs, other SPE4s, EPE5s, RM14Ks etc.

> 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.

SPE4 RS-422 port to POWERLOGIC RS-485 (4-wire Multidrop Master)

```
  SPE4 RS-422 Port      Circuit Monitor Unit N       Circuit Monitor Unit 1

    1 ———————————————  IN -  ———————————————  IN -
    2 ———————————————  IN +  ———————————————  IN +
    3 ———————————————  OUT -  ——————————————  OUT -
    4 ———————————————  OUT +  ——————————————  OUT +
    5 ─┐
    6 ─┘
    7 ─┐
    8 ─┘
    9 ———————————————  SHIELD  —————————————  SHIELD
```
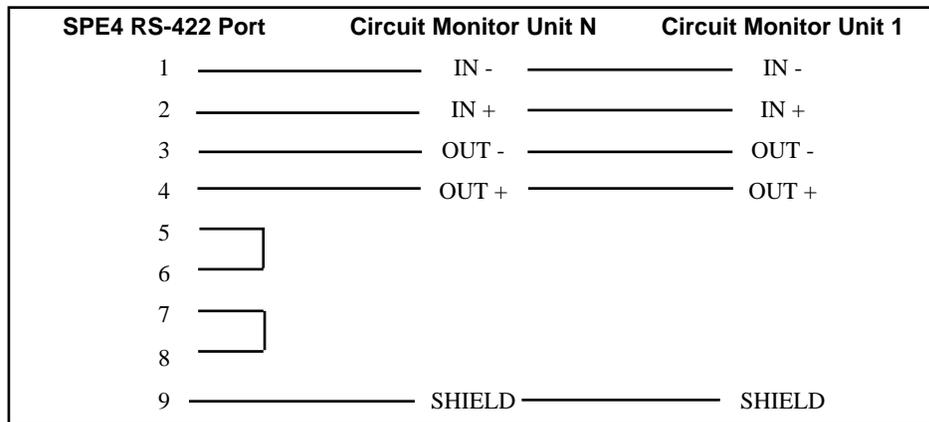
When connecting to POWERLOGIC, or any other 4-wire multidrop network, always include proper termination at the far end of the network. The SPE4's RS-485 ports have internal biasing and terminating resistor networks so there is no need for termination at the SPE4 end.

For 4-wire networks, such as the POWERLOGIC network, where the SPE4 is serving as the master, leave the Options bits for Multidrop off so Multidrop is set to FALSE. This will enable the SPE4'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 may set with the SPE4SW software by selecting Driver Mode = Pt to Pt.

Be certain to jumper the RTS/CTS pairs at the SPE4 port.

SPE4 RS-485 port to Modicon RS-485 (4-wire Multidrop Slave)

| Modbus Master		SPE4 Slave Port		Other Slave
RX (IN) -	————	1	————	TX (OUT) -
RX (IN) +	————	2	————	TX (OUT) +
TX (OUT) -	————	3	————	RX (IN) -
TX (OUT) +	————	4	————	RX (IN) +
		5		
		6		
		7		
		8		
SHIELD	————	9	————	SHIELD
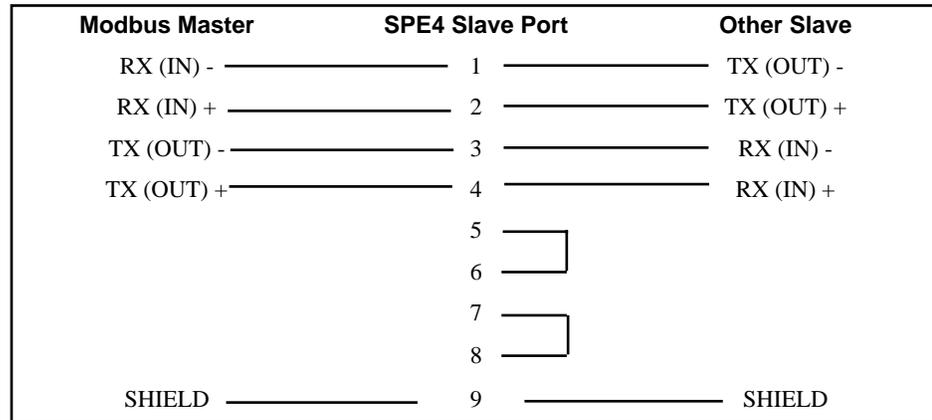
When connecting to Modicon 4-wire multidrop networks, always include proper termination at the far end of the network. The SPE4's RS-485 ports have internal biasing and terminating resistor networks so there is no need for termination at the SPE4.

For 4-wire networks, such as the Modicon network, where the SPE4 is serving as a slave, set the Options bits for Multidrop on so Multidrop is set to TRUE. This will disable the SPE4'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 may set with the SPE4SW software by selecting Driver Mode = FOUR WIRE.

Be certain to jumper the RTS/CTS pairs at the SPE4 port.

SPE4 RS-485 port to Modicon RS-485 (2-wire Multidrop)

Other Device		EPE5 Port		Other Device
-	————	1	————	-
		2		
		3		
+	————	4	————	+
		5		
		6		
		7		
		8		
Shield	————	9	————	Shield
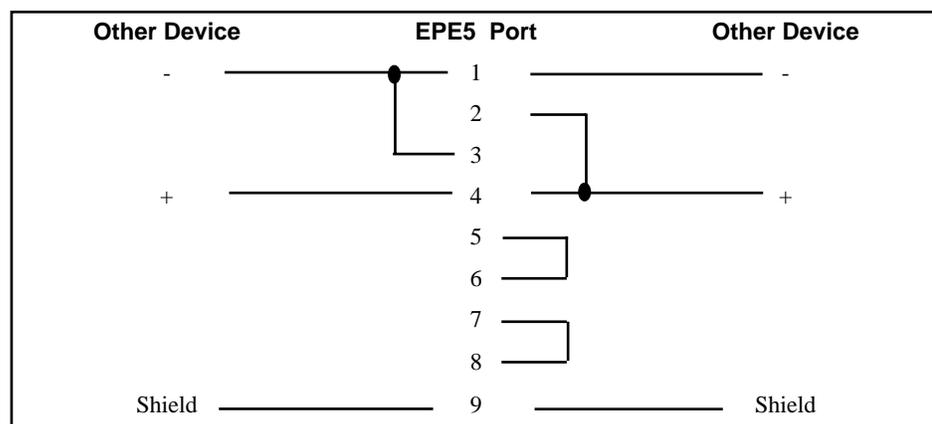
When connecting to Modicon 2-wire multidrop networks, always include proper termination at the far ends of the network. The SPE4's RS-485 ports have internal biasing and terminating resistor networks so there is no need for termination at the SPE4.

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 SPE4'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 operation. This will allow the SPE4 to not hear its own transmissions. These options may set with the SPE4SW software by selecting Driver Mode = TWO WIRE.

Be certain to jumper the RTS/CTS pairs at the SPE4 port.

Personal Computer to SPE4 RS-422 port

Use of a Niobrara SC406 or SC902 smart cable is recommended although any RS-232 to RS-422 converter, such as the Square D ICM-200, may be used.

Note: The included power supply with the SC406 or SC902 must be used when connecting to ports 1-4 of the SPE4-xD. The power supply is not needed when connecting to port 0 of either version.

The SC406 and SC902 RS-232 to RS-422 converter cables may be used whenever a single RS-232 port is required on a SPE4-xD or when another RS-422 port is needed on an SPE4-S.

It should be noted that the SC406 and SC902 do not support handshaking and that functionality of certain modes of the SPE4 may not be implemented. But in most cases this will not be a concern.

RS-232 Cables

RS-232 DTE (personal computer) to SPE4-S RS-232 port

```
DB-25P                                    DE-9S
  2  ──────────────────────────────────    2
  3  ──────────────────────────────────    3
 20  ──────────────────────────────────    8
  5  ──────────────────────────────────    7
  7  ──────────────────────────────────    5
  4  ─────────┐
  6           │
  8  ─────────┘
```
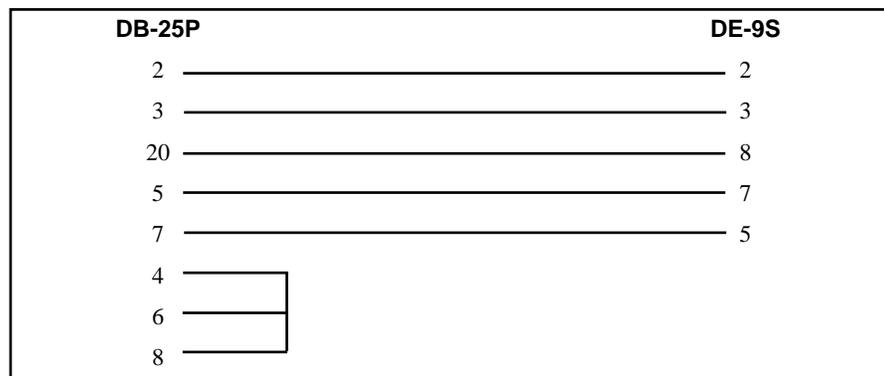
This cable allows a 25 pin personal computer COM port to be connected to a 9 pin SPE4-xS RS-232 port. This cable supports full RTS/CTS handshaking.

RS-232 DTE (personal computer) to SPE4-S RS-232 port

```
DE-9S                                     DE-9S
  2  ──────────────────────────────────    3
  3  ──────────────────────────────────    2
  5  ──────────────────────────────────    5
  7  ─────────┐                  ┌──────    7
  8  ─────────┘                  └──────    8
```
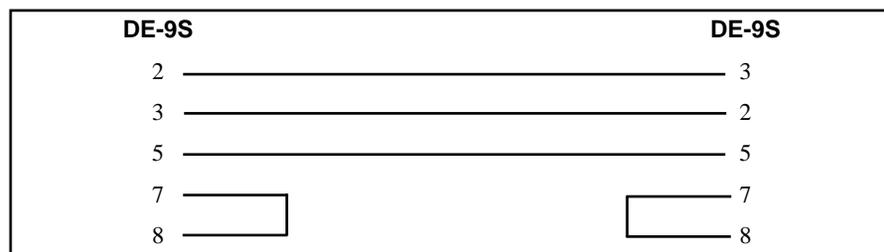
This cable allows a 9 pin personal computer COM port to be connected to a 9 pin SPE4-xS RS-232 port. This cable does not support full RTS/CTS handshaking but is the easiest to build. This cable is also used to connect a pair af SPE4-xS RS-232 ports together.

RS-232 DCE (modem) to SPE4 RS-232

DB-25P	DE-9S
2 ——————————————— 3
3 ——————————————— 2
5 ——————————————— 8
7 ——————————————— 5
20 ——————————————— 4

This cable allows a 9 pin RS-232 port of an SPE4-xS to be connected to a 25 pin port on an RS-2332 modem.

RS-232 DTE (terminal) to SPE4 RS-232 port

DB-25P	DE-9S
2 ——————————————— 2
3 ——————————————— 3
20 ——————————————— 8
5 ——————————————— 7
7 ——————————————— 5
4
6
8

21
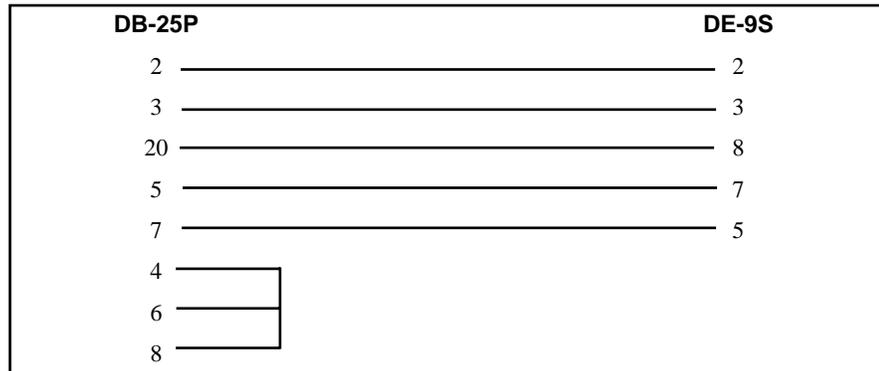
Applications

This chapter describes a few actual applications for the SPE4 and SPE4 *PLUS* modules.

Example 1 : POWERLOGIC Remote Rack Interface

The SPE4-2D may be easily used to interface POWERLOGIC Circuit Monitors (CM) to a Square-D Class 8020 PLC. The Auto-Scan READ capability of the PLUS version allows an SPE4-2D module to be able to transfer data from the CMs to the Mailbox registers without processor intervention. A section of the Mailbox registers may be rack addressed by the PLC and the CM data is then available to the PLC over the backplane. The register data will appear as PLC INPUT data in a block of registers. This type of application is very useful in multi-processor transfer interface systems, systems where it is inconvenient to run additional communication lines, or when the communication capabilities of the PLC are being overloaded.

Setup

An SPE4-2D is located in a remote rack and is connected to a Model 400 PLC via a Local/Remote Interface. A network of three POWERLOGIC CM-100s is connected to Port 2 of the SPE4 using the wiring connection on page 142. The CM are configured for 9600 baud and have a unit numbers of 1, 2, and 3. The SPE4 port is configured for 9600 baud, EVEN parity, 8 data bits, 1 stop bit, PLOGIC Mode. The drop number of Port 0 is set to 10 so Port 2 has a drop number of 12. It is desired to read the first 10 registers from each CM thus providing the live voltage and current data to the PLC. The SPE4 has been rack addressed for PLC registers 200 through 232. The first 10 registers will be the data from CM1, the next 10 register for CM2 and the final 10 registers for CM3.   Registers 230, 231, and 232 will provide the status information for the Auto-Scan. In this application, only the first three bits of register 230 will be active as only the first three Auto-Scan entries are used. These bits will be set when the appropriate CMs are responding to the scans. The Auto-Scan is set up as in figure 21-2.

Figure 21-1 Auto-Scan Example

Figure 21-2 POWERLOGIC Auto-transfer Screen

If other devices, such as a personal computer running POWERLOGIC software, are connected to other ports of the SPE4 and are accessing the Circuit Monitors, the Auto-Scan Transfer Interval may need to be increased slightly to prevent a possible throughput problem which would result in the buffers filling on the PLogic port. An inspection of the Statistical registers for the Plogic port will provide information of messages lost due to lack of buffers.

Example 2: Modbus DCS to POWERLOGIC

The SPE4 may be used to provide a gateway for devices using the Modbus RTU protocol to reach devices on the SY/NET. In this example, a distributed control system is currently installed in a factory and operates using the Modbus protocol. POWERLOGIC Circuit Monitors have been recently added to the plant. It is desired to have circuit monitor data to be available to both the Modbus DCS and to POWERLOGIC System Manager Software. The SPE4-1D provides the entire solution in one module.

Figure 21-3 displays a minimal system consisting of a single SPE4-1D, three POWERLOGIC Circuit Monitors, the DCS, and a personal computer.
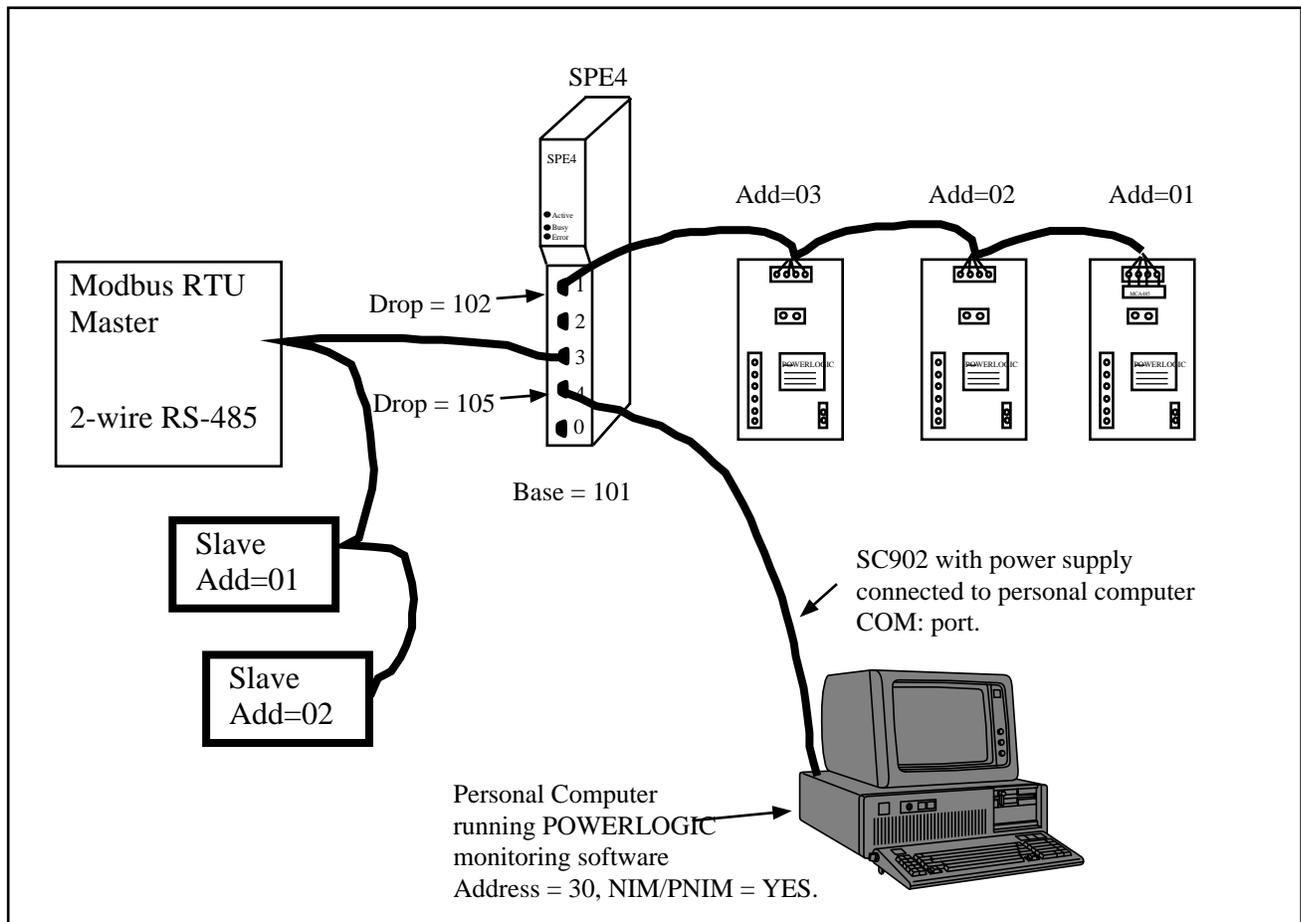
Figure 21-3 Modbus Slave, POWERLOGIC Example

Port 1

Port 1 of the SPE4-1D is in PLOGIC mode at 9600 baud, EVEN parity, 8 data bits, 1 stop bit, BCC checksum. The SY/NET drop number is 102. The POWERLOGIC Circuit monitors are multidropped from this port to form a 4-wire RS-485 network. The SPE4 port is by default in Pt to Pt device driver mode to act as the 4-wire master. The wiring of the POWERLOGIC units is shown on Page 142.

Port 3

Port 3 of the SPE4 is in MODBUS Gate mode and set to match the DCS. This port will act as a Modbus RTU Slave. The SY/NET drop number is 104. The Device Driver is in 2-wire mode for a half duplex, multidrop network. The wiring diagram for the 2-wire network connection is shown on Page 143.

There are two other slave devices on the network with Modbus address 01 and 02. The SPE4 port will be set up for Modbus Addresses 03, 04, and 05 to allow access to CMs number 1, 2, and 3 respectively. The Modbus Address Table for Port 2 will look like Figure 21-4. When the DCS needs information from CM#1, it will perform a read on Modbus Address 3. For CM#2, the read will be on Modbus Address 4 and CM#5 will be on Modbus address 5.

The register offset value for the SPE4 Modbus Slave operation is always zero. Therefore, to read SY/MAX register 1 in the CM, have the DCS perform a register read with the remote register of 1. To read register 1034 in the SY/MAX device, perform a remote read on register 1034.

```
                    S P E 4   P O R T   E X P A N D E R
Niobrara R&D                                                    15Jun95
                    CONFIGURATION AND UTILITY SOFTWARE
oNline          oFfline              Utility            Setup         Quit
       MODBUS ROUTING FOR PORT 2, BASE DROP = 3
            DROP   DEVICE   ROUTE
             3     OTHER    104,102,1
             4     OTHER    104,102,2
             5     OTHER    104,102,3
             6     OTHER    NONE
             7     OTHER    NONE
             8     OTHER    NONE
             9     OTHER    NONE
            10     OTHER    NONE
            11     OTHER    NONE
            12     OTHER    NONE
            13     OTHER    NONE
            14     OTHER    NONE
            15     OTHER    NONE
            16     OTHER    NONE
            17     OTHER    NONE
            18     OTHER    NONE
                         Use arrows to select field. Home to edit base drop.
                         Use PgUp and PgDown to select port. Escape to exit.
```

Figure 21-4 Modbus Address Table for Port 2

Port 4

Port 4 is in SY/MAX mode at 9600, EVEN parity, 8 data bits, 1 stop bit, and BCC checksum. The personal computer is connected to this port using an SC902 with the external power supply.

The System Manager Software is configured for NIM/PNIM operation with its internal drop number set to 30. The route to reach CM#1 will be 030, 105, 102, 001. The route to reach CM#2 will be 030, 105, 102, 002 and CM#3 will be 030, 105, 102, 003.

Operation

This configuration allows the DCS to read and write data in the Circuit monitors independently of the POWERLOGIC System Manager software. Both the DCS and SMS are able to communicate with the circuit monitors at the same time. The SPE4 takes care of the single-threading of the messages to the POWERLOGIC multidrop network.

Future Expansion

This layout may be easily expanded at a later date. For instance, a second personal computer may be added for additional monitoring of the Circuit Monitors. The SPE4 may also be connected to a Square D NIM in Net-to-Net mode to provide a bridge from the Modbus DCS to a plant wide network. Similarly, a Net-to-Net connection could be made to another SPE4-1D to provide more POWERLOGIC, SY/MAX, and Modbus ports. The EPE5-D module could be used to allow the DCS access to the Square D 802.3 Ethernet.

Example 3: Modbus Port Expander

In this example, a Modicon Micro PLC needs to be accessed by three RS-232 Modbus Masters. Although the SPE4 is normally considered to by a SY/MAX port expander, it will also act as a Modbus RTU port expander. Each of the ports that will act as slaves are configured to send the messages to the master port. The SPE4 will take care of single-threading the messages to the PLC. In stand alone applications, the SPE4 may be mounted and powered with the Niobrara NRK2 single slot rack and power

supply. This example is included on the distribution disk as EXAMPLE3.SPE and the oNline Edit Screen is shown in Figure 21-9.
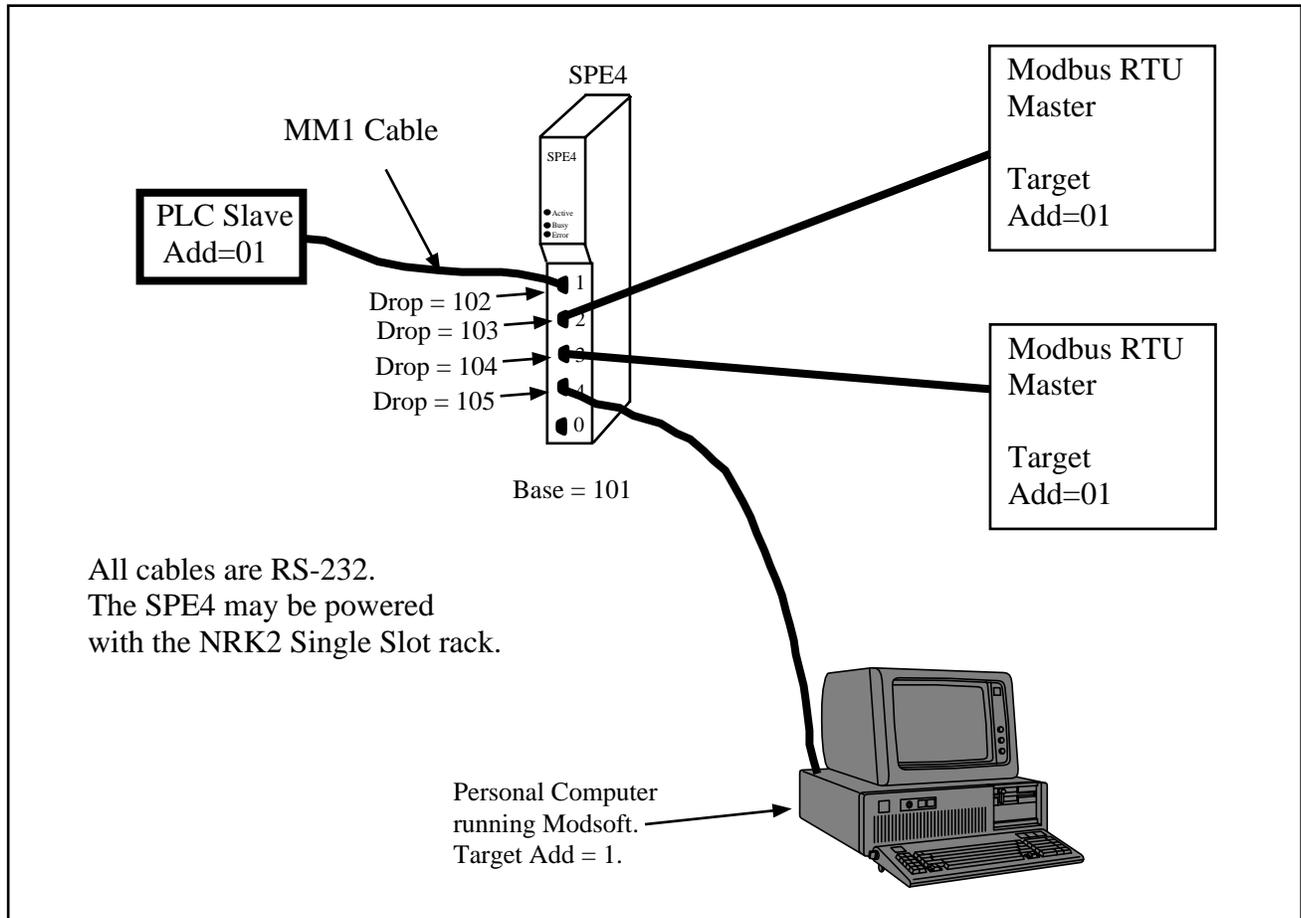
Figure 21-5 Modbus Port Expander

Port 1

Port 1 of the SPE4-1S is connected to the Modicon PLC with a Niobrara MM1 RS-232 cable. The Micro has been configured for Modbus RTU protocol and has an address of 01. The SPE4 port is configured for MODBUS Gate mode at 9600 baud, EVEN parity, 8 data bits, 1 stop bit, and Device Driver = Pt to Pt. This port will act as a Modbus master.

Port 2

Port 2 is configured for MODBUS Gate mode and will act as a slave and is configured to match the Master to which it is connected. The Modbus Address table for Port 2 is configured to respond to messages with the Modbus Address of 01. These messages are then routed to Port 1 of the SPE4 with the route 103, 102, 1. The target device is set for MODBUS. The target device is set for MODBUS. (See Figure 21-6.)

```
                         S P E 4    P O R T    E X P A N D E R
Niobrara R&D                    SPE4-1 14JUN95 Port 0                      15Jun95
                           CONFIGURATION AND UTILITY SOFTWARE
oNline            oFfline              Utility              Setup              Quit
      MODBUS ROUTING FOR PORT 2, BASE DROP = 1
         DROP  DEVICE   ROUTE
           1   MODBUS   103,102,1
           2   OTHER    NONE
           3   OTHER    NONE
           4   OTHER    NONE
           5   OTHER    NONE
           6   OTHER    NONE
           7   OTHER    NONE
           8   OTHER    NONE
           9   OTHER    NONE
          10   OTHER    NONE
          11   OTHER    NONE
          12   OTHER    NONE
          13   OTHER    NONE
          14   OTHER    NONE
          15   OTHER    NONE
          16   OTHER    NONE
                            Use arrows to select field. Home to edit base drop.
                            Use PgUp and PgDown to select port. Escape to exit.
```

Figure 21-6 Modbus Address Table for Port 2

Port 3 (Modbus Slave)

Port 3 is configured for MODBUS Gate mode and will act as a slave and is configured to match the Master to which it is connected. The Modbus Address table for Port 4 is configured to respond to messages with the Modbus Address of 01. These messages are then routed to Port 1 of the SPE4 with the route 104, 102, 1.

```
                         S P E 4    P O R T    E X P A N D E R
Niobrara R&D                    SPE4-1 14JUN95 Port 0                      15Jun95
                           CONFIGURATION AND UTILITY SOFTWARE
oNline            oFfline              Utility              Setup              Quit
      MODBUS ROUTING FOR PORT 3, BASE DROP = 1
         DROP  DEVICE   ROUTE
           1   MODBUS   104,102,1
           2   OTHER    NONE
           3   OTHER    NONE
           4   OTHER    NONE
           5   OTHER    NONE
           6   OTHER    NONE
           7   OTHER    NONE
           8   OTHER    NONE
           9   OTHER    NONE
          10   OTHER    NONE
          11   OTHER    NONE
          12   OTHER    NONE
          13   OTHER    NONE
          14   OTHER    NONE
          15   OTHER    NONE
          16   OTHER    NONE
                            Use arrows to select field. Home to edit base drop.
                            Use PgUp and PgDown to select port. Escape to exit.
```

Figure 21-7 Modbus Address Table for Port 3

Port 4 (Personal Computer)

Port 4 is configured for MODBUS Gate mode and will act as a slave and is configured to match the Personal Computer. The Modbus Address table for Port 4 is configured to respond to messages with the Modbus Address of 01. These messages are then routed to Port 1 of the SPE4 with the route 105, 102, 1. The target device is set for MODBUS.

```
          S P E 4   P O R T   E X P A N D E R
Niobrara R&D              SPE4-1 14JUN95 Port 0              15Jun95
                   CONFIGURATION AND UTILITY SOFTWARE
oNline         oFfline           Utility          Setup           Quit
      MODBUS ROUTING FOR PORT 4, BASE DROP = 1
          DROP  DEVICE   ROUTE
            1   MODBUS   105,102,1
            2   OTHER    NONE
            3   OTHER    NONE
            4   OTHER    NONE
            5   OTHER    NONE
            6   OTHER    NONE
            7   OTHER    NONE
            8   OTHER    NONE
            9   OTHER    NONE
           10   OTHER    NONE
           11   OTHER    NONE
           12   OTHER    NONE
           13   OTHER    NONE
           14   OTHER    NONE
           15   OTHER    NONE
           16   OTHER    NONE
                        Use arrows to select field. Home to edit base drop.
                        Use PgUp and PgDown to select port. Escape to exit.
```

Figure 21-8 Modbus Address Table for Port 4

```
          S P E 4   P O R T   E X P A N D E R
Niobrara R&D              SPE4-1 14JUN95 Port 0              15Jun95
                   CONFIGURATION AND UTILITY SOFTWARE      Press F2 for help.
oNline         oFfline           Utility          Setup           Quit
               PORT 0      PORT 1      PORT 2      PORT 3      PORT 4
Drop           101         102         103         104         105
Protocol       SY/MAX      MODBUS      MODBUS      MODBUS      MODBUS
Baud Rate      9600        9600        9600        9600        9600
Parity         EVEN        EVEN        EVEN        EVEN        EVEN
Data Bits      8           8           8           8           8
Stop Bits      1           1           1           1           1
Buffer Limit   16          16          16          16          16
Driver mode                PT TO PT
Read Command               4
Write Command              16
Retry Timeout              100
Register Bias              0
```

Figure 21-9 Example 3 oNline Edit Screen

Example 4: SY/MAX Port Expander

The most common use for the SPE4 is a SY/MAX port expander. In the following example, Two
PanelMate operator interfaces and a Spectrum Operator Interface (SOI) must be connected to a Model
400 PLC. It is also desirable to be able to connect a personal computer for ladder program mainte-
nance. An SPE4-1D will be used to allow all of the connections to be made to the PLC. The factory
default settings of the SPE4 are used in this example.
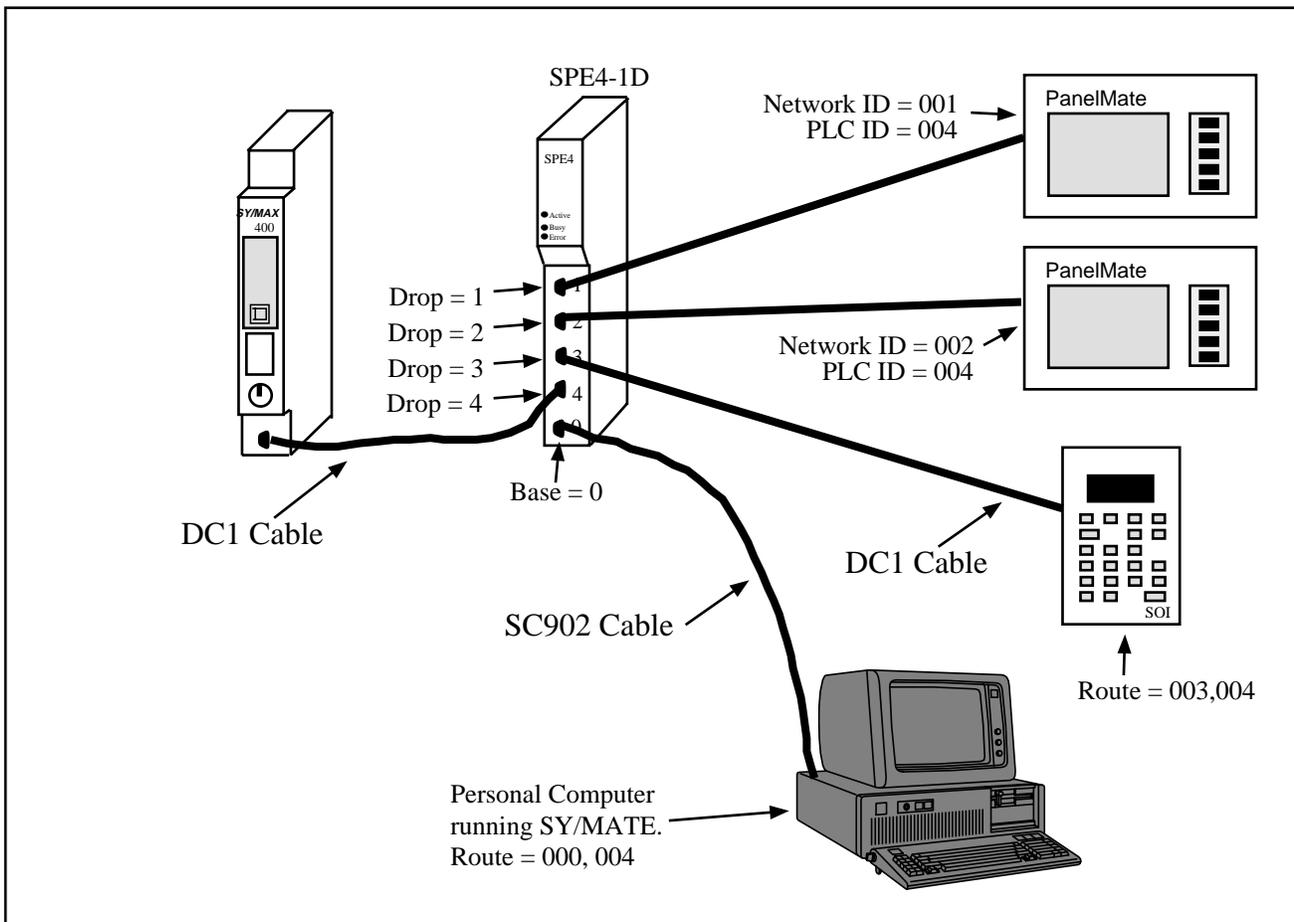
Figure 21-10SY/MAX Port Expander Example

Port 1 (PanelMate)

Port 1 is configured for SY/MAX with a drop number of 001. The baud rate, data bits, stop bits, and parity are set to match the PanelMate and in this case 9600,8,1,EVEN. The SPE4 checksum is set for BCC. The PanelMate is configured for Square D, Elect. RS422 and its Network ID# is 1. The Model 400 has its PLC ID# set to 4.

> NOTICE: The PanelMate is only capable of a two drop SY/NET route. The first drop of the route is the Network ID# and second drop is the PLC ID#.

Port 2 (PanelMate)

Port 2 is configured for SY/MAX with a drop number of 002. The baud rate, data bits, stop bits, and parity are set to match the PanelMate and in this case 9600,8,1,EVEN. The SPE4 checksum is set for BCC. The PanelMate is configured for Square D, Elect. RS422 and its Network ID# is 2. The Model 400 has its PLC ID# also set to 4.

Port 3 (SOI)

Port 3 is connected to the Spectrum SOI with a standard DC1 (CC-100 type) cable. The SPE4 port and the SOI are configured for 9600 baud, EVEN parity, 8 data bits, and 1 stop bit. The drop number of this port is 003. The SPE4 checksum is set for BCC. The SOI is configured for a route of 003, 004 to get to the Model 400.

Port 4 (Model 400)

Port 4 is connected to the Model 400 with a standard DC1 cable (CC-100 type). The SPE4 port and the Model 400 are configured for 9600 baud, EVEN parity, 8 data bits and 1 stop bit. The SPE4 checksum is set for BCC.   The drop number of this port is 004. (Note: The baud rate may be increased to 19200 for higher throughput.)

Port 0 (Personal Computer)

Port 0 is connected to the personal computer COM1: port using an SC902 cable. The SY/MATE software on the personal computer is configured to match the SPE4 port at 9600 baud, 8 data bits, EVEN parity, 1 stop bit, and BCC checksum. The drop number of this port is 000. The route is set for 000, 004 to reach the Model 400.

Throughput

It is entirely possible to set the polling rates of the PanelMates and SOI to small enough numbers to overrun the 9600 baud link to the PLC. The Square D PLCs are allowed up to 5mS at the end of each scan to service their communication ports. If more messages arrive at the PLC than can be handled within this time, the buffers of the PLC will fill. Similarly, the buffers of the SPE4 port will also start filling and this will eventually slow things down. The number of buffers in use and the percentage of theoretical throughput on each of the ports of the SPE4 may be monitored with the Statistics Sreens within the SPE4SW program. In general, the Screen Scan Delay and Alarm Scan Delays on the Panel-Mates should be set to values that provide good throughput but do not overload the PLC port.

Appendix A
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 RS232 connection was for connecting terminals to modems as shown in Figure A-1 The standard connectors were mounted on the equipment were DB25 females. Straight through cables with 25 pin male connectors were used to connect the DTE to DCE.
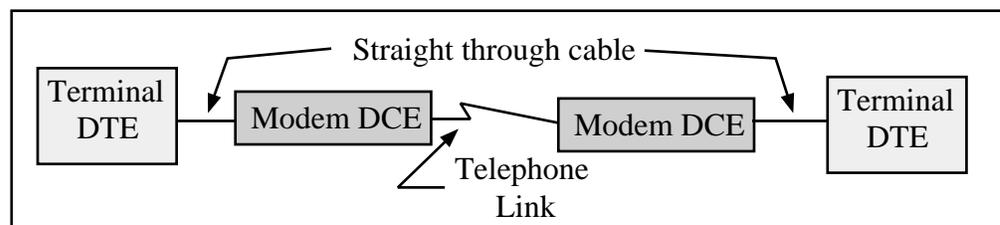
Figure A-1   DTE to Modem connection

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 DTE 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 A-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 A-2 and A-3. The only difference is pins 2 and 3.

Table A-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 A-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 A-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.
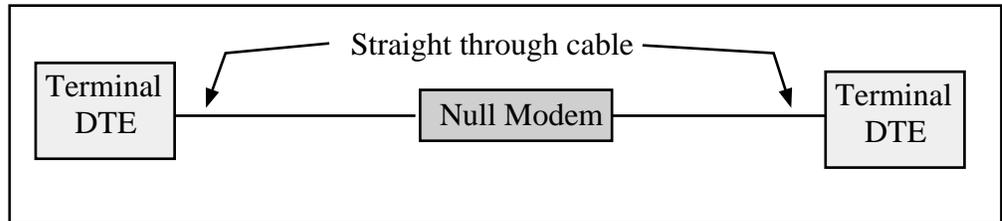
Figure A-2 Null Modem connection

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 A-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 A-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 A-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.
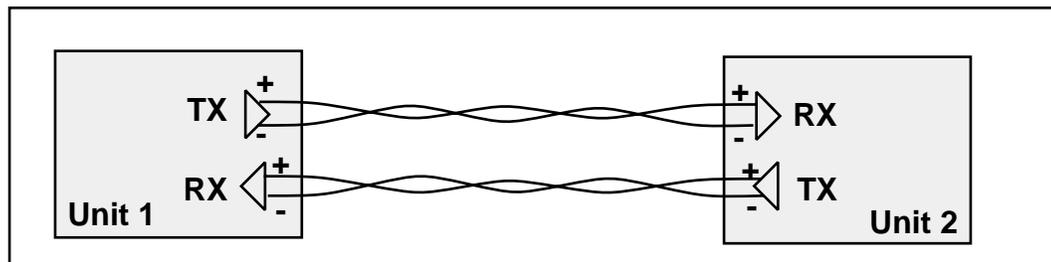
Figure A-3 RS-422 Setup

Like RS-485, the RS-422 protocol may be used in a multidrop configuration as shown in Figure A-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 A-4. Square D POWERLOGIC Circuit monitors use this type of RS-485 for communication.
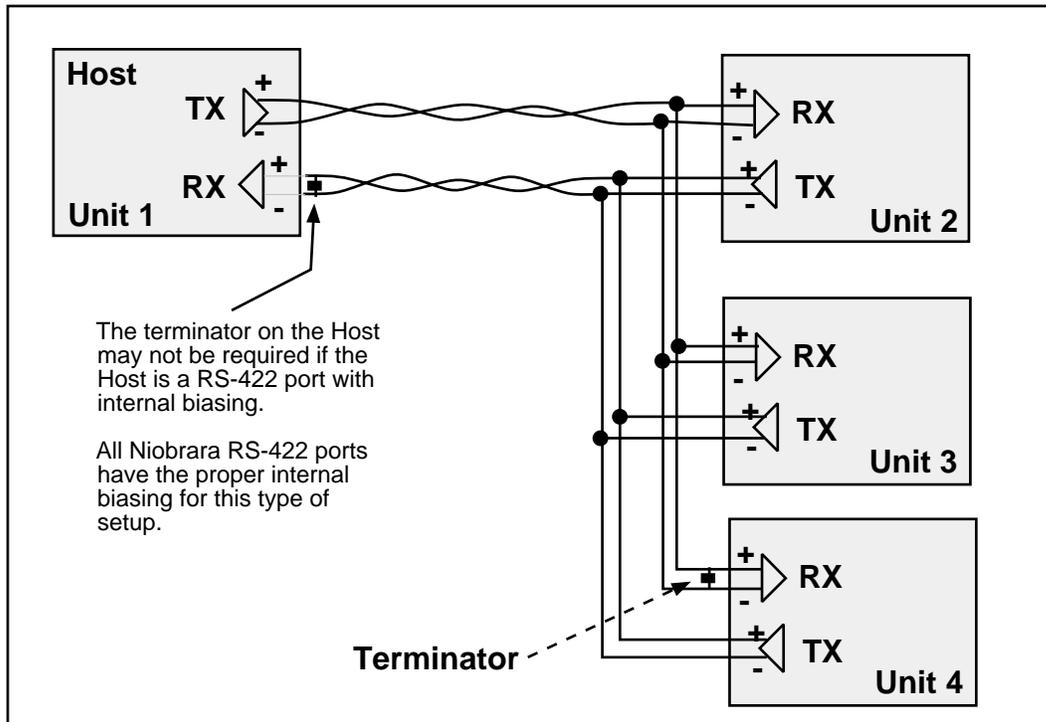

Figure A-4   RS-485 Four Wire Setup

As shown in Figure A-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 A-5.

The Allen-Bradley® Data Highway is an example of a two wire RS-485 multidrop network.
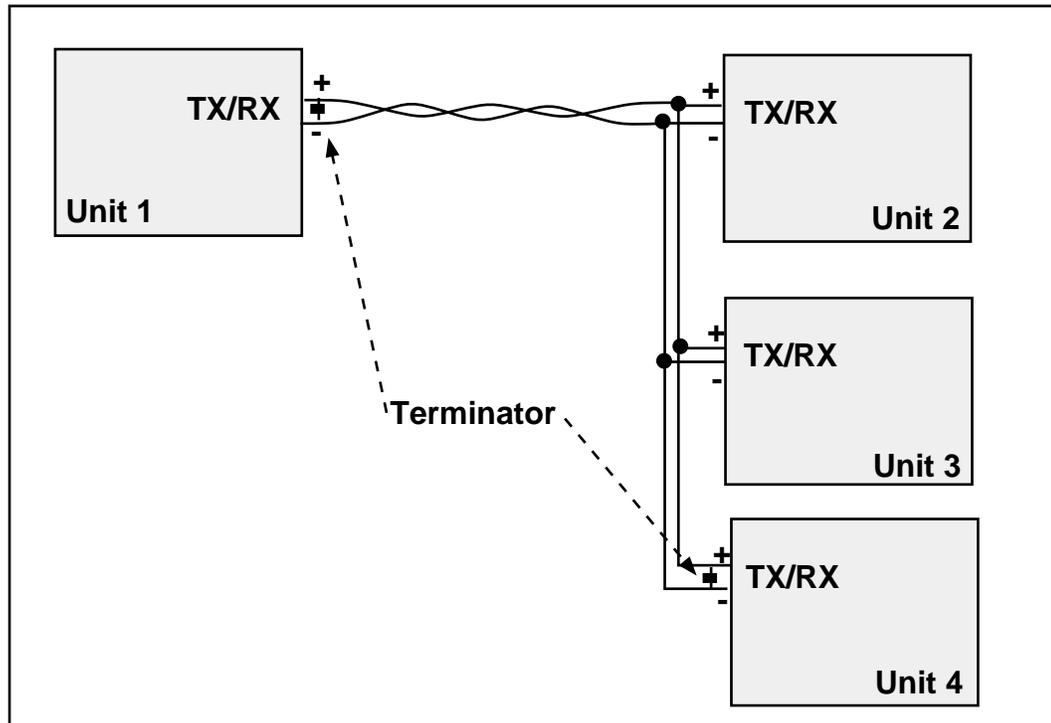
Figure A-5 RS-485 Two wire Multidrop Setup

> **Note:** Occasionally the manufacture incorrectly labels the polarity of the con-
> nections. 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 ex-
plained as simply opening a normally closed switch for the data bit transmission. The receiver is usu-
ally 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 A-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 compli-
ance voltage of the current source.

Some Red Lion Controls equipment such as the Apollo message centers use a 20mA current loop for serial communication.
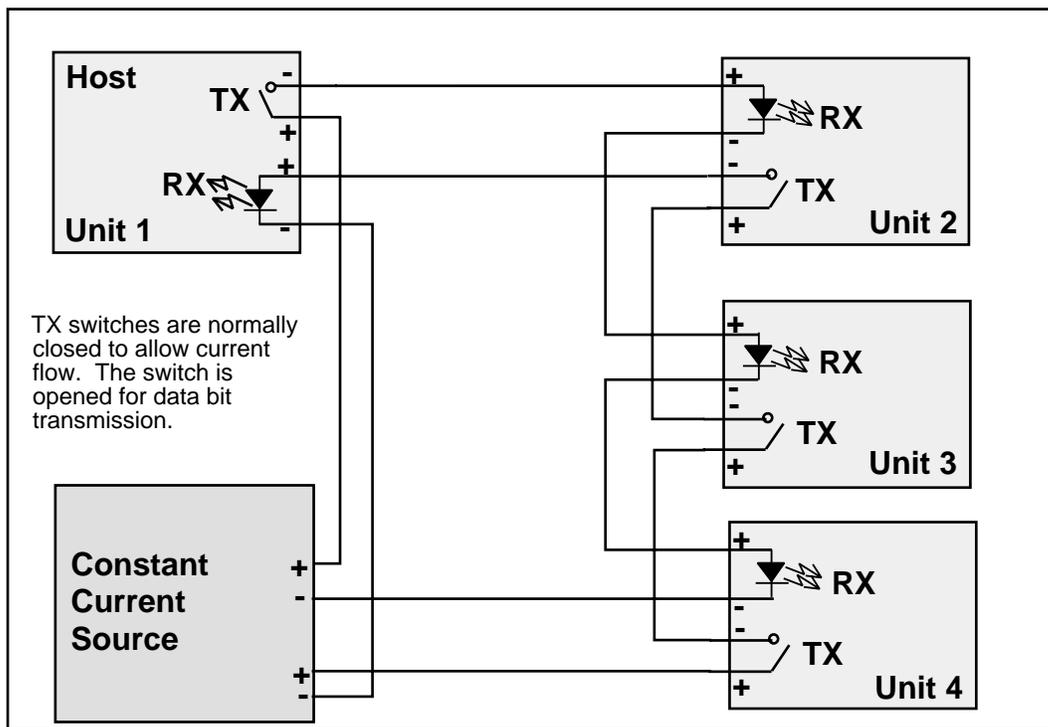
Figure A-6 20mA Current Loop (Full Duplex)

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 169.) 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 A-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 166.) 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 A-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

Appendix B
NR&D on the Internet

Niobrara is now on the World Wide Web! Visit our home page at:

http://www.niobrara.com

where you will find product information, downloadable files, and e-mail to various members of the product support team and marketing.

Technical support questions may be E-mailed to:

techsupport@niobrara.com

Marketing and sales questions may be E-mailed to:

marketing@niobrara.com

Index