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Instruction Bulletin

Subject: **SY/MAX®**
Class 8010 Type SFI-510, 533, and 534
SY/LINK Network Interface Boards

DESCRIPTION:

The SY/LINK Network Interface Board is a circuit board which mounts in a long expansion slot of an IBM Personal Computer or compatible. The SY/LINK board gives the computer direct access to the SY/NET® Local Area Network for communication with programmable controllers and other devices.

The SY/LINK board manages network communication, relieving the user program of these tasks. The board can flag the user program when a reply, alarm condition or unsolicited message is received. An additional RS-422 port is provided which allows a second device to access the network. A block of data registers is included on the SY/LINK board which any device on the network can use for storage.

Three versions of the SY/LINK board are available. The SFI-510 provides network communication, while the SFI-533 and 534 provide network communication and support two different levels of SY/MATE™ programming software.

Click here to view photo of Interface Board.

ATTENTION
This device contains static sensitive integrated circuits and is subject to damage by electrostatic discharge. Do not handle device by gold edge contacts.

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PREFACE

Introduction

It is assumed that the user of this bulletin is familiar with the components of the personal computer in which the SY/LINK board will be used. The manual or handbook supplied with the computer should be read and referred to for application information specific to the computer.

How to Use This Bulletin

The first-time user should become familiar with Sections 1 through 4 of this bulletin which provide an overview of the SY/LINK board, the SY/NET network, and installation and connection information. The Quick Start Guide (Section 2) provides a procedure for those who only wish to install the board.

Sections 5 through 9 provide information for those who wish to establish or troubleshoot network communication using the SY/LINK board.

Additional information on the SY/LINK board is included in the READ.ME file on the Demonstration/Example disk included with the board. To view this file, insert the Demonstration/Example disk, enter the command TYPE READ.ME after the DOS prompt, and press the Enter (Return) key. Press the Ctrl Num-Lock key combination to pause the display; press any key to resume.

Information on using Type SFI-533 and 534 SY/LINK Boards for programming SY/MAX Programmable Controllers can be found in Instruction Bulletins 30598-312-XX, 30598-317-XX, (with addendums for SFW-333 and 334 software.)

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1.0 INTRODUCTION TO SY/LINK

1.1 What Is It?

The Class 8010 Type SFI-510, 533 and 534 SY/LINK Network Interface Boards are printed circuit boards which mount in an IBM Personal Computer or compatible and allow the computer access to the SY/NET network via built-in protocol.

The SY/LINK board functions in a similar manner to the SY/NET Network Interface Module (NIM). While the NIM mounts in a SY/MAX programmmable controller register rack, the SY/LINK board mounts inside a personal computer. Because it mounts in the computer, the SY/LINK board allows the computer to connect to the network without the extra rack and power supply which would be required if a NIM were used.

Both the NIM and the SY/LINK board allow two devices (programmable controllers, CRT programmers, computers, printers, etc.) to connect to the SY/NET network. With the SY/LINK Board, one device is the computer and the other device connects to the board's RS-422 port. (For more information on the NIM, see Instruction Bulletin 30598-257-XX.)

The SY/LINK board also has a number of features not found in the NIM. The SY/LINK board includes a block of data registers which can be accessed by any device on the network. These registers act as a "mail box" for information being passed between the computer and other network devices. The SY/LINK board provides a simplified software interface to SY/MAX communication protocol; the user's computer program need not do all the work of building communication messages, detecting errors and handling unsolicited messages. Also, the computer can access the network at higher data rates because it communicates to the SY/LINK board through the board's edge connector rather than through an RS-422 port. The SY/LINK board does include an RS-422 port which allows a second device (in addition to the computer) to access the network.

In addition to network interfacing, the Type SFI-533 and 534 versions of the SY/LINK board support SY/MATE programming software. With this software, the computer can be used to program and monitor a SY/MAX processor or D-LOG module either by direct cable connection or over the network. The Type SFI-533 board supports Type SFW-333 software while the Type SFI-534 board supports Type SFW-333 *and* Type SFW-334 software (SFW-334 has additional functions). Board and software are sold together as the Type SYM-533 and SYM-534 packages.

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1.2 What Are Typical Applications?

With a SY/LINK board installed, a personal or industrial computer has powerful access to the data and control functions available from programmable controllers. The following are some typical applications for a computer equipped with the SY/LINK board.

SUPERVISORY CONTROL

A computer with a SY/LINK board can monitor programmable controllers on the SY/NET network. When it recognizes a need for control action, the computer can communicate instructions to the programmable controllers. For example, the computer could detect a materials shortage situation and instruct a remote programmable controller to start conveyors to move material from an alternate site.

ALARM MANAGEMENT

The SY/LINK board has three separate alarm queues. Three priorities of alarms - alerts, faults, and warnings - can be received from SY/MAX programmable controllers and interpreted by the personal computer. The personal computer can display the alarms, acknowledge the alarms, store the alarm information, or take supervisory action based on the alarms received.

PRODUCTION MANAGEMENT

SY/LINK allows a personal computer to rapidly acquire real-time production data from programmable controllers. This data can be parts counts, machine operating times, temperatures, statistical information, and other programmable controller information. Once the production data has been acquired by the SY/LINK board, the computer can prepare management reports, pass the data to another computer, or initiate real-time control action through the programmable controllers.

1.3 Specifications

1.3.1 SY/LINK BOARD SPECIFICATIONS

Mounting Requirements	1 Full Length Expansion Slot of a SY/GATE Mini-Cell Controller, IBM Personal Computer, IBM Industrial Computer, or 100% compatible computer.
Current Draw on Computer Power Supply	1.5 Amp

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Weight	0.75 lb. / 0.34 kg
Ambient Temperature Rating	
Operating	0 to 60° C
Storage	–40 to 80° C
Humidity Rating	0 to 95% non-condensing
Connectors	
Board Edge Connector	Provides computer access to SY/LINK board.
RS-422 Port	Optically isolated, 9-pin female. Provides network access for external device at up to 19.2K Baud.
High Speed (SY/NET) Port	Optically isolated, 9-pin male. Connects SY/LINK board to network.
Indicator Lights	4 LEDs: Network, Active, TX1, RX1 (see Section 3.2).
Board Configuration	DIP switches define board location in computer memory. Other functions are software-configured.

SY/LINK Compatibility With Personal Computers

The SY/LINK board has been tested for proper operation in a variety of personal computers with various microprocessors, clock speeds, and varying numbers of wait states.

Because personal computer technology is changing rapidly, a complete list of compatible computers is difficult to maintain. Therefore, compatibility between the SY/LINK board and a personal computer is defined by the timing diagrams in Figure 1.1.

In the case of a memory read, SY/LINK will present valid data to the personal computer a maximum of 170 nanoseconds after the ALE (Address Latch Enable) signal has gone low, and 205 nanoseconds after the address lines are valid.

For a memory write (personal computer writing data to SY/LINK), the address lines must be valid 170 nanoseconds prior to the rising edge of the /MEMW (Write Signal). Also, the ALE signal must be valid a minimum of 135 nanoseconds before the /MEMW is valid, and the new data must be valid a minimum of 55 nanoseconds before the /MEMW is valid.

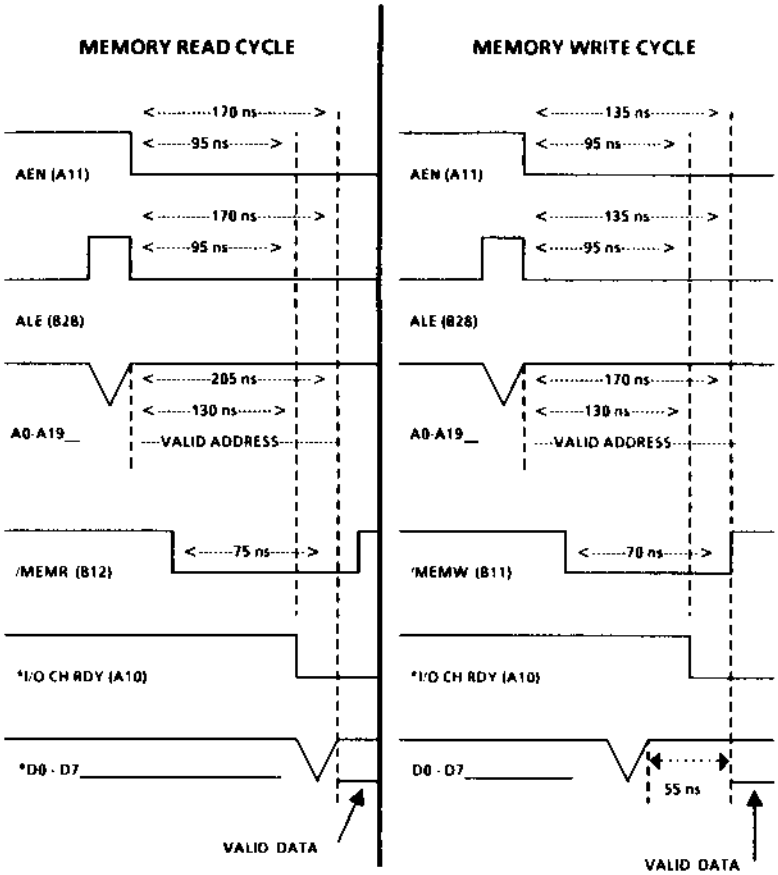
A user can compare a particular computer's clock speed and wait states for 8-bit memory access to assist in determining compatibility.

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For example, a typical 80286-based computer at 6 mHZ has a clock cycle of 167 nanoseconds. The 8-bit bus access to 8-bit devices takes 6 clock cycles, or 1,000 nanoseconds. Since SY/LINK requires only 205 nanoseconds, SY/LINK will operate properly in the example personal computer.

Be cautious if it is determined that the computer timing is close to the minimum required by SY/LINK. Each computer vendor may specify timing differently from another vendor. Each brand of computer may have differing propagation delays for the critical timing signals. If detailed questions arise, the computer vendor should be contacted to determine ultimate computer to SY/LINK compatibility.

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1. ALL TIMES ARE MAXIMUMS EXCEPT THE WIDTH OF /MEMR AND THOSE RELATIVE TO /MEMW, WHICH ARE MINIMUMS.
2. I/O CH RDY IS PULLED LOW BY THE SY/LINK CARD ONLY WHEN ITS INTERNAL ADDRESS MATCHES THAT ON THE PC BUS.

* GENERATED BY SY/LINK BOARD.

Figure 1.1 - Backplane Timing Information

1.3.2 SY/NET NETWORK SPECIFICATIONS

Network Configuration	Bus
Transmission Mode	Baseband
Network Cable	Twinaxial, Belden 9463 or equivalent
Maximum Cable Length	15,000 feet (4572 meters)

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Terminators	Required on each end of network cable.
Clock Frequency	1 megahertz
Maximum Transmission Speed	500,000 Baud
Transmission Type	Manchester encoded HDLC
Message Format	Packet type similar to ANSI 3.28.
Network Controller	Floating master
Collision Avoidance	Token passing, based on time windows.
Priority	Based on interface number (lowest number has highest priority).
Error Checking	CRC (cyclic redundancy code) on all network transmissions.
Message Routing	Source/destination message routes placed in command for each device initiating communication.
Number of Devices	200 devices per network maximum.
Expansion	Net-to-net linking, standard, virtually unlimited.

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2.0 QUICK START GUIDE

2.1 Unpacking

After unpacking, ensure that the following items are included and free of damage:

1 Class 8010 SY/LINK Board (Type SFI-510, 533, or 534)
1 Network Connection Cable (part # S30600-162-50)
1 Class 8010 Type CC-100 9-Pin Differential Communication Cable
1 Demo/Example Disk 5 1/4 inch (part # S30600-519-50)
1 Demo/Example Disk 3 1/2 inch (part # S30600-519-51)

When ordered as a Type SYM-533 or 534 package, the Type SFI-533 and 534 boards will also come with SY/MATE software disks and manual.

2.2 Board DIP Switch Settings

Mounted on the SY/LINK board is a DIP switch package with four individual switches. See Figure 2.1. These switches must be set to tell the computer which memory addresses to use for SY/LINK board functions.

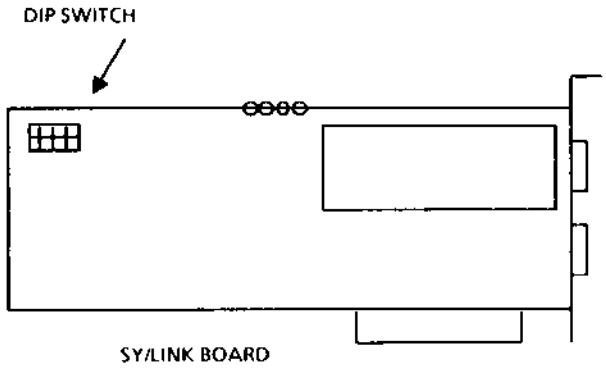


Figure 2.1 - DIP Switch Location

The label on the side of the board (see Figure 2.2) lists switch settings for various memory address ranges. Each range is a 4K block of which the SY/LINK board uses the lower 1K. The other 3K is available for other purposes. The setting for each switch is given as a "1" or a "0". A "1" represents a switch setting of CLOSED or ON

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(depending on how the DIP switch itself is labeled). A "0" represents a switch setting of OPEN or OFF.

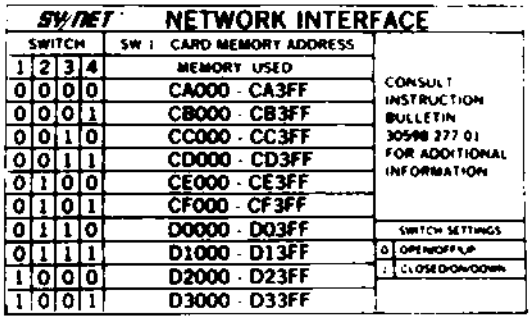


Figure 2.2 - DIP Switch Setting Label

The memory address range selected will depend on which ranges are not being used by other boards in the computer. In general, use the lowest memory range (CA000-CA3FF, switch setting "0000") unless you know this range is being used by another board. If multiple SY/LINK boards are used in one computer, each board must be assigned a separate memory range.

2.3 Installing the SY/LINK Board

Once the DIP switch for memory range is set, the SY/LINK board may be installed in the computer. Use the following procedure:

1. Remove all power to the computer.

2. Remove the cover of the computer to provide access to the expansion board slots. (Refer to computer manual for procedure.)

3. Remove the protective cover plate from the slot in which the SY/LINK board is to be mounted. Save the screw. A long expansion slot is required.

4. Take the SY/LINK board from its anti-static bag. Do not handle the board by its gold edge connectors. This can cause damage to static-sensitive devices on the board.

5. Holding the board by its upper corners, position the board in the guides of the expansion slot and press the board firmly into place in the slot's edge connector.

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6. Using the cover plate screw, fasten the board's metal retaining bracket to the frame of the computer. See Figure 2.3.

Click here to view graphic.

Figure 2.3 - Installing the SY/LINK Board

7. Replace the cover of the computer.

8. Plug the network connection cable into the SY/NET port of the SY/LINK board. Screw in the connector retaining screws to firmly attach the cable connector to the board. Figure 2.4.

9. Connect the network connection cable to the network cable. The network connection cable can be attached directly to a "Tee" connector on the network cable or to an extension cable (such as the Type CC-201 or CC-202) which leads to the "Tee" connector. See Figure 2.5.

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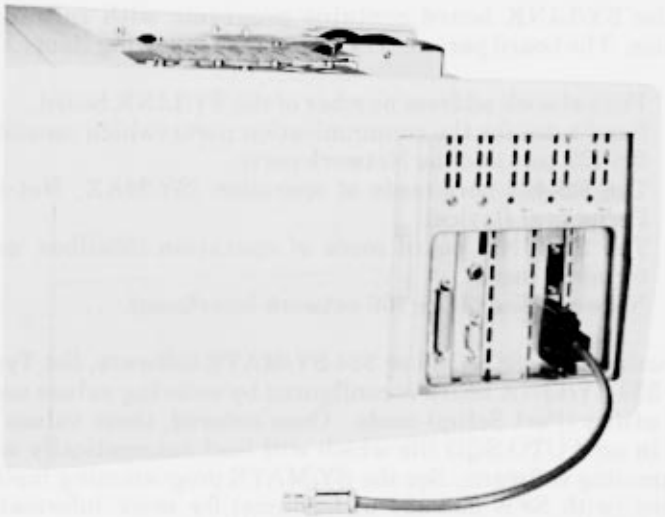


Figure 2.4 - Attaching the Network Connection Cable

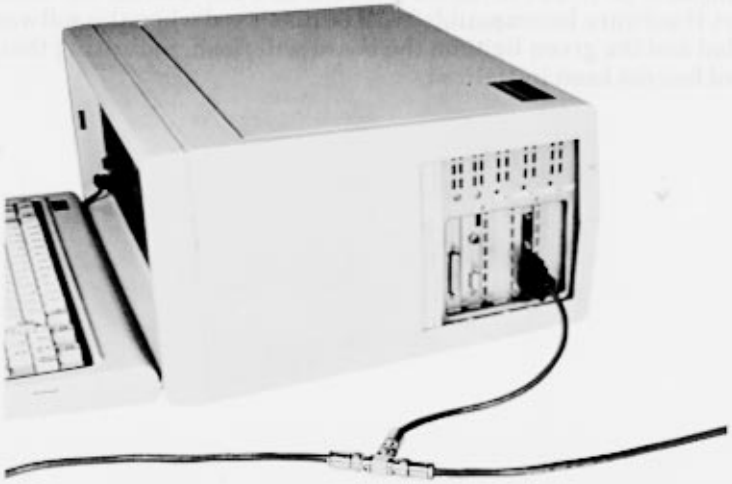


Figure 2.5 - Attaching Network Connection Cable to Network Cable

2.4 Board Configuration

Before it can communicate on the network, the SY/LINK board communication parameters must be set by the user program. Section 6 discusses these parameters. The sample program disk provided

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with the SY/LINK board contains programs with initialization examples. The board parameters include the following items:

- The network address number of the SY/LINK board.
- Baud rates for the communication ports (which consist of the RS-422 port and the Network port).
- The RS-422 port mode of operation (SY/MAX, Net-to-Net, Peripheral Device).
- The SY/LINK board mode of operation (Mailbox mode or terminal mode).
- Network Size (31 or 100 network interfaces).

When using Type SFW-333 or 334 SY/MATE software, the Type SFI-333 or 334 SY/LINK board is configured by entering values using the initial utility (Port Setup) mode. Once entered, these values can be stored in an AUTO.SQD file which will load automatically with the programming software. See the SY/MATE programming instruction bulletins (with SFW-333/334 addendums) for more information on using Type SFW software with the SY/LINK board.

If the programming software is incompatible with the board (for example, if SFW-334 is loaded with the SFI-333 board), the message "Port Hardware Incompatible" will be displayed when the software is loaded and the green light on the board will flash, indicating that the board has not been initialized.

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3.0 SY/LINK BOARD DESCRIPTION

3.1 General

The SY/LINK board is a printed circuit board that mounts in a full length expansion slot of an IBM personal computer or compatible. It has indicating lights, communication ports, and DIP switches which are described in the following sections.

Click here to view graphic.

Figure 3.1 - SY/LINK Board (side view)

3.2 Indicating Lights

The SY/LINK board has four light emitting diode (LED) indicating lights which provide information about the operation of the board. The LEDs are designated Network, Active, TX1 and RX1, and are located as shown in Figure 3.2.

The meanings of each LED are as follows.

Network - This yellow LED illuminates to indicate activity on the network. Typically, this light is very dim. As more and more devices communicate over the network, the Network light glows brighter.

Active - This green LED indicates the operational status of the SY/LINK board. When the board is powered up, the Active light will flash until the board is initialized at which time the light will glow steadily. When the Active light flashes, it indicates one of the following conditions: A.) the user has issued a reset, B.) a hardware error has been detected while the diagnostic program is being run, or C.) a RAM error or PROM checksum error has been detected on power-up.

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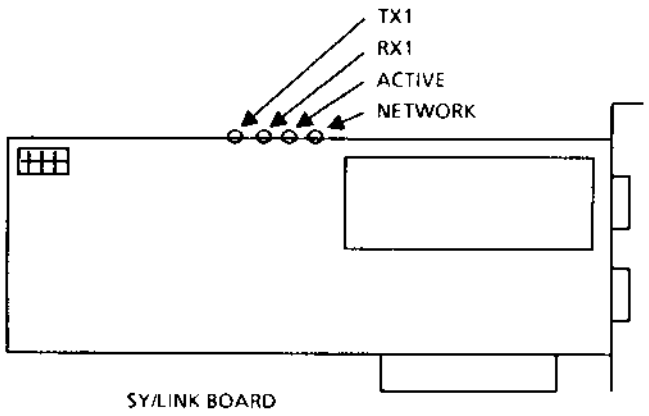


Figure 3.2 - Indicating Lights

TX1 - This yellow light flashes to indicate when the board is transmitting data to the device connected to the RS-422 port.

RX1 - This yellow light flashes to indicate when the board is receiving data from the device connected to the RS-422 port.

See Section 8 Troubleshooting for more information on the indicating lights.

3.3 Communication Connectors

The SY/LINK board has two communication ports for cable connections and the board edge connector which is the communication link between the board and the computer. See Figure 3.3.

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Click here to view graphic.

Figure 3.3 - SY/LINK Communication Connectors

RS-422 (COMM) Port - This 9-pin, D-type female connector allows a device other than the computer (for example, a SY/MAX programmable controller) to access the network through the SY/LINK board. This port can be configured for different modes of operation (SY/MAX, Net-to-Net, Peripheral Device - see Section 6.3) and for different Baud rates (110 to 19.2K baud - see Section 7.2.1). A terminal mode is also available which allows the computer to act as an ASCII terminal for a device (such as a D-LOG module) connected to the RS-422 port .

SY/NET Port - This 9-pin, D-type male connector is used to connect the SY/LINK board to the SY/NET network cable. This is done via the network connector cable which plugs into the SY/NET port on the board and into a "Tee" connector on the network cable. See Section 4.3.4 for more information.

Board Edge Connector - The computer communicates to the SY/LINK board through the board's edge connector. The computer can access the network at higher speeds through the edge connector than would be possible through a serial port.

3.4 DIP Switch

Mounted on the SY/LINK board is a DIP (Dual In-line Package) switch unit having four individual switches. These switches are set to determine which address range in the computer's memory is assigned to SY/LINK board functions. The switch settings for each

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range are shown on the label on the side of the SY/LINK board. See Section 2.2 for more information.

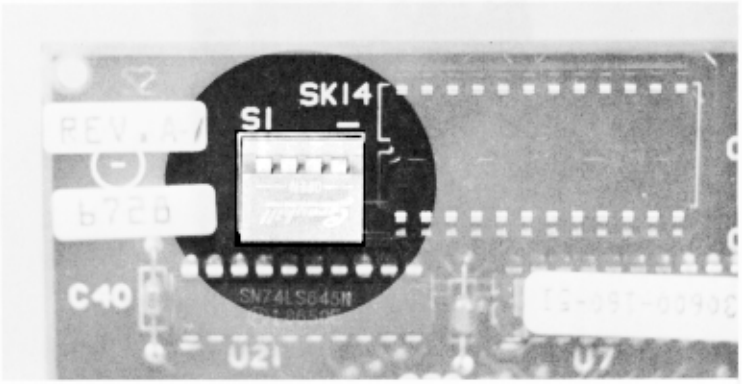


Figure 3.4 - DIP Switch

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4.0 NETWORK CONFIGURATION AND CONNECTIONS

4.1 Introduction

The following sections will first present general information about the SY/NET network. Then information on how to connect the SY/LINK board to the network will be given.

4.2 SY/NET Network Configuration

The SY/NET Local Area Network is a high speed industrial communication system which allows up to 200 devices to intercommunicate. The network has a bus configuration with a single twinaxial cable serving as the network communication pathway. See Figure 4.1.

Programmable controllers and other devices such as computers, printers, D-LOG modules, and CRT programmers are connected to the network through SY/LINK boards or Class 8030 Type CRM-510 SY/NET Network Interface Modules (NIMs).

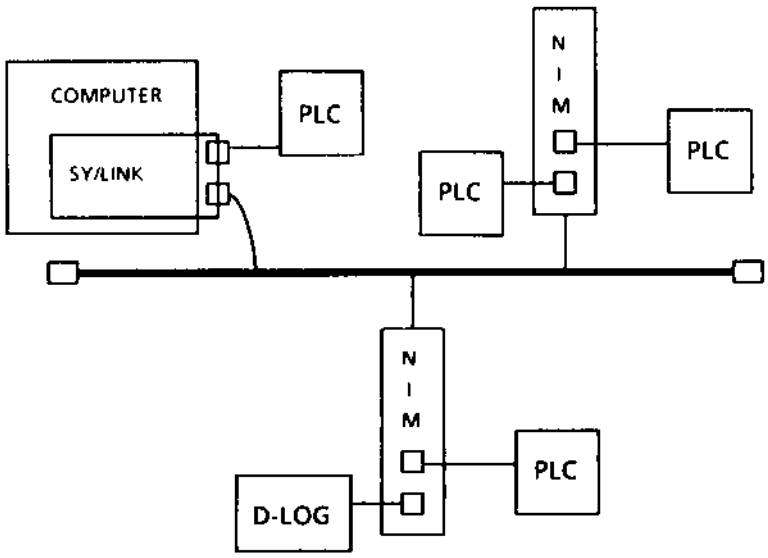


Figure 4.1 - Typical SY/NET Network Configuration

A maximum of 100 network interfaces (NIMs or SY/LINK boards) can be connected to a single network. Each interface can connect two

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devices to the network. Therefore, a network can have a maximum of 200 devices. However, even more devices can communicate by connecting multiple networks together.

The SY/NET Network Interface Module mounts in a register slot of a SY/MAX programmable controller I/O rack assembly. The NIM has a two digit thumbwheel for setting a network address number between 00 and 99. This address number not only identifies the NIM module (and the devices connected to it) but also sets the communication priority that the NIM module has in relation to other NIMs on the network.



Figure 4.2 - Network Interface Module

The NIM has two RS-422 COMM ports to which the programmable controllers or other devices are connected. The two ports are numbered 0 and 1. These port numbers are combined with the NIM address number to identify the devices for network communication. For example, the device connected to port 1 of NIM 55 would be identified by the number 155 in the route portion of network communication commands. The device connected to port 0 of the same module would have the number 055. (See Section 9.2.1 for a discussion of network route instructions.)

On the bottom of the NIM module is a high speed, network port to which the network cable is connected. This port is connected directly to a "Tee" connector on the network cable (see Figure 4.2) or to an extension cable which leads to a "Tee" connector.

Like the NIM, the SY/LINK board also allows two devices to be connected to the network. One device is the computer in which the

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board is mounted, a second device can be connected to the RS-422 port on the SY/LINK board. See Figure 4.1.

Like the NIM, a number between 00 and 99 is assigned to each SY/LINK board as an address and communication priority. The network address of the SY/LINK board is set by the user program. The board's edge connector is considered port 0 and the RS-422 port is considered port 1. Therefore, if the SY/LINK board is given an address of 28, the computer will have the number 028, and the device connected to the RS-422 port will have the number 128.

For network-to-network communication, a COMM port on one network is connected to a COMM port on another network using a CC-100 series differential communication cable. The two COMM ports involved in the net-to-net connection must have the same address number. For example, port 007 on network 1 must be connected to port 007 on network 2. See Figure 4.3. The two ports must also be set for the same baud rate. See Section 9.2.2 for a discussion of the routing necessary for net-to-net communication commands.

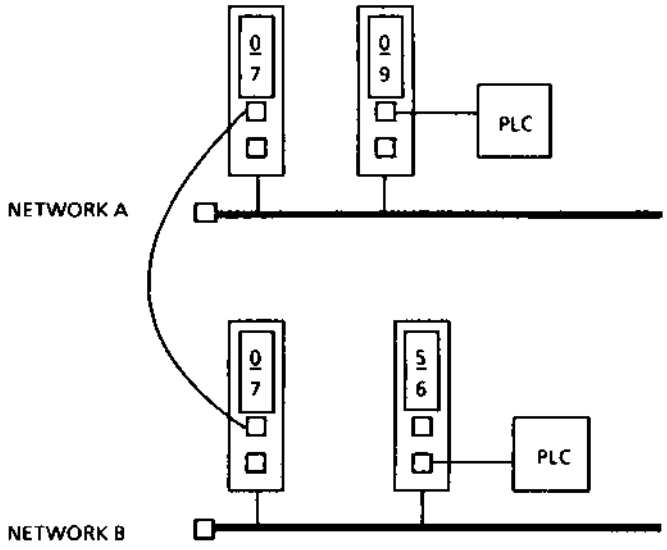


Figure 4.3 - Network-to-Network Configuration

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4.3 SY/NET Network Connections

4.3.1 COMM (RS-422) PORT

The COMM port on the SY/LINK board (and NIM) utilize RS-422 signal levels.

The following signals are available at the SY/LINK Board COMM port.

Pin Number	Function	Direction
1	Transmit Data –	Out
2	Transmit Data +	Out
3	Receive Data –	In
4	Receive Data +	In
9	Shield	

4.3.2 SY/LINK BOARD TO SY/MAX DEVICE

To connect the RS-422 port on the SY/LINK board to a SY/MAX family device, a Class 8010 Type CC-100 series cable is required. This cable can be purchased in several lengths (a CC-100 cable is included with the SY/LINK board):

Class	Type	Length
8010	CC-100	10 feet (3 meters)
8010	CC-101	30 feet (9.1 meters)
8010	CC-102	2 feet (0.6 meter)

When an application requires a cable length longer than 30 feet (9.1 meters), the user can purchase a connector kit and assemble a custom length cable of up to 10,000 feet (3,048 meters).

The cable connector kit (Class 8010 Type CCK-102) consists of:

2	- 9-Pin Connectors DB9P
2	- Connector Covers
18	- Pins

Recommended cable type is Belden 8723 or equivalent (2 pairs shielded, with ground). Pin connection for Series CC-100 cables is shown in Figure 4.4.

Type CC-100 series cables can be used for interconnections between a variety of SY/MAX devices. Consult the Instruction Bulletins for the devices being used.

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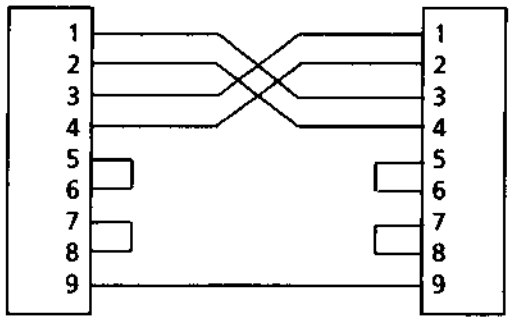


Figure 4.4 - Type CC-100 Series Cable Wiring Diagram

4.3.3 RS-232 DEVICE TO SY/LINK BOARD

When it is necessary to connect an RS-232 device to the RS-422 port of the SY/LINK board, an RS-232 to RS-422 adaptor can be used. Square D offers two such adaptors: the Class 8010 Type CRM-600 and CRM-601. The CRM-601 mounts in a SY/MAX register slot, while the CRM-600 is a freestanding unit. See Figure 4.5. Consult the CRM-601 Instruction Bulletin 30598-152-01 and the Printer Instruction Bulletin for more information.

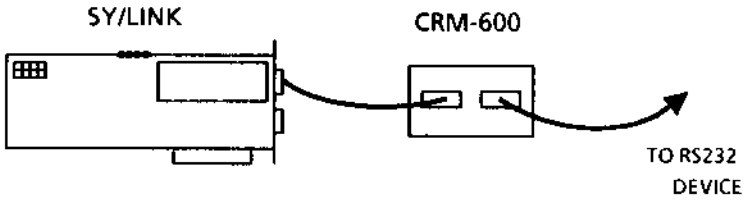


Figure 4.5 - Connecting an RS-232 Device

4.3.4 SY/NET PORT

The 9-pin male connector on the SY/LINK board is the SY/NET port which gives the board access to the network. The network connection cable links the SY/NET port with the network cable. See Figures 2.4 and 2.5.

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4.3.5 NETWORK CONNECTION CABLE

The network connection cable (part number S30600-162-50) has a 9-pin female connector on one end which plugs into the SY/NET port on the SY/LINK board. The other end has a male plug which connects to a Class 8030 Type CCK-212 "Tee" connector on the network cable (see Figure 4.6).

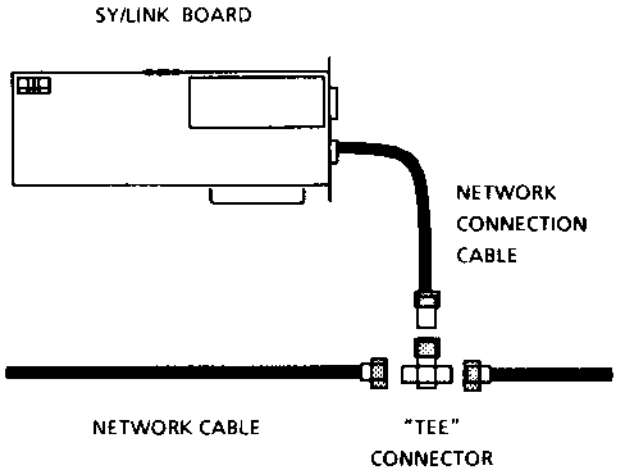


Figure 4.6 - Network Cable Connections

The network connection cable can also connect to a Type CC-202 or similar cable which in turn connects to the "Tee" connector for an extended drop length (see Figure 4.7).

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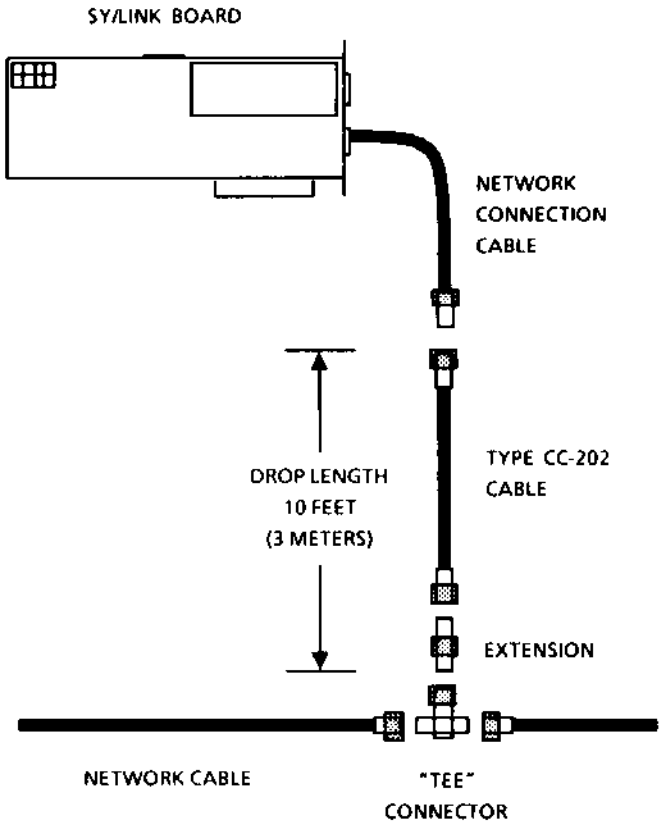


Figure 4.7 - Extended Network Cable Connection

4.3.6 NETWORK CABLE AND CONNECTORS

The main network cable consists of Belden 9463 twinaxial cable or equivalent. Factory assembled cables (complete with cable ends) are available in two lengths:

Class	Type	Length
8030	CC-201	2 feet (0.6 meter)
8030	CC-202	10 feet (3 meters)

These cables are useful for connections between closely located network components. Most users, however, will find it necessary to assemble longer cables to meet specific application requirements.

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When building a network cable, the following types of connectors are used:

Connector	Class	Type
Cable End	8030	CCK-211
Tee Connector	8030	CCK-212
Terminator (set of 2)	8030	CCK-213
Cable Extension	8030	CCK-214

Cable End - The cable end consists of a female socket. Two cable ends are required for each length of network cable.



Figure 4.8 - Cable End

See Appendix A for cable assembly instructions.

Tee Connector - The Tee connector allows a SY/LINK board or NIM to tie into the network cable. The Tee connector has two male plugs which connect to the network cable and a female connector which connects to the SY/LINK board or NIM. See Section 4.3.7.



Figure 4.9 - Tee Connector

Terminator - A terminator is required at each end of the main network cable (two terminators required per network). The terminator consists of a female socket and an internal 78 ohm resistor.

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Figure 4.10 - Terminator

Cable Extension - The cable extension consists of two male plugs. This extension can be used to (1) connect two network cables together, (2) replace a Tee connector when a SY/LINK board or NIM is removed from the network, (3) provide the splice for the future installation of a SY/LINK board or NIM by replacing the cable extension with a Tee connector, and (4) extend the distance between a NIM and the Tee connector.



Figure 4.11 - Cable Extension

4.3.7 NETWORK CABLE LENGTH

The maximum network cable length is dependent on the selected speed of network communication and on the drop lengths used on the network. The drop length is the cable distance between the SY/LINK board or NIM and the Tee connector.

The following table lists the maximum network cable length based on network baud rate.

Network Baud Rate	Maximum Network Length (Feet/Meters)
62.5 K Baud	15,000 / 4,572
125 K Baud	9,250 / 2,819
250 K Baud	4,250 / 1,295
500 K Baud	2,400 / 732

(drop length = 0 feet/meters)

The above network cable lengths are based on connecting the network Tee connector directly to the network connection cable from the SY/LINK board (drop length of 0 feet). When it is necessary to extend the length of the network drop, the following chart can be

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used as a guide in determining the maximum possible network length.

Network Baud Rate	Number of Drops	Drop Length	Maximum Network Length (Feet/Meters)
62.5 K Baud	25	100	15,000 / 4,572
62.5 K Baud	100	100	950 / 290
125 K Baud	100	0	9,250 / 2,819
250 K Baud	100	0	4,250 / 1,295
500 K Baud	100	0	2,400 / 732

4.3.8 NETWORK CABLE INSTALLATION CONSIDERATIONS

When installing the network cable, the following rules should be applied:

1. Provide a minimum six inch (15 cm) distance between the network cable and 120 volts AC. Provide 12 inches (30 cm) distance from 240 volts AC and 24 inches (61 cm) from 480 volts AC.

2. When the network cable is routed through conduit, the conduit must be grounded to building steel.

The signal level on the network cable is approximately five volts DC (RS-422 voltage levels, Manchester encoded). Routing of the network cable should be done in accordance with standard wiring practices for low level switching signals. See Instruction Bulletin 30598-175-01 (Planning and Installation Guide).

4.4 Network Performance Considerations

A number of factors effect the efficiency with which messages are transmitted on the network. Network throughput can be negatively affected if many devices wish to speak on the network at the same time. This problem can be avoided by programming that ensures that devices communicate no more often than is truly necessary.

The hardware factors that effect network performance include network cable length, network baud rate, and network size setting.

Network cable length was discussed in Section 4.3.7.

4.4.1 NETWORK BAUD RATE

The default network baud rate for the SY/LINK board is 62.5K, which provides the most noise-tolerant system with the maximum network cable length. By increasing the network baud rate to 125K

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baud, network speed (throughput) is increased by seven percent. Each increase in the network baud rate will improve throughput by seven percent up to a maximum baud rate of 500K. See Section 4.3.7 for maximum network cable length based on baud rate.

Note: each SY/LINK Board and NIM on the network must be set for the same network baud rate.

4.4.2 NETWORK SIZE SETTING

The SY/NET network can have a maximum of 100 network interfaces (SY/LINK boards or NIMs) on a single network. However, to improve performance, the maximum network size can be set for a maximum size of 31 (interface numbers 00 through 30). Using this setting causes the timers that control network access to time up to 30 rather than 99 (see Section 5.2.2). This improves network access by a factor of three.

This setting is only possible for networks having 31 interfaces or less. Interfaces 31 to 99 will not gain access to the network.

Network size for the SY/LINK board is set by the user program. See Section 7.2.

Note: all interfaces on the network must have the same network size setting.

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5.0 SY/LINK OPERATION AND MESSAGE HANDLING

5.1 Power Up Sequence

When power is applied to the SY/LINK board, it will automatically go into a self-test sequence. This sequence tests the internal PROM memory for checksum, clears the built-in RAM memory and performs a read/write test on this memory. During this start-up sequence, the green Active light on the SY/LINK board will flash on and off. If the board passes these tests, it will then go into a normal operational mode. If a RAM error or PROM Checksum error is detected, the Active light will flash and pause in a pattern that indicates the type of error found. Cycling power will reset the board. On power-up all board parameters will be set to their default values.

NOTE: Any messages received by the SY/LINK board during power-up will be ignored. Devices initiating these messages (i.e., processors, CRTs) will receive an error.

5.2 Message Handling

5.2.1 TYPES OF COMMUNICATION

Basically, the SY/LINK board supports two types of communication: (1) network communication between the SY/LINK board and other network interfaces, and (2) communication between the SY/LINK board and the devices associated with it. The board also coordinates the communication between the devices, the SY/NET port, and the SY/NET network.

Network communication consists of a synchronous data stream from one network interface (SY/LINK board or NIM) to another. This data structure is in the form of a protocol known as HDLC (High Level Data Link Control).

HDLC provides data transfer, message acknowledgments, and error recovery. All SY/NET network ports communicate to each other using HDLC.

SY/LINK board RS-422 port communication consists of an asynchronous data stream from the SY/LINK board to a programmable controller, CRT programmer, etc. The data structure is similar to ANSI 3.28 protocol. This protocol contains data which refers to ladder rungs, register data, I/O status, etc.

The SY/LINK board, when it receives a message from the RS-422 port, will check for a valid data format, message type, size, and checksum and then send the message either out the network port or

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to the computer (depending on the route address data received from the incoming message).

Communication from the computer (user program) to the SY/LINK board is through the computer's bus to the SY/LINK board edge connector. The SY/LINK mailbox function handles conversion to and from SY/MAX protocol.

As messages are received by the SY/LINK board, it will either, (1) send the message to another port, (2) build an error message and send it to the initiating device, or (3) hold the message for later use. In all cases, the SY/LINK board will reply to the initiating device.

5.2.2 NETWORK ACCESS

Before a message is sent over the network, the SY/LINK board will hold the message and wait for its turn to communicate.

Since all network communications occur over the same twinaxial cable (Belden 9463), network access by all network interfaces must be controlled to prevent message collisions.

Network access is controlled by a time sharing method which, 1) allows every interface a chance to "talk" on the network, 2) prevents any interface from dominating the network, and 3) provides device priority for important (alarm) messages.

The network address number (00 to 99) assigned to each SY/LINK board and NIM module determines the time slot when the interface is allowed to send a message.

Each SY/LINK board (and NIM) has an internal timer which is synchronized with the timers of the other network interfaces. On power-up and at the end of every message these timers are reset and then start timing. (Noise will also reset all timers.) At a timer value of 0, interface 00 is allowed to talk on the network. If interface 00 has no message to put on the network, the timer continues timing and interface 01 is allowed to send a message. This sequence continues to a count of 99; allowing every network interface the opportunity to talk on the network. When the timers reach a count of 100, all interfaces will reset their timers to 0 and the sequence will start over.

The time slot for each interface is approximately 200 µs for a total slot (or loop around) time of 20 ms for 100 network interfaces. If the network contains less than 30 interfaces, the total slot time can be reduced to 6 ms. See Section 4.4.2 for information on setting network size.

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5.2.3 PRIORITY

Priority refers to the ability of one network device to send a message before another device can gain access to the network.

Since the time slot timer starts at 00 and advances to 99, module 00 will get first access to the network.

At the end of any message on the network, all timers are reset and the lower numbered interfaces again get first chance to talk on the network. For example, if interface 22 is sending a message and interface 23 has a message waiting to be sent, interface 23 will have to wait its turn. When interface 22's message ends, all timers will reset to 0 and begin timing. If no other interfaces have a message to send, the timer will advance to 23 allowing interface 23 to send its message.

Note: You cannot interrupt a message already in progress.

As network activity increases, the SY/NET priority system ensures that all interfaces have an opportunity to communicate. If priority were based solely on address numbers, a low-numbered interface with multiple messages could dominate the network.

Under the SY/NET system, when there are multiple interfaces that wish to communicate during the same time loop, an interface that sends a message cannot communicate again until every other interface on the network has been given an opportunity to communicate. In other words, the time loop from 0 to 100 (or 0 to 30, depending on the network size setting) must be completed before that interface can send another message. For example, suppose interface 07 gains access to the network and sends a message. When interface 07's message is done, all interface timers are reset to zero and start timing. When the timer reaches 07 and interface 07 has another message to send, it must skip its turn.

Each time another interface sends a message, it too is blocked and the interface timers are reset to zero. Once the interface timers reach a value of 100 (or 30), all interfaces that were blocked will be unblocked.

5.2.4 BUFFERING

Another function performed by the SY/LINK board is buffering. Buffering refers to 1) message communications speed conversion and 2) the holding of messages for later use.

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As messages are received through the network port, the SY/LINK board waits until the complete message is received, acknowledges the message, and then retransmits the message to the destination device (the computer or the device connected to the RS-422 port).

During retransmission to the RS-422 port, a baud rate change takes place. The message received at 62.5-500K baud (network speed) is retransmitted at 110-19.2K baud (COMM port speed). The same conversion takes place when messages are sent to the SY/LINK board via the RS-422 port. Upon receiving a complete message, the SY/LINK board acknowledges the message and then retransmits the message over the network at 62.5-500K baud.

Incoming network messages intended for the computer are placed in a buffer by the SY/LINK board. The user program can be designed to periodically poll this buffer or be flagged or interrupted when a new message comes in. When the computer wishes to send a message over the network, it places a command code into the appropriate SY/LINK board command register. The SY/LINK board will then send the message and either flag or interrupt the computer when a reply is received.

When the SY/LINK board receives messages for the computer or RS-422 port device faster than these devices can accept them, the board will save the messages in a buffer until they can be accepted. The SY/LINK board can buffer up to 16 messages for the RS-422 port device and the computer (combined). When more messages are received than the buffer can hold, a Network Overflow error (code 11) is sent to the communication status register in the originating device.

5.3 Error Handling

In addition to parity, checksum, and CRC checks associated with each message, every message on the network is acknowledged. This means that for every command message, there is a reply message.

If a message sent out the network port is not acknowledged (due to a device that is busy or nonexistent), or a negative acknowledgment is received, the SY/LINK board will automatically retransmit the message up to four times. If after four attempts, a negative acknowledgment or no acknowledgment is received, an error code will be posted in the error flag location.

By automatically retransmitting messages when an error occurs, messages are allowed to get through the network even under noisy electrical conditions.

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When sending messages to the device connected to its RS-422 port, the SY/LINK board will automatically retransmit the message up to eight times if it receives a message indicating that the device is inactive. After eight attempts, it will post an error (code number 17, Device Inactive) in the Error Flag location.

If the SY/LINK board receives a signal indicating the RS-422 port device is busy, it will retransmit the message continuously until it gets through. For this latter case, the user program should contain a routine that limits the number of retransmissions by using a timeout.

5.4 Routing

Route values are used as part of each network communication to direct the message to the desired destination and to direct the acknowledgment back to the initiating device.

A route value is simply the network address of a device. (The network address is the network interface number preceded by a 0 or 1, depending on which port the device is connected to. The SY/LINK board's edge connector is considered port 0 and the RS-422 port is considered port 1. See Section 4.2).

The first route value is that of the initiating device. The last route is the destination device. (Note: for SY/LINK user program applications, a route value of FFH is used after the destination device route to signify the end of the route list.)

For applications that send messages from one network to another, additional route values (for the ports that connect the networks) are placed between the initiating route and the destination route.

When the user program has to read or write to the 512 processor equivalent registers on the SY/LINK board, a route value of FFH is used as the first route.

5.5 Special Routes

Route values of 000 to 199 are the general route values used to direct a communication to specific devices on the network. Above this range are special route values of 200 to 254. These special route values allow the following functions:

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Route	Function
200	Read NIM module status
201	Don't care source route (first route)
202	Port to port (in-out same module)
203	Module pair (last route)
204	Don't care - no action taken
205-232	Unused
233-254	Broadcast messages

The following sections describe these special route functions.

CAUTION: Care must be taken when using the special route instructions, as more than one module may be affected.

5.5.1 ROUTE 200 - NIM STATUS

This route allows the status of a network interface (NIM or SY/LINK board) to be read in the form of register data. These are internal status registers of the network interface. The available data is described in the following table.

Register	Description
1	Type number (1510-SY/LINK, 510-NIM)
2	Software revision
3	Module number
4	Port 0 baud rate
5	Port 1 baud rate
6	Serial port number - if the message originates from the COMM ports this indicates which port the message came from (0 or 1). If the message came from the network, then the returned data is to be ignored.
7	Partitioned broadcast port 0 address
8	Partitioned broadcast port 1 address
9	Number of Tx errors
10	Number of Rx errors
11	SY/LINK Error Code Register
12-15	SY/LINK Parameters

The route number following the 200 route value indicates which network interface will have its status read. For example, to read interface number 14 status, you would use route values of:

A, 200, B

where A is the route number of the initiating device, 200 is the Read Status route number, and B is the route to the interface being read.

The 200 route must be the second to the last route instruction.

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5.5.2 ROUTE 201 - DON'T CARE SOURCE ROUTE

This route instruction allows an initiating device to communicate over the network without specifying its own route address. For example, to communicate to device 122, the require route values would be:

201,122

where 201 is used as the network address of the initiating device (regardless of its real address) and 122 is the network address of the destination device.

The 201 route must be used as the first route value.

NOTE: A special case exists where the last route instruction could be 201. The route values 200,201, would allow the reading of the status registers of the network interface of the initiating device without knowing the address number of that device.

5.5.3 ROUTE 202 - PORT TO PORT (IN-OUT SAME MODULE)

This route allows communication to occur between two devices connected to the same network interface without knowing the interface number. For example, the route values:

201,202

allow communication from port 0 to port 1 or from port 1 to port 0 within the same interface.The route 202 instruction must be the second route instruction. No additional route values can be used.

5.5.4 ROUTE 203 - MODULE PAIR

This route allows communication between a pair of network interfaces without knowing either interface number. The pair of network interfaces must consist of an even numbered module and its module number plus one (or an odd numbered module, and its number minus one). For example, if the route values:

201,203

were used in a device connected to interface 006, the message would be sent to interface 007 (the next higher interface number). If they were used in a device connected to interface 113, the message would be sent to interface 112 (the next lower interface number).

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The 203 route sends communication to the same port number (1 or 0) as the initiating device.

The 203 route value must be the second route instruction, no additional route values can be used.

5.5.5 ROUTE 204 - DON'T CARE (NO ACTION TAKEN)

When route 204 is used, no action is taken by the network interface. The route is ignored and the next route instruction is used. For example the route values:

103,204,025

are the same as route values 103,025. The 204 route value allows increased flexibility with the D-LOG module when used with redundant networks.

5.5.6 ROUTE 233-254 BROADCAST

Broadcast route values allow a single message to be sent to more than one device on the network. In contrast to point-to-point communication in which all messages are acknowledged, the nature of broadcast messages does not allow acknowledgment and therefore broadcast capability should be used with caution.

Broadcast routes can be used for WRITE or ALARM messages.

Broadcast route instructions must be the last route instruction.

NOTE: Broadcast messages are only sent over the network. Broadcast messages will not be received by the same module that initiated the broadcast message.

When performing net-to-net broadcasts, the module containing the net-to-net link will pass the broadcast message to the network, the opposite COMM port on the same interface will not receive the broadcast message.

CAUTION: Broadcast messages are not acknowledged. It is the user's responsibility to determine which devices should be affected.

Every device on the network has the option of not receiving broadcast messages. With NIM modules, this is done by setting DIP switches. With the SY/LINK board, broadcast messages are enabled or disabled for each port by setting the appropriate bits when the board is configured (see Section 7.2).

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There are two general broadcast route values. One of them broadcasts to port 0 of all network interfaces, the other to port 1 of all network interfaces.

Route 253 Broadcast to all interfaces, port 0
Route 254 Broadcast to all interfaces, port 1

There are twenty more broadcast route values which allow broadcast messages to be sent only to one group of network interfaces.

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ROUTE NUMBER	PORT	INTERFACE GROUP RECEIVING
233 234	0 1	0 – 9
235 236	0 1	10 – 19
237 238	0 1	20 – 29
239 240	0 1	30 – 39
241 242	0 1	40 – 49
243 244	0 1	50 – 59
245 246	0 1	60 – 69
247 248	0 1	70 – 79
249 250	0 1	80 – 89
251 252	0 1	90 – 99
253 254	0 1	GENERAL

For example, a route value of 235 will broadcast to port 0 of network interfaces 10 through 19 (device numbers 010 through 019). Route 236 will broadcast to port 1 of interfaces 10 through 19 (device numbers 110 through 119).

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6.0 SY/LINK BOARD CONFIGURATION

This section describes the parameters that the user (and the program) must set to allow the SY/LINK board to communicate on the network. Section 7.2 describes how to access these parameters.

To configure the SY/LINK board, selections must be made for such items as computer memory address range, network address number, network baud rate, network size, RS-422 port operating mode, and RS-422 port baud rate.

NOTE: When using the Type SFW-333 or 334 SY/MATE Programming Software with the Type SFI-533 and 534 SY/LINK boards, the initial utility (Port Setup) mode can be used to manually enter configuration values for the board. These values can be stored (using the Auto File mode) so that they load automatically from a disk along with the SY/MATE software. See SFW-333 or 334 Addendum to SY/MATE programming manual.

The computer memory address range used by the SY/LINK board is determined by setting the DIP switches on the board (see Section 2.2 for more information). The other configuration choices are set by the user program. The remainder of Section 6 describes these configuration parameters. Section 7.2 describes programming considerations for board configuration.

6.1 Network Address Number

As described in Section 4.2, each SY/LINK board or NIM on the network is assigned a number between 00 and 99 which serves as a network address number. This number also establishes communication priority on the network (lower numbers have higher priority).

The network address number for SY/LINK boards is assigned by the user program. See Section 5.2.3 for more information on communication priority.

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6.2 Interrupt Enable

The SY/LINK board can be set to interrupt the user program when it receives certain types of messages. The messages types include: data writes to SY/LINK processor equivalent registers, replies to messages from SY/LINK, fault alarm messages, alert alarm messages, warning alarm messages. The interrupt number establishes which interrupt signal on the board edge connector the SY/LINK board will use.

6.3 RS-422 Port Modes Of Operation

The RS-422 port on the SY/LINK board, like the COMM ports on the NIM module, can be set for different modes of operation. These modes allow communication with different kinds of devices.

The mode of the RS-422 port is set by the user program. The four available modes of operation are described in the following paragraphs.

6.3.1 SY/MAX FAMILY MODE

This mode allows communication with SY/MAX Family devices including the following:

Model 300, 400, 500, 600 and 700 Programmable Controller Processors
CRT Programmers
D-LOG Data Controller Modules
PID Loop Control Modules
Cartridge Tape Loader/Recorders

SY/MAX devices connected to the network can exchange or transfer I/O status, register data, and ladder rungs.

A Type CC-100 series cable is required for connecting the SY/MAX device to the SY/LINK board RS-422 port (see Section 4.3.2).

For communication programming format, see Section 9.

6.3.2 NET-TO-NET MODE

This mode is used for the connecting link when two or more SY/NET networks are connected. Net-to-Net connection allows distributed networks, a large capacity network (more than 200 devices), or network redundancy (more than one path between two devices).

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As described in Section 4.2, the two ports (one on each network) used for the net-to-net link must be set for the same address number, the same mode (net-to-net), and the same baud rate. For SY/LINK boards, these settings are all made using the configuration software provided with the board.

A Type CC-100 series cable is used for the net-to-net connection.

For information on net-to-net routing commands, see Section 9.2.2.

6.3.3 PERIPHERAL MODE

This mode allows ASCII devices such as printers and CRT terminals to be connected to the network. The D-LOG Data Controller module also uses this mode for sending and receiving ASCII data. The D-LOG module can send alarm messages, reports, and machine faults to any ASCII device on the network. It can also read ASCII input from a keyboard or other ASCII device on the network.

Because the D-LOG module ports use RS-422 communication, they can be connected directly to the SY/LINK board RS-422 port using a CC-100 series cable (see Section 4.3.2).

To connect an RS-232 ASCII device to the SY/LINK board RS-422 port, an RS-232/RS-422 adapter will have to be used. See Section 4.3.3.

6.3.4 TERMINAL MODE

The terminal mode allows the computer to act as a "dumb terminal" for an ASCII device connected to the SY/LINK board RS-422 port. The terminal mode is useful for programming or displaying data from a SY/MAX D-LOG module. Terminal mode must be selected both as an RS-422 port parameter and as a network port operating mode parameter.

Network communication is not possible when the SY/LINK board is in terminal mode.

6.3.5 RS-422 PORT PARITY, WORD SIZE, BAUD RATE

The following RS-422 port parameters can also be set.

Parity (Odd, Even, or No Parity)
Word Size (7 Bit or 8 Bit)
Baud Rate (110 to 19,200 Baud)

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6.4 Network Port Parameters

These parameters determine how the SY/LINK board communicates on the network.

6.4.1 NETWORK BROADCAST ENABLE

The SY/LINK board can be set to accept or not accept broadcast messages from the network directed to the SY/LINK processor equivalent registers or the alarm queue. Broadcast messages are network communications which are not directed at any one device. (See Section 5.5.6.)

6.4.2 RS-422 PORT BROADCAST ENABLE

The SY/LINK board can also be set to accept or not accept broadcast messages directed to the device connected to the RS-422 port.

6.4.3 NETWORK/RS-422 ENABLE

The SY/LINK board can be set to allow or prevent other devices on the network from communicating to the RS-422 port device. If prevented, only the computer holding the SY/LINK board can communicate to the RS-422 port device.

6.4.4 SY/LINK OPERATING MODE

The SY/LINK board can be set for several general operating modes. The current choices are Mailbox mode, Terminal mode, and SY/MAX (programming) mode.

Mailbox mode is the standard mode for network communication using the SY/LINK board. It is so named because the SY/LINK processor equivalent registers act as a mailbox into which the user program can place data for transmission or examine data from other devices.

The Terminal mode allows the personal computer to act as an ASCII terminal for another device on the network. If the SY/LINK board RS-422 port is also set for terminal mode, then the personal computer can act as an ASCII terminal for the device connected to the RS-422 port. This would allow, for example, the programming of a SY/MAX D-LOG module.

The SY/MAX mode allows the computer to act as a programming interface for SY/MAX programmable controllers and D-LOG modules while running Type SFW-333 or 334 programming software.

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SY/MAX mode is supported only by the Type SFI-533 and 534 SY/LINK boards and should not be selected by the user program.

6.4.5 NETWORK SIZE

A SY/NET network can be set for a maximum size of 100 or 31 network interfaces. (See Section 4.4.2). The SY/LINK board must be set for the same network size value used by the other interfaces on the network.

6.4.6 NETWORK BAUD RATE

The SY/LINK board can be set to communicate on the network at speeds of 62.5K, 125K, 250K, or 500K baud. The slower speeds allow longer cable runs and greater noise tolerance (see Section 4.3.7). The SY/LINK board must be set to use the same network baud rate used by all the other interfaces on the network.

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SECTION 7 - USER PROGRAM CONSIDERATIONS

7.1 Introduction

The SY/LINK board relieves the computer's user program of most of the burden of handling network communication. Basically, the user program tells the board what data to send or retrieve and the network route to the destination device. The board then takes over, managing protocol conversion, transmission, acknowledgment, reply, error checking, etc. The board can also accept unsolicited communications from other devices and either flag or interrupt the user program.

To achieve network communication, the user program must address the following functions:

1. Initializing SY/LINK board parameters
2. READ operations (for applications that gather information)
3. WRITE operations (for applications that send information)
4. Error handling
5. ALARM handling (for applications that respond to alarm conditions)
6. Unsolicited message handling (for applications receiving unsolicited messages)

The programming required for these functions will depend on the application and on the programming language of the user program. The SY/LINK system will operate with virtually any computer language that will run on a personal computer (BASIC, Compiled BASIC, FORTRAN, C, Assembler, etc.).

The following sections describe the data values that the user program must set to achieve network communication.

Example programs for various communication functions are included on the demonstration disk provided with the SY/LINK board. These programs are described in Appendix B of this manual and in the READ.ME file on the demonstration/example disk.

NOTE: All hexadecimal data values in this manual are followed by the letter H. Data values without this notation are decimal.

Examples:
20H – Hexadecimal value
155 – Decimal value

All personal computer bits are identified 7 to 0, where 7 is most significant and 0 is least significant. All

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programmable controller bits are identified 16 to 1 where 16 is most significant and 1 is least significant.

All SY/LINK memory locations are relative to the start address for the board selected by the DIP switch setting (see Section 2.2).

7.2 Initializing SY/LINK Board Parameters

7.2.1 SY/LINK BOARD PARAMETERS

The SY/LINK board has parameters which determine in what mode, speed, and format the board will communicate. Except for the board's network address number, these parameters have default values which, if acceptable for the application, need not be set by the user program.

Figure 7.1 summarizes SY/LINK board parameters and the memory locations where they are stored. Descriptions of each parameter follow.

SY/LINK board parameters were also discussed in Section 6.

CAUTION: All personal computer memory assigned to SY/LINK is writable. Care should be taken so that programs running in the computer do not accidentally write over SY/LINK data.

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CONFIGURATION FUNCTION	ADDRESS (WORD)*	BITS	VALUE
SY/LINK NETWORK ADDRESS (REQUIRED)	3FDH	–	00 to 99
INTERRUPT SELECT (MESSAGE TYPES)	3F9H		
REPLIES		7	1 = GENERATE INTERRUPT
WRITE TO SY/LINK REGISTER		4	
FAULTS		2	
ALERTS		1	
WARNINGS		0	
INTERRUPT ENABLE	3FAH	–	0,2,3,4,5,6,7
RS-422 PORT PARAMETERS	3FBH		
PARITY		7,6	00 = NO PARITY 01 = ODD PARITY† 10 = NO PARITY 11 = EVEN PARITY
WORD SIZE		5	0 = 7 BIT† 1 = 8 BIT
MODE		4,3	00 = SY/MAX† 01 = NET TO NET 10 = PERIPHERAL 11 = TERMINAL‡
BAUD RATE		2,1,0	000 = 110 BAUD 001 = 300 BAUD 010 = 600 BAUD 011 = 1200 BAUD 100 = 2400 BAUD 101 = 4800 BAUD 110 = 9600 BAUD† 111 = 19200 BAUD

* ADDRESS IS RELATIVE TO DIP SWITCH SELECTED STARTING ADDRESS
† DEFAULT VALUE
‡ NETWORK PORT PARAMETERS MUST ALSO BE SET FOR TERMINAL MODE.

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CONFIGURATION FUNCTION	ADDRESS (WORD)*	BITS	VALUE
NETWORK PORT PARAMETERS	3FCH		
NET BROADCAST ENABLE		7	0 = DISABLED† 1 = ENABLED
RS-422 BROADCAST ENABLE		6	0 = DISABLED† 1 = ENABLED
NETWORK/RS-422 ENABLE		5	0 = ENABLE 1 = DISABLE
SY/LINK MODE		4,3	00 = SY/MAX Prog 01 = MAILBOX† 10 = TERMINAL 11 = ILLEGAL
NETWORK SIZE (DROPS)		2	1 = 31 0 = 100†
NETWORK BAUD RATE		1,0	00 = 62.5K BAUD† 01 = 125K BAUD 10 = 250K BAUD 11 = 500K BAUD

* ADDRESS IS RELATIVE TO DIP SWITCH SELECTED STARTING ADDRESS
† DEFAULT VALUE

Figure 7.1 -- SY/LINK Board Configuration Parameters

SY/LINK NETWORK ADDRESS, 3FDH -- A value of 00 to 99 is placed at this location to establish the network address of the SY/LINK board. This address must be unique (used by no other interface on the network). The network address value defaults to FFH on power-up (this value does not allow network communication). Values other than 00 to 99 will cause an error code to be placed in the setup error code location 3F8H when an attempt is made to load them. A value of FF is legal in terminal mode, however this is the only case where FF is legal.

INTERRUPT SELECT, 3F9H -- Setting certain bits of this memory location determine which types of incoming network messages will generate an interrupt of the user program. Setting the appropriate bit to a value of 1 will cause that message type to generate an interrupt. Any combination of the following bits may be set.

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Bit	Message Type
7	Replies to SY/LINK initiated messages
4	Writes to SY/LINK processor equivalent registers (from other device)
2	Fault messages
1	Alert messages
0	Warning messages

INTERRUPT ENABLE, 3FAH -- The value placed at this location determines which personal computer interrupt to the 8259 chip is used by the SY/LINK board. The interrupt selected must not be used by any other personal computer functions. The available interrupts (and the corresponding values to be placed in 3FAH) are 2, 3, 4, 5, 6 and 7. Any other values (except 0) will cause an error code to be placed in the setup error code location 3F8H. A value of 0 indicates no interrupts are selected. On power-up, the interrupt enable byte will be set to a value of 0.

RS-422 PORT PARAMETERS, 3FBH -- The bits at this memory location can be set to establish the communication parameters for the SY/LINK board RS-422 port. As indicated in Figure 7.1, each of these parameters has a default value. Care should be taken to change only those bits that require a new setting.

Parity -- The pattern of bits 7 and 6 of 3FBH select odd, even, or no parity. Odd parity is the default selection. This bit is ignored if SY/MAX mode is selected.

Word Size -- Bit 5 of 3FBH allows a word size of 7 or 8 bits to be selected. Default selection is 7-bit. This bit is ignored if SY/MAX mode is selected.

Mode -- Bits 4 and 3 of 3FBH allow the RS-422 port communication mode to be set for SY/MAX, Net-to-Net, Peripheral, or Terminal modes. The Terminal mode causes the computer to be treated as a dumb terminal connected to the RS-422 port. That is, communications (ASCII data) entering the RS-422 port will be passed to the computer with no protocol conversion, and vice versa. Note: the network port parameters (3FCH, bits 4, 3) must also be set for terminal mode. SY/MAX mode is the default mode selection.

Baud Rate -- Bits 2, 1 and 0 of 3FBH set the baud rate of the RS-422 port for speeds from 110 to 19200 baud. The default value is 9600 baud.

NETWORK PORT PARAMETERS, 3FCH -- The bits at this memory location can be set to establish the communication

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parameters for the SY/LINK board Network port. As indicated in Figure 7.1, each of these parameters has a default value. Care should be taken to change only those bits that require a new setting.

Network Broadcast Enable -- Setting bit 7 of 3FCH to a value of 1 enables SY/LINK alarm queue or processor equivalent registers to receive broadcast messages from the network. (See Section 5.5.6 for more on broadcast messages.) If the broadcast message is to the alarm queue, it is treated as a fault, alert, or warning. The default setting for this bit is 0 (broadcast disabled).

RS-422 Broadcast Enable -- Setting bit 6 of 3FCH to a value of 1 enables the RS-422 port to receive broadcast messages from the network. This bit defaults to 0 (broadcast disabled).

Network/RS-422 Enable -- Setting bit 5 of 3FCH to a value of 1 prevents other network devices from communicating to the RS-422 port device, allowing only the computer holding the SY/LINK board to communicate to this device. This bit defaults to a value of 0.

SY/LINK Mode -- The pattern of bits 4 and 3 of 3FCH determine the operating mode of the SY/LINK board. The choices are Mailbox mode, Terminal mode, and SY/MAX Programming mode. Mailbox mode is the standard network operating mode of the SY/LINK board. Terminal mode allows the computer to act as a dumb terminal for the RS-422 port device if the RS-422 port parameters (3FBH, bits 4, 3) are also set for Terminal mode. (Network communication is not possible in this mode.) If RS-422 port parameters are not set to Terminal mode, then setting the SY/LINK mode to terminal allows the computer to act as a terminal attached to the network (normal network communication can occur with the RS-422 port). SY/MAX Programming mode is for use with SY/MATE programming software and should not be selected by the user program. Mailbox mode is the default selection.

Network Size -- Bit 2 of 3FCH selects a maximum network size of 100 interfaces or 31 interfaces. The default setting is 100.

Network Baud Rate -- Bits 1 and 0 of 3FCH determine the speed of network communication from 62.5K to 500K baud. The default setting is 62.5K.

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7.2.2 INITIALIZATION FLAGS

There are two flags used in initializing the SY/LINK board, one controlled by the user program and one controlled by the SY/LINK board.

The user program-controlled flag, 3FFH bit 0, is set to a value of 1 to tell the board that new parameters are available.

The board-controlled flag, 3FEH bit 0, is set to a value of 1 by the SY/LINK board to let the user program know that it has accepted the new parameters.

7.2.3 INITIALIZATION SEQUENCE

The following is a description of the sequence of events in the initialization of the SY/LINK board. See Figure 7.2 for a graphic representation of this sequence.

NOTE: All SY/LINK message buffers are purged at initialization.

1. First, the user program must place the required board parameter values in the appropriate memory locations. Section 7.2.1 describes these parameters and their memory locations.

2. The user program sets the user initialization flag (3FFH bit 0) to a value of 1 to signal the SY/LINK board that new board parameters are available.

3. The SY/LINK board processes the new parameters. If the new values are accepted, the board will set the SY/LINK initialization flag (3FEH bit 0) to a value of 1 to signal the user program that initialization is complete. If the new board parameters are not accepted (due to invalid values), the SY/LINK initialization flag will remain at a value of 0 and an error code will be placed in the initialization error location (3F8H).

4. If the initialization was successful, the user program should reset the user initialization flag to a value of 0. The SY/LINK board will then reset the SY/LINK initialization flag to 0.

NOTE: If desired, the SY/LINK board parameters can be reset to their default values by setting 3FFH bit 2 to a value of 1.

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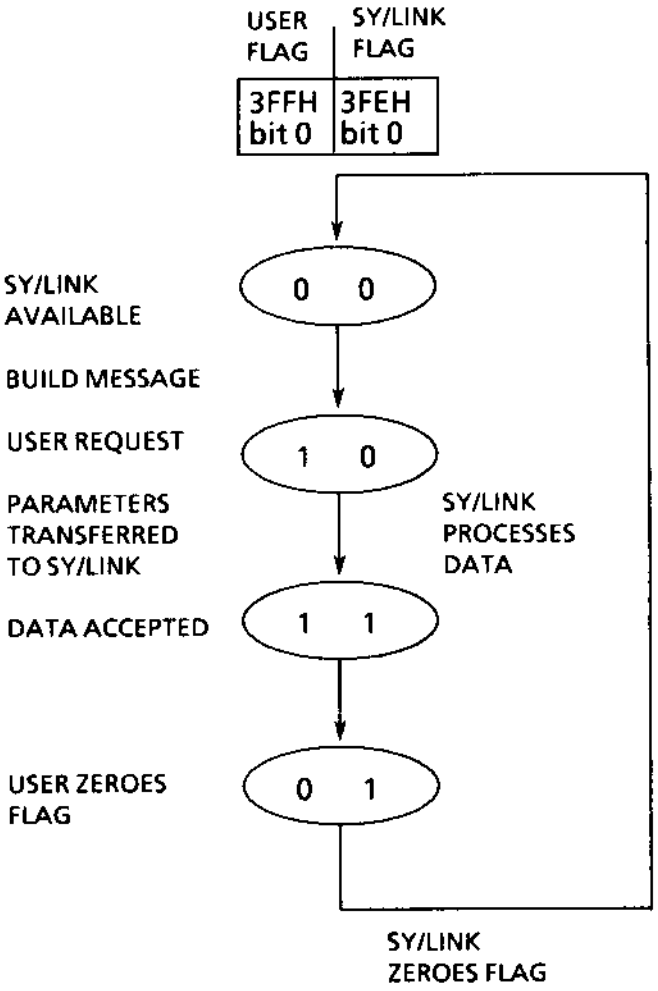


Figure 7.2 - SY/LINK Board Initialization Sequence

7.3 READ Operations

READ operations allow the user program to obtain data values from storage registers located in other devices on the network or on the SY/LINK board.

To perform a READ operation, the user program loads values into certain memory locations. These values tell the SY/LINK board

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what registers to read and where to find them. When ready, the user program sets a send flag and the SY/LINK board performs the desired READ operation. If the READ is successful, the SY/LINK board will store the requested data in the reply data buffer and reset the send flag to zero. The user program can then examine the data. If the READ is unsuccessful, the SY/LINK board will place an error code in the error flag location and reset the send flag without storing data in the reply data buffer.

SY/MAX data registers are numbered from 00001 to 32768. Not all SY/MAX devices have all these registers. Reading a nonexistent register will return data of 0000. Registers 1 to 8192 are data registers, 8193 to 16384 are status registers, 16385 to 24576 are force enable registers, and 24577 to 32768 are force status registers.

There are three kinds of READ operations: Non-priority READ, Priority READ, and Random Access READ.

Non-priority READ operations are normally used by peripheral devices gathering data from SY/MAX processors. For the majority of SY/LINK applications, the user program should use Non-priority READs. A Non-priority READ can be preempted by a Priority READ (or WRITE) operation that requires the network at the same time. The Non-priority READ can be preempted a maximum of 32 times before it is allowed on the network.

Priority READ operations are normally used for processor-to-processor communications. As described above, Priority READs can preempt Non-Priority READs. NOTE: Priority READs should be employed in the user program only when there is a critical need to obtain data as quickly as possible. Over-use of Priority READs can interfere with other network communications.

Random Access READ operations can obtain data from a group of registers whose addresses are not continuous. (Standard Non-priority and Priority READs access continuous blocks of registers.) The Random Access READ is classified as a non-priority operation; it can be preempted by a Priority READ.

The following sections discuss the programming necessary to perform READ operations.

NOTE: The SY/LINK board will configure all data it receives in the personal computer (lower address byte - least significant / higher address byte - most significant) format.

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7.3.1 NON-PRIORITY READ

To perform a Non-priority READ, the user program must set appropriate values for the following parameters (this information is summarized in Figure 7.4):

SY/LINK Opcode (location 24H) -- A value of 00H must be placed in the opcode location to select a Non-priority READ.

SY/MAX Register Count (location 25H, 26H) -- The value at this location determines how many SY/MAX data registers will be read. A maximum of 128 registers can be read in one operation.

SY/NET Route (location 2CH-34H) -- Values at this location identify the network route to the device containing the registers to be read. A message can include a maximum of eight route values. Note: The list of routes must terminate with a route value of FFH. To read the SY/MAX processor equivalent registers on the SY/LINK board, use FFH as the first route value.

SY/MAX Register Address (3EH, 3FH) -- The value at this location specifies the starting address of the group of SY/MAX registers being read.

All SY/MAX processors allow up to 128 registers to be read by a Non-Priority READ command.

7.3.2 PRIORITY READ

To perform a Priority READ, the same parameters must be set as described in the Non-priority READ section (7.3.1). The only difference is the SY/LINK opcode value which is 20H for a Priority READ (the opcode location remains 24H).

This information is summarized in Figure 7.4.

NOTE: The maximum number of registers that can be read by a Priority READ command depends on the Type and series of SY/MAX processor being accessed. This information is summarized in the following table.

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PROCESSOR	MAXIMUM MESSAGE LENGTH
SCP-1XX	16 registers
SCP-3XX	16 registers
SCP-4XX	128 registers
SCP-5XX rev. 1-6 rev. 7 & up	64 registers 128 registers
SCP-6XX	128 registers
SCP-7XX	64 registers
DLM-110	128 registers
DLM-120	128 registers
PCM-110	64 registers

Priority READ Register Limits

7.3.3 RANDOM ACCESS READ

To perform a Random Access READ, the user program must set the following parameters (this information is summarized in Figure 7.4):

SY/LINK Opcode (location 24H) -- A value of 04H must be placed in the opcode location to select a Non-priority READ.

SY/NET Route (location 2CH-34H) -- Values at this location identify the network route to the device containing the registers to be read. A message can contain a maximum of eight route values. Note: The list of routes must terminate with a route value of FFH. To read the SY/MAX processor equivalent registers on the SY/LINK board, use FFH as the first route value.

SY/MAX Register Address (3EH-3FH) — The values at this location specify the addresses of the SY/MAX registers being read. Up to 128 separate register addresses can be entered. This list must be terminated with the address 00H. Note: this address list is stored at memory locations 3EH through 3FH. The portion of this memory area from 40H through 3FH is also used as the write data buffer by WRITE commands.

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7.3.4 READ OPERATION SEQUENCE

The following is a description of the sequence of events in a READ operation. See Figure 7.3 for a graphic representation of this sequence.

1. First, the user program loads the READ operation parameter values into the appropriate memory locations. (These values are discussed in the previous sections describing the various READ operations.)

2. When ready, the user program sets the Send Flag (20H) to a non-zero value to inform the SY/LINK board that a communication is ready.

3. The SY/LINK board performs the desired READ operation. If the READ is successful, the SY/LINK board will store the requested data in the reply data buffer (starting at location 140H and allocating 16 bits for each register value) and reset the Send Flag to zero. If the READ is unsuccessful, the SY/LINK board will place an error code in the Error Flag location 21H,22H and reset the Send Flag to zero.

4. When the Send Flag is reset, the user program can examine the data in the reply data buffer. If an error (non-zero value) is detected in the Error Flag location, the user program can reset the error code by placing a non-zero value in the Reset Flag location 23H or by setting the Send Flag to send another message.

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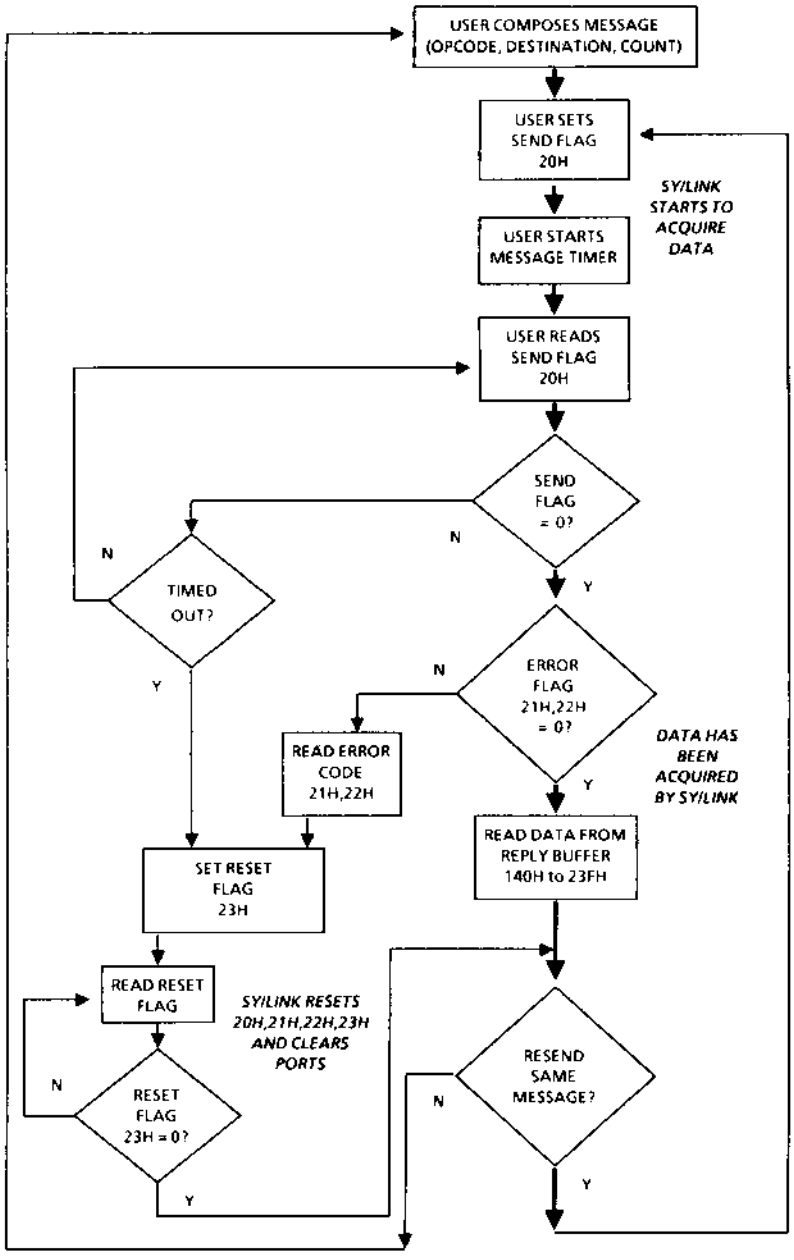


Figure 7.3 - READ Operation Sequence

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	NON-PRIORITY READ	PRIORITY READ	RANDOM ACCESS READ
SY/LINK OPCODE 24H	00H	20H	04H
SY/MAX REGISTER COUNT 25H, 26H	1 TO 128	1 TO 128 See Restrictions Sec. 7 3 2	NOT USED
SY/NET ROUTE 2CH-34H	000 TO 203	000 TO 203	000 TO 203
SY/MAX REGISTER ADDRESS 3EH, 3FH*	00001 TO 32768	00001 TO 32768	1 TO 128 ADDRESSES FROM 1 TO 32768 TERMINATED WITH 00H
REPLY DATA BUFFER 140H-23FH	16 BITS TIMES REGISTER COUNT	16 BITS TIMES REGISTER COUNT	16 BITS TIMES NUMBER OF ADDRESSES

* Random Access Read register address list can extend into the Write Data Buffer (40H-13FH).

Figure 7.4 - READ Operation Parameter Summary

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7.4 WRITE Operations

WRITE operations allow the user program to send data values to storage registers located in other devices on the network or on the SY/LINK board.

To perform a WRITE operation, the user program loads values into certain memory locations. These values tell the SY/LINK board what registers to write to, where to find them, and what data to put in them. When ready, the user program sets a send flag and the SY/LINK board performs the desired WRITE operation. If the WRITE is successful, the SY/LINK board will reset the send flag to zero. If the WRITE is unsuccessful, the SY/LINK board will place an error code in the error flag location and reset the send flag.

SY/MAX data registers are numbered from 00001 to 8192. Not all SY/MAX devices have all these registers. Writing to a nonexistent register generates an error code.

There are three kinds of WRITE operations: Non-priority WRITE, Maskable Non-priority WRITE, and Priority WRITE.

Non-priority WRITE operations are normally used by peripheral devices sending data to SY/MAX processors. For the majority of SY/LINK applications, the user program should use Non-priority WRITEs. A Non-priority WRITE can be preempted by a Priority WRITE (or READ) operation that requires the network at the same time. The Non-priority WRITE can be preempted a maximum of 32 times before it is allowed on the network.

Maskable Non-priority WRITE operations allow specified bits of a SY/MAX register to be written to without changing the other bits of that register. This operation uses a bit mask value that specifies which bits in the destination register will be alterable by the Maskable WRITE operation. See Section 7.4.2 for more information.

Priority WRITE operations are normally used for processor-to-processor communications. As described above, Priority WRITEs can preempt Non-Priority WRITEs. NOTE: Priority WRITEs should be employed in the user program only when there is a critical need to send data as quickly as possible. Over-use of Priority WRITEs can interfere with other network communications.

The following sections discuss the programming necessary to perform WRITE operations.

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NOTE: All data supplied to the SY/LINK board must be in the personal computer (low byte/high byte) format.

7.4.1 NON-PRIORITY WRITE

To perform a Non-priority WRITE, the user program must set appropriate values for the following parameters (this information is summarized in Figure 7.7):

SY/LINK Opcode (location 24H) -- A value of 02H must be placed in the opcode location to select a Non-priority WRITE.

SY/MAX Register Count (location 25H, 26H) -- The value at this location determines how many SY/MAX data registers will be written to. A maximum of 128 registers can be written to in one operation.

SY/NET Route (location 2CH-34H) -- Values at this location identify the network route to the device containing the registers to be written. A message can include a maximum of eight route values. Note: The list of routes must terminate with a route value of FFH. To write to the SY/MAX processor equivalent registers on the SY/LINK board, use FFH as the first route value.

SY/MAX Register Address (3EH, 3FH) -- The value at this location specifies the starting address of the group of register being written to.

Write Data Buffer (40H-13FH) -- This is the area where the data to be sent to the SY/MAX registers is stored. Beginning at 40H, 16 bits are allocated for each register value. This data is sent in sequence to the block of registers defined by the SY/MAX Register Address and SY/MAX Register Count values. Note: a Random Access READ of greater than one register will overwrite the write data buffer with addresses of the registers to read (see Section 7.3.3).

7.4.2 MASKABLE NON-PRIORITY WRITE

To perform a Maskable Non-priority WRITE, the user program must set the same parameters described for a standard Non-priority WRITE with the following differences:

The SY/LINK Opcode value for a Maskable Non-priority WRITE is 03H (placed in location 24H).

A register bit mask must be placed in location 27H, 28H. This bit mask is simply 16 bits that determine which bits in the destination register(s) will be changed. A "1" value in a bit mask location allows the corresponding bit in the destination register to be altered by the

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Maskable WRITE operation. A "0" value in a bit mask location prevents the corresponding bit in the destination register from being altered. Figure 7.5 illustrates the effects of various bit mask values.

BIT MASK			MODIFIABLE BITS
28H	27H		
0000 0000	0000 0000	(0000H)	No bits modifiable.
0000 0000	0000 0001	(0001H)	Bit 1 modifiable.
0000 0000	0000 0010	(0002H)	Bit 2 modifiable.
0000 0000	0000 0011	(0003H)	Bits 1 and 2 modifiable.
•	•		
•	•		
1111 1111	1111 1111	(FFFFH)	All bits modifiable

Figure 7.5 - Bit Mask Values

7.4.3 PRIORITY WRITE

To perform a Priority WRITE operation, the same parameters must be set as described in the Non-Priority WRITE section (7.4.1). The only difference is the SY/LINK Opcode value which is 1EH (in location 24H) for a Priority WRITE.

This information is summarized in Figure 7.7.

NOTE: The maximum number of registers that can be written to by a Priority WRITE command depends on the Type and series of SY/MAX processor being accessed. This information is summarized in the following table.

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PROCESSOR	MAXIMUM MESSAGE LENGTH
SCP-1XX	16 registers
SCP-3XX	16 registers
SCP-4XX	128 registers
SCP-5XX rev. 1-6 rev. 7 & up	64 registers 128 registers
SCP-6XX	128 registers
SCP-7XX	64 registers
DLM-110	128 registers
DLM-120	128 registers
PCM-110	64 registers

Priority WRITE Register Limits

7.4.4 WRITE OPERATION SEQUENCE

The following is a description of the sequence of events in a WRITE operation. See Figure 7.6 for a graphic representation of this sequence.

1. First, the user program loads the WRITE parameter values and the data values to be written into the appropriate memory locations.

2. The user program sets the Send Flag (20H) to a non-zero value to inform the SY/LINK board that a communication is ready.

3. The SY/LINK board performs the desired WRITE operation. If the WRITE is successful, the SY/LINK board will reset the Send Flag to zero. If the WRITE is unsuccessful, the SY/LINK board will place an error code in the Error Flag location (21H,22H) and reset the Send Flag.

4. By monitoring the Send Flag, the user program can tell if the WRITE was successful. If an error (non-zero value) is detected in the Error Flag location, the user program can reset the error code by placing a non-zero value in the Reset Flag location 23H or by setting the Send Flag to send another message.

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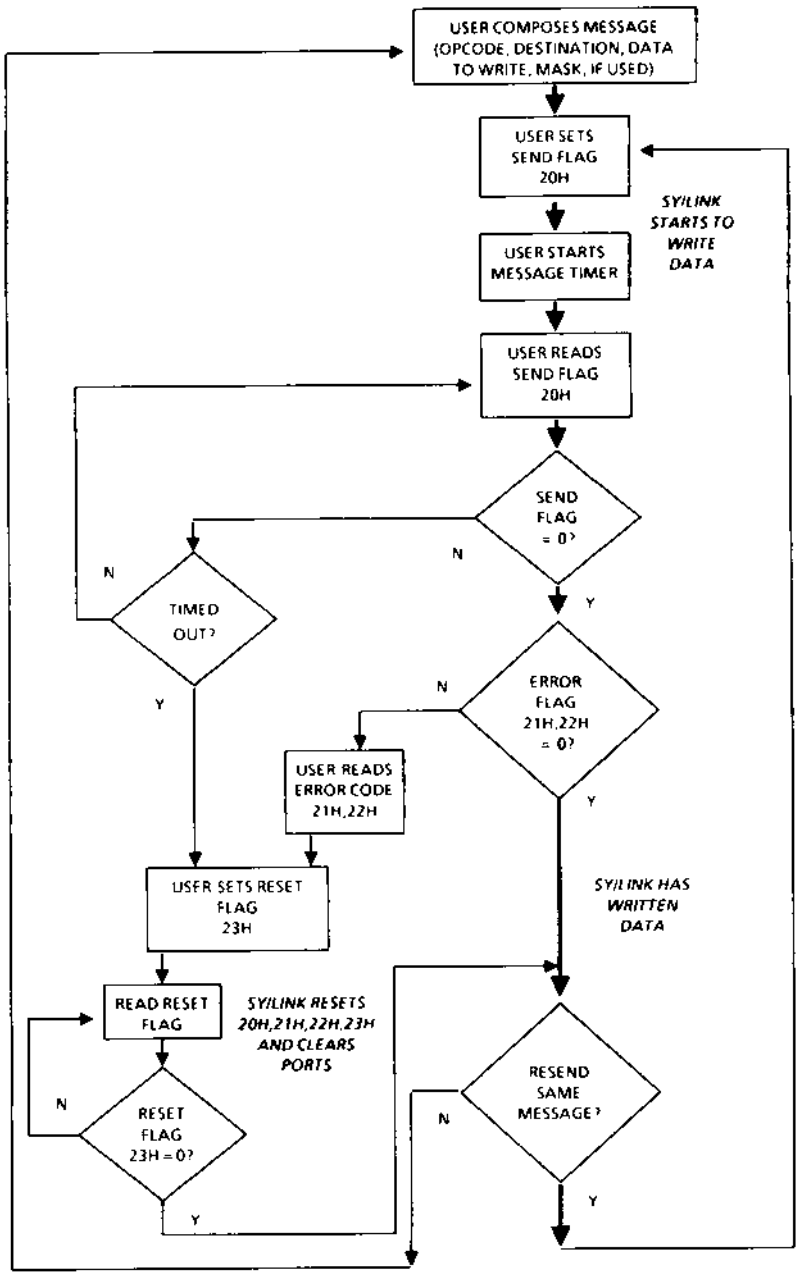


Figure 7.6 - WRITE Operation Sequence

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	NON-PRIORITY WRITE	MASKABLE NON-PRIORITY WRITE	PRIORITY WRITE
SY/LINK OPCODE 24H	02H	03H	1EH
SY/MAX REGISTER COUNT 25H, 26H	1 TO 128	1 TO 128 See Restrictions Sec. 7.4.3	1 TO 128
REGISTER BIT MASK 27H, 28H	NOT USED	16 BIT MASK	NOT USED
SY/NET ROUTE 2CH-34H	000 TO 254	000 TO 254	000 TO 254
SY/MAX REGISTER ADDRESS 3EH, 3FH*	0001 TO 8192*	0001 TO 8192*	0001 TO 8192*
WRITE DATA BUFFER 140H-23FH	-32767 TO 32768	-32767 TO 32768	-32767 TO 32768

* Not all registers above 8000 are writable by SY/LINK. See any SY/MAX programming manual for information about which control registers are read/write and which are read only.

Figure 7.7 - WRITE Operation Parameter Summary

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7.5 Error Handling and Security

During a READ or WRITE operation, the user program can monitor the Error Flag location (21H) for non-zero values. A non-zero value placed here during a communication indicates that the communication was unsuccessful due to an error condition.

A list of command/reply error codes and their meanings is given in Appendix C.

As described in Section 5.3, the SY/LINK board will automatically retransmit network messages up to four times if the message is not acknowledged or if a negative acknowledgment is received.

The user program can be designed to respond to the error in a manner corresponding to the nature of the error. For example, if the error code is 017 (Remote Device Inactive), the user program could display or print a message informing an operator that the remote device is unpowered or not connected.

The Error Flag location (21H,22H) can be reset before the next communication is attempted. A non-zero value placed in location 23H will reset the Error Flag.

7.5.1 MESSAGE TIMEOUT

The user program should start a timer each time the SY/LINK board is requested to transmit a message. This message timer will set an upper limit on the amount of time the user program will wait for the SY/LINK board to reset the Send Flag (20H).
When the SY/LINK board resets the Send Flag, the user program should reset the message timeout timer.

The length of time to allow for a message to be completed depends on the nature of the application. In some applications, each message will be completed in a consistent amount of time.

However, if the application includes slower communications caused by several net-to-net links, lower baud rates, busy networks, or a combination of these conditions, message times will lengthen and become more variable.

The user program should take appropriate action if the SY/LINK board does not reset the Send Flag in the time allowed by the message timer.

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Suggested action in the event of a timeout is to set the Reset Flag (23H) and either resend the original message, send another message, or alert the operator that a timeout has occurred. The Reset Flag must be set before the Send Flag can be set to send another message. The Send Flag must be reset before it can be set for the next message.

7.5.2 PROCESSOR CONTROL REGISTERS

Register data can be obtained from and written to a SY/MAX processor directly or over the network even when the SY/MAX processor is halted or in disable outputs mode.

To further determine the cause of communication errors, the user program should read the contents of SY/MAX processor control registers .

Each SY/MAX processor contains a block of control registers in the 8000 range which indicate the operating status of the processor. There are also bits in these registers which can be altered to change the processor operating mode (run/halt, forcing enable, etc.). A complete description of these registers can be found in the instruction bulletins for SY/MAX processors.

Here are some examples of information that can be obtained from processor control registers.

Item	Register
Processor Scan Time	8172
Processor Error Number	8175
Processor Monitor/Control	8176
Processor Mode/LED Status	8186
Number of Rungs in Memory	8187
Processor Type	8188
Memory Used	8191-8192

It is strongly recommended that the user program examine the processor control registers at the initialization of the user software and periodically during steady state operation.

There are several advantages to reading the processor control registers. Some of these advantages are:

- Verification that the SY/MAX processor is in Run or Halt as intended.
- Assurance that the SY/LINK board is communicating with the correct SY/MAX processor.

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- Confirmation that the proper ladder diagram is installed in the SY/MAX processor.

The user program can easily monitor the status of the SY/MAX processor lights and keyswitch, and present this information to the user.

7.6 Alarm Handling

SY/MAX processors can be programmed to send ALARM messages (see Section 9.3.3). ALARM messages are similar to WRITE messages except that ALARM messages send a constant value (alarm code) rather than variable data from a storage register. The receiving device can be programmed to respond to various alarm codes in an appropriate manner.

7.6.1 ALARM QUEUES

The SY/LINK board has an area of memory set aside as three alarm queues. Each alarm queue can store 20 alarm messages in the order in which they are received. Each stored alarm message contains the alarm code, the network route from the device that send the alarm, and (optionally) some additional alarm data. See Figure 7.8.

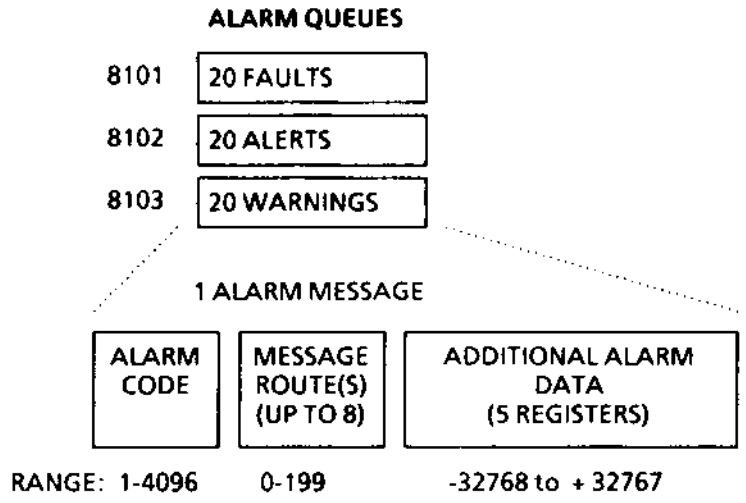


Figure 7.8 - SY/LINK Board Alarm Queues

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The three alarm queues are called Warnings, Alerts and Faults. Having three separate queues allows the alarm messages to be categorized in different levels. Generally, Warnings are considered the least serious kind of alarm, Alerts are more serious, and Faults are the most serious. However, the manner in which each type is responded to depends on how the user program is designed.

Each of the three SY/LINK alarm queues has a SY/MAX register address, allowing SY/MAX devices to direct alarm messages to the appropriate queue. The Fault queue is 8101, the Alert queue is 8102, and the Warning queue is 8103. For example, the following ALARM rung in a SY/MAX processor (network address 120) would put an alarm code in the fault queue of a SY/LINK board (network address 011).

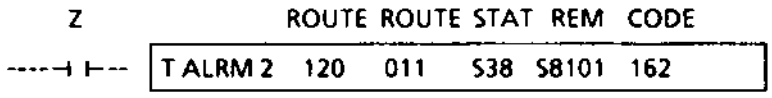


Figure 7.9 - Example SY/MAX ALARM Rung

Messages can be placed in an alarm queue via ALARM commands or WRITE commands. When a WRITE command is used, up to five registers of data can be written to a message location in an alarm queue. The first register serves as the alarm code, while the other 5 registers can provide additional data from the initiating device. Not only does a WRITE rung allow more information to be sent to the queue than an ALARM rung, the data is dynamically definable. That is, the alarm "code" information may be loaded into the SY/MAX processor register based on real-time I/O status and other real-time conditions. With an ALARM rung, the alarm code is fixed when the ladder program is developed.

Refer to Section 9.2 for more information on ALARM and WRITE rungs.

The user program can utilize SY/LINK opcodes to view an alarm, acknowledge an alarm (to the device that sent it), and clear the alarm from the queue.

7.6.2 ALARM CHANGE FLAGS

When an alarm is received in one of the alarm queues, the change flag for that queue is set to its new count.

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The alarm change flag locations are:

	CHANGE FLAG	COUNT	QUEUE SELECT
Fault Queue	2H	24DH	24AH
Alert Queue	3H	24EH	24BH
Warning Queue	4H	24FH	24CH

The user program can be designed to poll for a flag change or be interrupted by a flag change. The program can then view the error code and take other appropriate action. Alarm change flags are only cleared at power-up and restart by SY/LINK. It is not recommended that the user program clear these flags since notification of a new, incoming alarm could be lost. Instead, the user program should save the current value for comparison to future values.

7.6.3 VIEWING ALARMS

To view an alarm, the user program selects which alarm in the queue it wishes to see and copies the alarm data to a buffer where it can be be viewed.

Following is the procedure for viewing an alarm message.

1. The user program detects an Alarm Change flag.

2. The user program should check the Alarm Count location for the appropriate queue to determine the number of alarm messages there. (Alarm count locations: Fault Queue 24DH, Alert Queue 24EH, Warning Queue 24FH.)

3. The user program selects which message (1 to 20) in the queue to view. It places this number in the Alarm Select location. (Alarm select locations: Fault Queue 24AH, Alert Queue 24BH, Warning Queue 24CH.)

4. The user program places the view command opcode in the Alarm Command location (243H). (View command opcodes: View Fault 01H, View Alert 02H, View Warning 03H.)

5. The user program sets the Go Flag (240H) to a non-zero value.

6. When the Go Flag is cleared, the selected message is available for viewing in the Alarm Message Data Buffer (260H-27FH). The terminating value in the Alarm Message Data Buffer is 00H. Routing information for this message is available in the Alarm Message Route Buffer (280H-289H). The terminating value in the Route Buffer is FFH.

7. The user program should also check the Error Number location (241H, 242H) for possible faulty parameters (Ref. Appendix C3). The

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Error Number location is cleared when the next command is entered or when the card is reset.

7.6.4 ACKNOWLEDGING ALARMS

If the application requires it, the user program can acknowledge the alarm (send the alarm code back to the originating device).

When a WRITE rung has been used to send a group of registers as an alarm message, only the first register is written back to the initiating processor as an acknowledgment (priority write format).

Following is the procedure for acknowledging an alarm message.

1. The user program sets the number of the alarm message to be acknowledged in the Alarm Select location. (Alarm Select locations: Fault Queue 24AH, Alert Queue 24BH, Warning Queue 24CH.) This number must not be greater than the number in the Alarm Count location.

2. The user program places the acknowledge command opcode in the Alarm Command location (243H). Two command options are available; acknowledge the alarm, or clear and acknowledge the alarm. (Acknowledge opcodes: Faults 11H, Alerts 12H, Warnings 13H. Clear and Acknowledge opcodes: Faults 31H, Alerts 32H, Warnings 33H.)

3. The user program puts a value in the Acknowledge Register that determines which register in the initiating device the alarm code is sent back to. (Acknowledge Register locations: Faults 244H,245H; Alerts 246H,247H; Warnings 248H,249H) On power-up the Acknowledge Register values default to values that are appropriate for SY/MATIC welder controls, but which may not be appropriate for other Square D devices. (Acknowledge Register default values: Faults 8101, Alerts 8102, Warnings 8103.)

4. The user program sets the Go Flag (240H) to a non-zero value.

5. The SY/LINK board clears the Go Flag when the message has been acknowledged (and cleared if the Clear and Acknowledge command was used) back to the originating device.

6. The user program should also check the Error Number location (241H, 242H) for possible faulty parameters. The Error Number location is cleared when the next command is entered or when the card is reset.

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NOTE: Alarms received via broadcast alarm messages should not be acknowledged. If they are acknowledged, error 29 will be posted in Error Number location 241H,242H. Error Number location 241H,242H is cleared when the next command is entered or when the SY/LINK board is reset.

7.6.5 CLEARING ALARM MESSAGES

Alarm messages remain in the alarm queues until they are cleared by the user program. When an alarm queue is full, the SY/LINK board will accept no more alarm messages for that queue.

Alarm messages can be cleared individually (usually after being viewed) with the Clear command. There is a Clear And Acknowledge command that clears an alarm after acknowledging it (see Section 7.6.4). There is also a command for simultaneously clearing all three alarm queues.

Following is a procedure for clearing individual alarms.

1. The user program sets the number of the alarm to be cleared in the Alarm Select location. (Alarm Select locations: Fault Queue 24AH, Alert Queue 24BH, Warning Queue 24CH.) This number must not be greater than the number in the Alarm Count location.

2. The user program places the clear command opcode in the Alarm Command location (243H). (Clear opcodes: Faults 21H, Alerts 22H, Warnings 23H.)

3. The user program sets the Go Flag (240H) to a non-zero value.

4. The SY/LINK board clears the Go Flag when the message has been cleared.

5. The user program should also check the Error Number location (241H, 242H) for possible faulty parameters. The Error Number location is cleared when the next command is entered or when the card is reset.

To clear all alarms, use the following procedure.

1. The user program places the Clear All Alarm opcode (24H) in the Alarm Command location (243H).

2. The user program sets the Go Flag (240H) to a non-zero value.

3. The SY/LINK board clears the Go Flag when all the alarm queues have been cleared.

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4. The user program should also check the Error Number location (241H, 242H) for possible faulty parameters. The Error Number location is cleared when the next command is entered or when the card is reset.

7.6.6 Alarm Command (243H)

	Faults	Alarms	Warnings
View	01H	02H	03H
Acknowledge	11H	12H	13H
Clear	21H	22H	23H
Clear & Acknowledge	31H	32H	33H
Clear All w/o Ack	24H	24H	24H

OPCODE SUMMARY

7.7 Unsolicited Message Handling

Devices on the network can write data into the 512 SY/MAX processor equivalent (mailbox) registers contained on the SY/LINK board. This allows the SY/LINK board to receive unsolicited data.

A Register Change Flag location (0H, 1H) contains the address of the last register to be written to. (If a block of registers is written to, the Register Change Flag location contains the lowest register number of the block.)

By monitoring the Register Change Flag, the user program need not poll all 512 registers to detect a change. The SY/LINK board can also be configured to generate an interrupt to the personal computer whenever a mailbox register is written to (see Section 7.2.1).

Register addresses in the Register Change Flag are only cleared on power-up and restart by SY/LINK. Repetitive writes to the same mailbox register will **not** change the address in the Register Change Flag after the first write. However, each write to the mailbox registers will generate an interrupt to the computer, if this interrupt condition is enabled.

When the interrupt method is used, the recommended action for the user program is to first clear the interrupt by reading NIM Flags (3FEH) and then read the Register Change Flag (0H, 1H) to verify that it has caused the interrupt. This allows a second interrupt to be latched if it occurs during the interrupt service routine.

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8.0 TROUBLESHOOTING

8.1 General

If the SY/LINK board does not appear to provide proper network communication, an attempt should be made to determine whether the problem lies with the board, with the user program, or with hardware or software elsewhere on the network.

8.2 SY/LINK Board

To check the SY/LINK board for proper operation, answer the following questions.

Is the board receiving power from the computer?

When the computer is powered up, the green Active light on the SY/LINK board should flash. If the light does not illuminate, the board is probably not receiving power. Try mounting it in another slot (power down the computer first).

Is the board using an acceptable part of the computer's memory?

The DIP switch on the SY/LINK board selects the address range in the computer memory that is used for SY/LINK functions. This range must be used by no other boards or programs. The SY/LINK application user program must be written to use the selected memory range. See Section 2.2 for DIP switch settings.

Are the cables properly connected to the SY/LINK board?

The network connection cable and the cable to the RS-422 port device (if used) must be securely connected at both ends. See Section 4.3.

Is the user program or SY/MATE programming software loaded and running in the computer?

The user program must be running to initialize the SY/LINK board and to activate communication functions. The SY/MATE software can automatically load initialization parameters, but only after these values have been previously loaded and stored in an AUTO.SQD file using the initial utility and auto modes of the software.

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Is the user program or SY/MATE software loading acceptable SY/LINK board parameters?

The user program or SY/MATE software can initialize the SY/LINK board with values that can cause communication problems. (Sections 6 and 7 discuss initialization.) The network address of the SY/LINK board must be used by no other interface on the network. The SY/LINK board must be in the Mailbox mode for the user program to communicate on the network. The network size and baud rate values must match the values used by every other interface (SY/LINK board or NIM) on the network. See Section 8.2.2 for information on reading SY/LINK parameters.

Is the SY/MATE software compatible with the board?

The Type SFW-333 software is supported by the Type SFI-533 and 534 SY/LINK boards. The Type SFW-334 software is supported only by the Type SFI-534 board. The Type SFI-510 board does not support SY/MATE programming software.

Has proper routing been established for the SY/MATE software?

When using SY/MATE programming software, routing must be set to the board to communicate through the RS-422 port or through the network port to one of the controllers on the network. This routing is set in the Network Port Setup mode of the SY/MATE software. To communicate to the RS-422 port device, use route 1XX, where XX is the interface number assigned to the SY/LINK board. To communicate to another device on the network, use an appropriate route sequence (see Section 5.4).

Are other devices on the network connected, powered up, and running?

Attempts to communicate to an unpowered or disconnected device will generate communication errors.

Is there an interrupt level conflict?

The SY/LINK board must not use an interrupt that is also used by another board.

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8.2.1 SY/LINK BOARD DIAGNOSTIC PROGRAM

The Demonstration/Example disk provided with the SY/LINK board contains a diagnostic program which may be run to test various parts of the board hardware.

This program requires a test plug to be inserted in the RS-422 port to test this port. The test plug may be ordered from Square D (Class 8010 Type CTP-11) or it can be built by connecting pins 1 to 3 and pins 2 to 4 on a 9-pin male plug.

To run the diagnostic program, insert the Demo/Example disk in the appropriate drive, type the filename TESTNIM and press the Enter (Return) key. The following screen will appear.

```
SY/LINK DIAGNOSTICS Version 1.0
(C)Copyright Square D Company 1987

SELECT THE STARTING ADDRESS THAT SWITCH S1 IS SET TO

        0 - CA000
        1 - CB000
        2 - CC000
        3 - CD000
        4 - CE000
        5 - CF000
        6 - D0000
        7 - D1000
        8 - D2000
        9 - D3000

ENTER 0 - 9 TO SELECT AN ADDRESS
```

Press the number key that corresponds to the memory range selected on the SY/LINK board DIP switch. If a key other than the ones requested is struck, the request will be repeated. After a number has been selected, press the Enter key. The following screen will appear.

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```
SELECT THE INTERRUPT LEVEL BEING USED WITH THE
SY/LINK CARD

    0 - NONE
    2 - INTERRUPT LEVEL 2
    3 - INTERRUPT LEVEL 3
    4 - INTERRUPT LEVEL 4
    5 - INTERRUPT LEVEL 5
    6 - INTERRUPT LEVEL 6
    7 - INTERRUPT LEVEL 7

ENTER 0 - 7 (EXCEPT 1) TO SELECT INTERRUPT LEVEL
```

Press the number key that corresponds to the interrupt level that the SY/LINK board has been initialized to use. Press the Enter key. The following message will appear.

```
PLACE SELF TEST PLUG ON RS-422 PORT AND DISCONNECT
NETWORK PORT. STRIKE ENTER KEY WHEN READY.
```

After inserting the test plug and pressing the Enter key, the testing will begin. The following screen will appear with the "TEST COMPLETED" lines appearing one by one as each test is successfully passed. Allow several minutes for all nine tests to be completed.

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```
PASS 1 STARTED.
STRIKE THE ESCAPE KEY TO EXIT DIAGNOSTICS.

    TEST 1 COMPLETED - PROGRAMMABLE TIMER CHECK
    TEST 2 COMPLETED - RS-422 PORT CHECK
    TEST 3 COMPLETED - SY/LINK ROM CHECKSUM CHECK
    TEST 4 COMPLETED - SY/LINK SYSTEM RAM 1 CHECK
    TEST 5 COMPLETED - SY/LINK SYSTEM RAM 2 CHECK
    TEST 6 COMPLETED - DMA / NETWORK PORT CHECK
    TEST 7 COMPLETED - SY/LINK DUAL PORT RAM CHECK
    TEST 8 COMPLETED - PC DUAL PORT RAM CHECK
    TEST 9 COMPLETED - PC INTERRUPT CHECK
```

NOTE: If no interrupt (0) was selected, Test 9 will not be run.

When all tests are completed, the following message will appear:

```
ALL TESTS COMPLETED SUCCESSFULLY. PASS 2 STARTED.
STRIKE THE ESCAPE KEY TO EXIT DIAGNOSTICS.
```

The diagnostic tests will repeat until the Escape key is pressed. (There may be a short delay after pressing the Escape key while the diagnostic program finishes a test.)

If the personal computer is unable to communicate with the SY/LINK board, the following error message will be displayed.

```
***** SY/LINK TIMEOUT ERROR *****
- VERIFY STARTING ADDRESS AND INTERRUPT LEVEL ARE CORRECT-
```

Check to be certain that the memory range and interrupt level selected at the beginning of the diagnostic program match those actually being used by the board.

If the board fails to pass any of the nine tests, the following messages will be displayed for the corresponding test.

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ERROR 1 - PROGRAMMABLE TIMER FAILURE
ERROR 2 - RS-422 PORT FAILURE
ERROR 3 - SY/LINK ROM CHECKSUM FAILURE
ERROR 4 - SY/LINK SYSTEM RAM 1 FAILURE
ERROR 5 - SY/LINK SYSTEM RAM 2 FAILURE
ERROR 6 - DMA / NETWORK PORT FAILURE
ERROR 7 - SY/LINK DUAL PORT RAM FAILURE
ERROR 8 - PC DUAL PORT RAM FAILURE
ERROR 9 - INTERRUPT XX FAILURE

These messages indicate a fault in the listed part of the SY/LINK board hardware.

8.2.2 READING SY/LINK PARAMETERS

To diagnose problems, it may be necessary to verify that the user program loaded the correct parameters into the SY/LINK board on initialization.

Each SY/LINK board has 15 16-bit registers of data that are readable after the SY/LINK board has been initialized.

These SY/LINK board status registers are accessed by using the route value sequence 201, 200, 201, FFH. Following this route, a conventional READ procedure starting at register 1 with a count of 15, will place data in the Reply Data Buffer. See Section 7.3 for information on READ operations.

The data from these 15 registers will consist of the following (only the first five registers are relevant to the user):

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1. Device Type
2. SY/LINK Software Revision Level*
3. Drop Number
4. Port 0 Parameters
5. Port 1 Parameters
6. Serial Port Number
7. Port 0 Broadcast Enable
8. Port 1 Broadcast Enable
9. Receive Network Error
10. Transmit Network Error
11. Contents of SY/LINK Location 3F8
12. Contents of SY/LINK Location 3FD
13. Contents of SY/LINK Location 3FC
14. Contents of SY/LINK Location 3FB
15. Contents of SY/LINK Location 3FA

* The software revision level for the first SY/LINK board release is 100 or 64H.

A BASIC program on the Demonstration/Example disk provided with the SY/LINK board demonstrates how to read and display the current board parameters. This program has the filename NETWORK. It may be studied for programming techniques.

8.2.3 ERROR CODES

The SY/LINK board stores error codes that indicate the causes of errors that occur during certain operations. The three error code locations are:

Location	Description
3F8H	Setup (Initialization) Errors. Errors that occur during initialization of SY/LINK board parameters, or when attempts are made to change certain parameters after initialization.
21H-22H	Error Flag (Command/Reply). Errors that occur during communication operations.
241H-242H	Alarm Parameters Errors. Errors due to faulty parameters used to access alarm messages.

The user program should be designed to check for error codes in these locations and alert the operator or perform other appropriate actions when errors occur. Appendix C provides lists of error codes.

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8.3 System Troubleshooting

If the SY/LINK board appears to be operating properly, but cannot communicate to one or more other network locations, check for the following conditions.

Other network locations connected and powered up (check for loose cable connections).

Other network interfaces set for their correct network addresses.

Error lights on NIMs.

See the NIM Instruction Bulletin (30598-257-XX) for more network troubleshooting information.

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9.0 SY/MAX COMMUNICATION PROGRAMMING

9.1 General

This section is intended to give the SY/LINK user an overview of programmable controller communication on the SY/NET network. Additional information can be found in the following Instruction Bulletins:

30598-257-XX SY/NET Network Interface Module (NIM)
30598-167-XX SY/MAX Deluxe CRT Programmer
30598-272-XX SY/MAX D-LOG Data Controller Module

SY/MAX programmable controllers store and exchange information as register data. Timer and counter values are stored as register values. I/O status is stored as individual bits of data registers. SY/MAX processors also have control registers in which some bits identify current processor conditions and other bits control processor operating modes.

The activities of any processor, therefore, can be monitored or controlled by looking at or changing (reading or writing) the data in its registers. This can be done by devices connected directly to the processor or by devices communicating over the SY/NET network.

In addition, SY/MAX programming devices such as CRT Programmers and personal computers with programming software can send entire ladder programs to processors over the network.

9.2 SY/MAX Processor Communication Rungs

SY/MAX processors are able to initiate communication through communication rungs included in their ladder programs. When these rungs are activated, the specified information is sent or retrieved.

The following communication rung instructions are available:

READ
WRITE
ALARM

READ - A READ rung is used to obtain the contents of one or more registers in a remote device and store this data in one or more registers in the device initiating the command (the local device).

WRITE - A WRITE rung is used to send register data values from the local device to registers in the remote device.

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ALARM - An ALARM rung is used to send a constant value from the local device to a storage register in the remote device.

These commands can be sent via a direct cable connection between devices or over the SY/NET network.

9.2.1 ROUTING

For communication over the network, routing information must be added to the communication rungs. The route numbers identify which device is initiating the communication (source) and which device is receiving the communication (destination).

A route number is simply the address number of the network interface to which the device is connected, preceded by a 0 or 1 depending on which interface port the device is connected to. For example, in Figure 9.1, the device connected to port 1 of interface 56 has a route value of 156.

9.2.2 NET-TO-NET ROUTING

For communication from one network to another, more than two route numbers are required. Between the originating route and the destination route, a net-to-net route is placed. The net-to-net route is the interface and port number that connects the two networks; this number must be the same on both networks.

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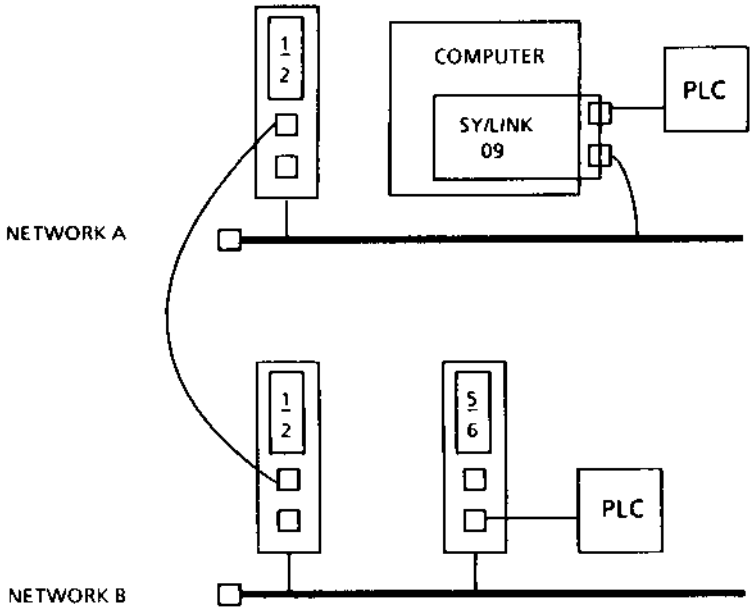


Figure 9.1 - Net-to-net Communication

In Figure 9.1, a communication from the PLC on network A to the PLC on network B would use the following route values: 109 (originating), 012 (net-to-net), 156 (destination).

If more than two networks are connected, a series of net-to-net route values may be used to route a message through several networks.

9.3 Example Rungs

9.3.1 READ RUNGS

Figure 9.2 shows a sample network layout.

Suppose PLC A requires some register data from PLC B. This can be accomplished by programming the READ rung in Figure 9.3 into PLC A.

The rung will read the contents of registers 30, 31, and 32 from the remote PLC (PLC B) and put the data into registers 20, 21 and 22 of the local PLC (PLC A). The purpose of each element of the rung is as follows:

Z The initiating contact which activates the rung.

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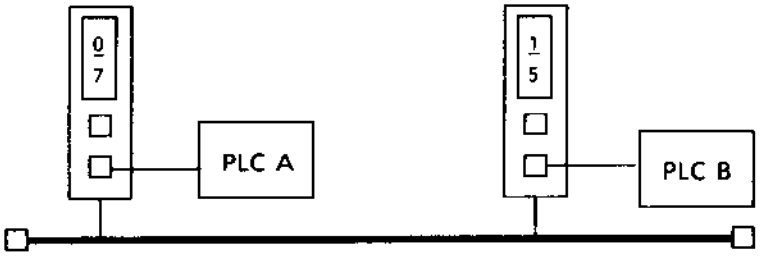


Figure 9.2 - Example Network Layout

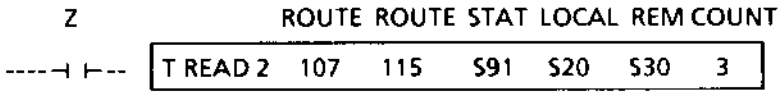


Figure 9.3 - Network READ Rung

READ	The command for getting data from another PLC.
2	Refers to communication using processor COMM port #2.
ROUTE 107	The network route number for the initiating device (PLC A).
ROUTE 115	The network route number for the destination device (PLC B).
STAT S91	Use register S91 as the status register. The status register contains information on the progress of the communication message.
LOCAL S20	The first register (starting address) in the local PLC to contain the data to be read.
REM S30	The first register in the remote from which data will be read.
COUNT 3	The number of consecutive registers that will be read.

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The communication rung is enabled once for each closure of contact Z because the READ rung is transition sensitive (indicated by the T before the READ command).

Communication Progress

During communication (contact Z closed), the STAT (status) register will contain data on the progress of the communication rung. The following is a description of the status register data. (This information applies equally to READ, WRITE, and ALARM rungs.)

Status Register Bit	Description
Bit 1	ON = error in communication
Bits 1-14	Error code (1 through 16383; all error codes are odd numbers). If an error is encountered in communications, an odd number error code will be put into the status register. See Appendix C for a list of error codes.
Bit 15	RUN/HALT status of remote processor. ON = Remote processor in Run mode. OFF = Remote processor in Halt mode. (Only valid when bit 16 is on - message complete.)
Bit 16	ON = Communication is complete. This bit can be used to initiate automatic repeat of communication rungs.
Bit 17	ON = Communication started, message is being sent.
Bit 22	ON = Rung enabled, continuity present up to the communication box.

These status bits can be used as ladder rung elements for control functions.

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9.3.2 WRITE RUNGS

Suppose PLC A (see Figure 9.2) must send some register data to PLC B. This can be accomplished by programming the following WRITE rung in PLC A.

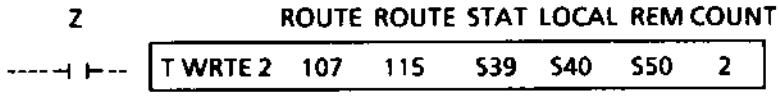


Figure 9.4 - Network WRITE Rung

The rung will write the contents of registers 40 and 41 from the local PLC (PLC A) and put the data into registers 50 and 51 of the remote PC (PLC B). The purpose of each element of the rung is as follows:

Z	The initiating contact which activates the rung.
WRITE	The command for getting data from another PLC.
2	Refers to communication using processor COMM port #2.
ROUTE 107	The network route number for the initiating device (PLC A).
ROUTE 115	The network route number for the destination device (PLC B).
STAT S39	Use register S39 as the status register. The status register contains information on the progress of the communication message.
LOCAL S40	The first register (starting address) in the local PC to be written (sent) to the remote PLC.
REM S50	The first register in the remote PLC in which data will be written.
COUNT 2	The number of consecutive registers that will be written.

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9.3.3 ALARM RUNGS

Suppose PLC B (see Figure 9.2) must inform PLC A whenever a certain condition occurs. This condition is assigned a code number, and whenever PLC A receives this code number (in a certain register) it will take appropriate action. An ALARM rung can be programmed in PLC B to send the code number to PLC A.

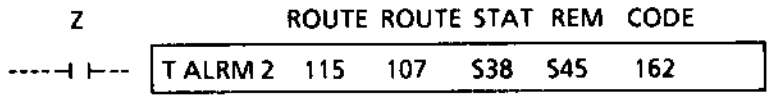


Figure 9.5 - Network ALARM Rung

Z	The initiating contact which activates the rung.
ALARM	The command for sending a constant value to another PC.
2	Refers to communication using processor COMM port #2.
ROUTE 115	The network route number for the initiating device (PLC B).
ROUTE 107	The network route number for the destination device (PLC A).
STAT S38	Use register S38 as the status register. The status register contains information on the progress of the communication message.
REM S45	The register in the remote PLC in which the alarm code will be stored.
CODE 162	The alarm code number that will be sent to the remote PLC.

PLC A would contain rungs to take appropriate action when the alarm code appears in register 45.

9.4 D-LOG Module Communication

The SY/MAX D-LOG module is a rack-mounted data logging module which is programmed in Extended BASIC. It is capable of

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communicating with programmable controllers and other devices, either directly or over the SY/NET network.

While SY/MAX processors use READ and WRITE commands to communicate, D-LOG modules use GETN and PUTN commands. For network communication, each group of GETN or PUTN commands is preceded by a ROUTE statement that establishes the network communication pathway.

Figure 9.6 shows an example network with a D-LOG module connected to port 1 of interface 09 and a programmable controller connected to port 0 of interface 11.

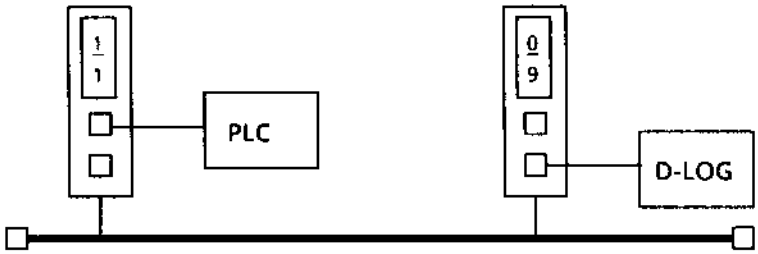


Figure 9.6 - Example Network With D-LOG Module

The following lines in the D-LOG module's BASIC program would perform communication to the programmable controller.

```
10 ROUTE 109,11
20 PUTN 66,95
30 GETN B(1),85,8
```

The function of each of these program lines is as follows:

Line 10 - Establishes the network communication route from the D-LOG module (network address 109) to the programmable controller (network address 011).

Line 20 - Places the value 66 into register 95 of the programmable controller.

Line 30 - Gets the values of programmable controller registers 85 through 92 (8 registers starting at register 85) and stores them in array variables B(1) through B(8).

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9.5 Network Access to SY/LINK Processor Equivalent Registers

The SY/LINK board has a block of 512 registers which are the equivalent of SY/MAX processor storage registers. These SY/LINK processor equivalent registers can be accessed (via READ and WRITE commands) by any device on the network.

It is these processor equivalent registers that enable the SY/LINK board to accept unsolicited messages. Whenever new data is written into this register group by an outside device, the Register Change Flag (0H-1H) is set to a non-zero state. It contains the address of the register that changed. The user program can monitor this flag and take appropriate action when it changes. This frees the user program from the need to constantly monitor each register.

The SY/LINK processor equivalent registers can also be used by devices on the network as a place for storing data. For example, if a processor has no unused registers of its own, it can store additional data in the SY/LINK registers.

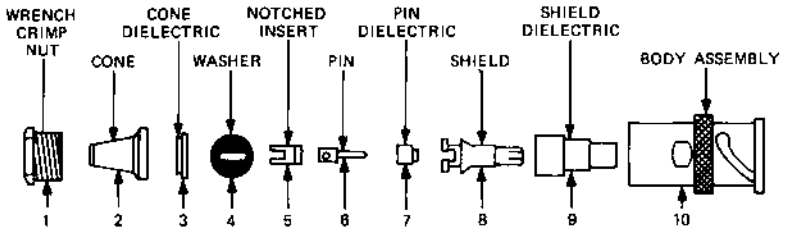
The computer containing the SY/LINK board uses a route value of FFH to READ or WRITE to the processor equivalent registers. For other network devices to access the SY/LINK registers, they simply include the network address of the computer as the destination (remote) route value of the communication command.

The SY/LINK processor equivalent registers are addressed as registers 1 through 512.

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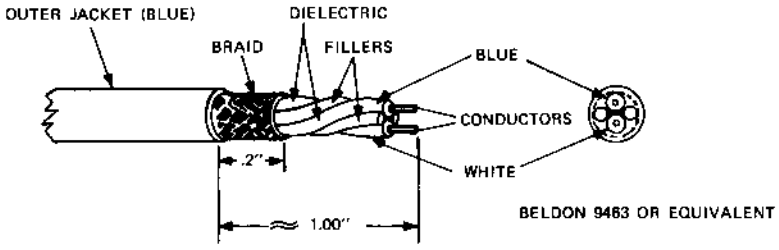
APPENDIX A - INSTALLING A NETWORK CABLE END

The network cable end (Class 8030 Type CCK-221) consists of ten parts.



NETWORK CABLE END

The twinaxial network cable (Belden 9463 or equivalent) consists of seven parts.



TWINAX CABLE

The following is a procedure for assembling a network cable end on the twinax cable.

STEP 1 - Place WRENCH CRIMP NUT (1) onto network cable; threaded part of nut should face right.

STEP 2 - Strip approximately one inch (2.5 cm) of insulation from end of cable, being careful not to damage shield wires.

STEP 3 - Cut back BRAIDED shield to within 0.2 inches (0.5 cm) of the cable jacket.

STEP 4 - Cut off filler cords to cable jacket.

STEP 5 - Thread blue and white wires through small end of CONE (2) and press cone into cable until recessed into cable jacket (cable end will flare out).

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STEP 6 - Place small end of CONE DIELECTRIC (3) over wires and seat inside CONE (2).

STEP 7 - Place red WASHER (4) over wires and seat against CONE DIELECTRIC (3).

STEP 8 - Cut blue and white wires to a length of 0.35 inches (0.9 cm) measured from red washer (4).

STEP 9 - Strip insulation off blue wire 0.2 inches (0.5 cm).

STEP 10 - Tin the BLUE wire.

STEP 11 - Bend the WHITE wire at a right angle away from the BLUE wire.

STEP 12 - Place white NOTCHED INSERT (5) over BLUE wire and press until flush with red WASHER (4). (WHITE wire should fit into notched insert.)

STEP 13 - Place PIN (6) over BLUE wire. Pin should be flush with NOTCHED INSERT (5).

STEP 14 - Carefully solder pin (6) to BLUE wire (apply solder bead to hole in side of pin).

STEP 15 - When solder cools, test connection by lightly pulling pin (6) with pliers - a common problem found with cable is cold solder joints.

STEP 16 - Place shield (8) over PIN assembly and seat against red WASHER (4). Thread WHITE wire through notch in SHIELD (8).

STEP 17 - Strip WHITE wire back 0.25 inches (0.6 cm).

STEP 18 - Wrap WHITE wire around shield (8) and solder. Let cool.

NOTE: Solder and wire must not extend beyond shield ridge - otherwise WHITE wire could come in contact with connector body.

STEP 19 - Place SHIELD DIELECTRIC (9) over shield (8) until flush with red WASHER (4).

STEP 20 - Place BODY ASSEMBLY (10) over shield assembly.

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STEP 21 - Thread WRENCH CRIMP NUT (1) into BODY ASSEMBLY (10).

STEP 22 - Perform continuity check on cable - you should have 10K ohms or greater resistance between blue wire and white wire and either wire and shield. If a lower resistance is found, check for short in cable end, cable, or opposite cable end.

NOTE: Resistance measurement should be made:
(1) without network interfaces attached
(2) without terminator attached

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APPENDIX B - DESCRIPTION OF EXAMPLE PROGRAMS ON SY/LINK DEMO DISK

ALARM1 - BASIC program for "mailbox" mode to provide alarm queue management; it allows a user to monitor the number of faults, alerts and/or warnings, to view a chosen alarm, to acknowledge a chosen alarm, to clear a chosen alarm, and to clear all alarms.

MAILBOX - C program, composite of alarm handling, register read/writes announced via interrupt routine. Program was compiled using Lattice MS-DOS C, version 3.11, copyright 1984 and linked using MS-DOS Linker.

NPREAD - BASIC program for "mailbox" mode to demonstrate communication time for 100 reads of a block of 32 registers. Register reads are non-priority. Best results are obtained on smaller, lightly loaded networks with the number of drop set to 30 and the network baud set to 500K.

PREAD - BASIC program for "mailbox" mode to illustrate a register read from SY/MAX processor. Scan time (register 8172) is read, using priority reads, and displayed on the screen.

MREAD - BASIC program for "mailbox" mode to illustrate a block read of noncontiguous registers (scattered read). Registers 61, 65, 69, 73, 77 are read in one block and displayed on the screen.

MWRITE - BASIC program for "mailbox" mode to illustrate the set/reset of bits. All parameters are user-selectable to allow for in-house demonstrations.

NPWRITE - BASIC program for "mailbox" mode that sends the current time and date, as resident in the PC, to a user-selectable PLC, registers 75 through 81.

MBTEST - BASIC program for "mailbox" mode doing block reads and writes of Mailbox Registers, 128 registers per block.

NETWORK - BASIC program for"mailbox' mode displaying internal register status of SY/LINK.

TERM1 - BASIC program for "terminal" mode providing terminal emulation for a D-LOG module connected to the RS-422 port. Characters received from the D-LOG are buffered in a 511 byte buffer. Note: since no flow control is provided on this port, an overflow condition can exist at 9600 baud when characters are received faster than the BASIC program can read them.

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NIMINT - Assembly language function to install an interrupt driver. Arguments consist of interrupt level and function name.

TESTNIM - An executable file to test SY/LINK hardware. A selftest plug is required to test the RS-422 port. A Class 8010 Type CTP-11 selftest plug may be ordered from your Square D distributor or build your own by connecting pins 1 to 3 and pins 2 to 4 on a 9 pin male plug.

SYLINK - A Quick Basic Module with a collection of useful subroutines and functions for communicating to SY/MAX devices using the SY/LINK Card. Callable routines include reading and writing to bit, registers and blocks of registers as well as extensive error handling and reporting.

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APPENDIX C - ERROR CODES

C.1 - Setup Error Codes

Presented in Setup Error Location 3F8H (errors associated with SY/LINK hardware failure or invalid setup parameters).

Error Code (Hex)	Description
001H*	Checksum error in Buffer I.
002H*	Checksum error in Buffer II.
003H*	Checksum error in Buffer III.
004H*	SY/LINK executive PROM checksum error.
005H*	Two port RAM diagnostic test error.
006H*	Scratch RAM diagnostic test error.
007H*	No memory available.
008H*	Two Port RAM diagnostic test error.
009H*	Handshaking error.
00AH*	DMA (Direct Memory Access) error
00BH*	ACIA error
020H	Invalid interrupt number.
021H	Invalid drop number.
022H	Invalid Network parameter change.
023H	SY/LINK receive buffer full.
024H	Illegal Bit combo (must be both Term & Periph)
025H	Illegal bit combination for RS-422 word
026H	Illegal port change
027H	Illegal mode change
028H	Illegal drop change
029H	Illegal to select burnin

NOTE: Errors 20H through 29H will not toggle the parameters accepted bit. The error code will be written to the Error Code register. These errors will only occur while in Terminal or Mailbox mode. The user must interrogate the Error Code register to see what caused the error.

*When these errors are generated, SY/LINK must be reinitialized by power cycling or setting 3FFH bit 2 to clear the error. Bit 0 of the NIM Flag (3FEH) will also be set, which will interrupt the computer. The computer will then automatically generate a restart.

Other errors may be cleared by writing a zero to the Error Code register, and correcting the error.

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C.2 - Command/Reply Errors

Presented in ERROR FLAG (21H-22H).

Error Code	Description
000	No Error
001	Illegal Protocol Opcode
002	Illegal Intermediate Code
003	Illegal Address Attempted
004	Illegal Rack Address Attempted
005	Instruction Attempted Which Is Not Allowed
006	Item Being Searched For Cannot Be Found
007	Attempt To Alter Data In A Protected Register
008	Attempt To Alter Data In Protected Memory
009	Attempt To Alter Data In A Read-Only Register
010	Attempt To Exceed Memory Limitations
011	Communications Overflow
012	Illegal CPU Rack Addressing
013	Communications Error
014	The Operation Attempted Is Not Allowed In Run
015	Communication Overflow
016	Register Count Too Large For The Processor
017	Remote Device Inactive
018	The Rung Number Used Is Not Allowed
019	Illegal Read Parameter
020	Illegal Channel Number
021	Trying to Change A Forced Bit
022	Forcing Function Is Inhibited
023	Attempt To Alter Data In A Fenced Register
024	Attempt To Force A Non-Forceable Register
025	CPU Error, Check Register 8175
026	Rack Addressing And User Memory Overlap
027	Memory Error - Clear All Operation Required
028	Illegal Baud Rate Selected
029	Attempt to Send Message With Illegal Route
030	Attempt To Alter Protected Memory - Inhibit Coil
031	End Of File Encountered
032	Operation Not Allowed In Protected Memory
033	Data Error
034	UVPROM Memory Error
035	Write Protected
036	Replace Not Allowed - Use Delete And Insert
037	Attempt To Skip Or Read A File Past Last File
038	Data View Protected - Cannot Read
039	Alarm Already Set
040	Hardware Memory Security In Effect
041	Illegal Register Write

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042 Illegal File Number
043 Illegal Operation Attempted
044 File Not Found
045 Operation Not Allowed - D-LOG Tape operation In Progress
046 Protected File
047 Operation Not Allowed Due To Keyswitch Position
048 Programming MCR In Subroutine Area Not Allowed
049 I/O, Register Or Channel Safeguarded
050 Rack Address Not Alterable While Forcing Active
051 Missing Module
053 Illegal Media Format - Erase Track/Clear Memory Required
054 Illegal Mark Number
055 File Operation Aborted
060 Illegal Mark Number For GOTO or GOSUB
061 Mark St. Sub Cannot Be Inserted - Append Only
062 Return Rungs Not Allowed In Ladder Area
063 Mark Number Previously Used
064 Operation Not Allowed In Run - Cannot Delete Return
065 Operation Not Allowed - Cannot Delete Mark St. Sub
066 Operation Not Allowed - Cannot Delete Mark Having Return
067 Operation Not Allowed - Return Must Have Mark
068 Operation Not Allowed - Only One Return Per Mark
069 Operation Not Allowed In Run - Gosub With No Return
070 Operation Not Allowed In Run - Goto To Mark With Return
071 Operation Not Allowed In Run - Cannot Delete Mark
072 Operation Not Allowed In Run - Unused Mark Number
079 Operation Not Allowed In Run With Programmable Interrupt
080 Insufficient Data
081 Unrecognized Command
082 Illegal Parameter
083 Illegal Source Parameter
084 Illegal Destination Parameter
085 Invalid Filespec
086 Invalid Input Channel
087 Invalid Output Channel
088 Device Not Available
089 Serial Link Not Established
090 Hardware Read Fault
091 Hardware Write Fault
092 Read Error
093 Write Error
094 Directory Read Error
095 Directory Write Error

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096	Directory Space Full
097	Device Space Full
098	File Not Found
099	File Access Denied
100	File Already Exists
101	File Already Open
102	File Format Error
103	File Wrong Type
104	Open Attempt To Open File
105	I/O Attempt To Unopen File
106	Write Attempt To Read Only File
107	Record Out Of Range
108	Too Many Open Files
109	Operation Aborted By User
110	Source Filespec Required
111	Destination Filespec Required
112	Maximum Open Count For File
113	Incompatible Source Device/File Type
114	Incompatible Destination Device/File Type
115	Device Timeout
116	Protected File
117	Illegal File Type
118	Illegal Device
119	File Type Required
120	Device Required
121	Channel Required
122	Route Required
123	Filename Required
124	Illegal Offset
125	Illegal Count
126	Source/Destination Cannot Be Same Device
127	Duplicate Label
128	File Mismatch
129	Invalid Register Address
130	Invalid File Name
131	Write Data Error
133	Insufficient Data For Write
135	Invalid Read Parameter

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C.3 - Alarm Parameter Errors

Presented in location 2411-2421.

Error Code	Description
001	Invalid opcode
002	Invalid fault count
003	Invalid alert count
004	Invalid warning count
005	Invalid fault acknowledgment register
006	Invalid alert acknowledgment register
007	Invalid warning acknowledgment register

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APPENDIX D - SY/LINK BOARD MEMORY MAP

WORD	FUNCTION
	Initialization
3FFH	NIM PARAMETERS (Flags controlled by user program)
3FEH	NIM FLAGS (Flags controlled by SY/LINK board)
3FDH	SY/LINK NETWORK ADDRESS (Drop number)
3FCH	SY/LINK NETWORK PORT PARAMETERS (Set by user program)
3FBH	SY/LINK RS-422 PORT PARAMETERS (Set by user program)
3FAH	INTERRUPT ENABLE (Sets interrupt to be used by SY/LINK)
3F9H	INTERRUPT SELECT (Sets type of message that generates interrupt)
3F8H	SETUP ERROR CODES (Errors that occur during board initialization)
	Alarm Handling
280H-289H	ALARM MESSAGE ROUTE BUFFER
260H-27FH	ALARM MESSAGE DATA BUFFER
24FH	WARNING COUNT IN WARNING QUEUE
24EH	ALERT COUNT IN ALERT QUEUE
24DH	FAULT COUNT IN FAULT QUEUE
24CH	WARNING SELECTED IN WARNING QUEUE
24BH	ALERT SELECTED IN ALERT QUEUE
24AH	FAULT SELECTED IN FAULT QUEUE
248H-249H	WARNING ACKNOWLEDGEMENT REGISTER
246H-247H	ALERT ACKNOWLEDGEMENT REGISTER
244H-245H	FAULT ACKNOWLEDGEMENT REGISTER
243H	ALARM QUEUE COMMAND (Selects viewing or clearing alarms)
241H-242H	ALARM PARAMETER ERROR (Errors that occur in alarm parameters)
240H	GO FLAG (Initiates alarm commands)
	Polled Communication
140H-23FH	REPLY DATA BUFFER (Holds data being sent or received)
3EH-13FH	COMMAND DATA BUFFER (Specifies starting address of group of registers being written to or read)
2CH-34H	COMMAND ROUTE BUFFER
27H-28H	COMMAND MASK (Determines which bits are alterable by a maskable write)
25H-26H	COMMAND COUNT (Number of registers being written to or read)
24H	COMMAND OPCODE (Selects type of READ or WRITE operation)
23H	RESET FLAG (Resets Send Flag and Error Flag)

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WORD	FUNCTION
21H-22H	ERROR FLAG (Command/Reply error - see Appendix C.2)
20H	SEND FLAG (Tells SY/LINK a message is ready to be sent)
	Change Flags
4H	WARNING CHANGE FLAG (Holds count of alarms in Warning Queue)
3H	ALERT CHANGE FLAG (Holds count of alarms in Alert Queue)
2H	FAULT CHANGE FLAG (Holds count of alarms in Fault Queue)
0H-1H	MAILBOX REGISTER CHANGE FLAG (Indicates address of last mailbox register written to. If block of registers is written, value is the lowest address in the block.)

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Subject: ***SY/LINK***® Class 8010 Type SFI510 Communications Interface Board (Addendum for Instruction Bulletin 30598-277-01A2)

SY/LINK Operation With 386 Personal Computers

A problem has been identified when the SY/LINK board is used with some 386 based personal computers. The primary symptom has been traced to the way the backplane bus on these machines operates. On many machines the address is left on the bus only long enough to complete the memory read or write to the SY/LINK board. On machines that operate out of cache memory, this address can be latched on the bus for several microseconds.

If the microporcessor on the SY/LINK board is accessing the same location that the personal computer program is, this will stop the SY/LINK microprocessor until the address on the PC bus changes. This freezes the clock to the Data Link Controller chip causing it to send out an extra byte of data. The extra byte is included in the frame check sequence so the remote NIM accepts the message as valid. When it parses the message, it may not be able to correctly interpret it and will discard it without sending a reply back to the SY/LINK board.

An application software work around is to read two locations in the SY/LINK when polling the send flag. This will result in the address being latched at a location the SY/LINK microprocessor is not accessing. The following code fragment illustrates what is in the current version of mailbox.c:

```
long int start_time;

*send_flag = SEND;
time (&start_time);
while (MB->send_flag && time (NULL) - start_time < time_limit);
```

The code was modified as follows to work around the problem:

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```
        long int start_time;
        int temp;

        *send_flag = SEND;
        time (&start_time);
        do
            {
            temp = * ( (int far *) &MB->send_flag;
            }
while ( (temp & 0x0ff) && time (NULL) - start_time < time_limit);
```

This code was compiled using version 5.1 of the Microsoft C compiler. For other compilers and languages it may be necessary to examine the assembly code produced to verify that two consecutive bytes starting at send_flag are read.

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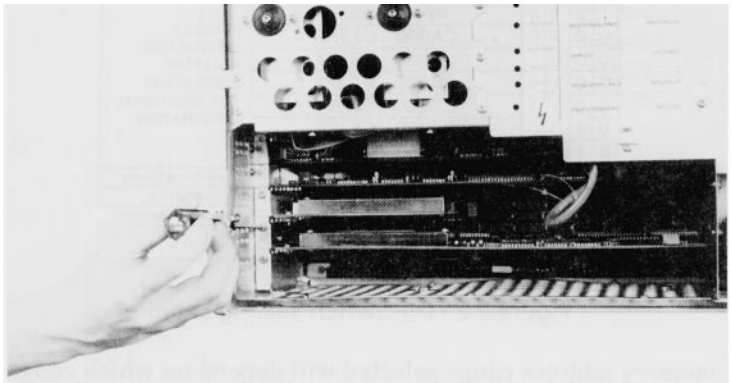


Figure 2.3 - Installing the SY/LINK Board

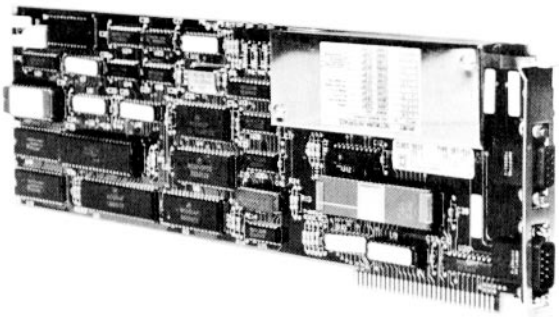


Figure 3.1 - SY/LINK Board (side view)



Figure 3.3 - SY/LINK Communication Connectors

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