Square D POWERLOGIC

Implementation of SY/MAX Protocol

Author: Mike Pyle
Edited by: Rob Smits / Don McComas
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1.0 Introduction

This document describes the SY/MAX point-to-point protocol communications as it has been implemented on the Square D Circuit Monitor 1 Series (CM1XX & CM2XX), the PIF-3, and PIF-85 series of devices, and the Circuit Monitor 2000 Series (CM2XXX) family of devices. This document describes the protocol differences in implementation between the devices listed above and that described in Square D Instruction bulletins 30598-713-01 (dated 12/08/88) and 30598-150-01 (dated July 1987). The protocol has been modified to accommodate multiple devices attached to a single host. This document is written for the technically-oriented reader wishing to interface equipment to the Square D products listed above or reside with them on the network. The user is asked to familiarize himself with the documentation listed below before any implementation is attempted:

Square D #	Title
30598-713-01	SY/MAX Point-to-Point Communications Protocol for Data Transfer Operations
30598-351-01	SY/MAX Simplified communications Protocol for Register Read and Write From SY/MAX PC Family of Processors
30598-277-01	SY/MAX Class 8010 Type SFI-510, 533, and 534 SY/LINK Network Interface Boards
30598-365-01A1	SY/NET Class 8030 Type CRM-511 Multi-Media Network Interface Module
30598-150-01	SY/NET Class 8030 Type CRM-560 Remote Network Interface Module
R3085.00-04	SY/MAX Family Communications Protocol
R3085.04-33	SY/MAX Family Communications
R3086.31-05	Radio Link Communications and Protocol

1.1 Host Computers

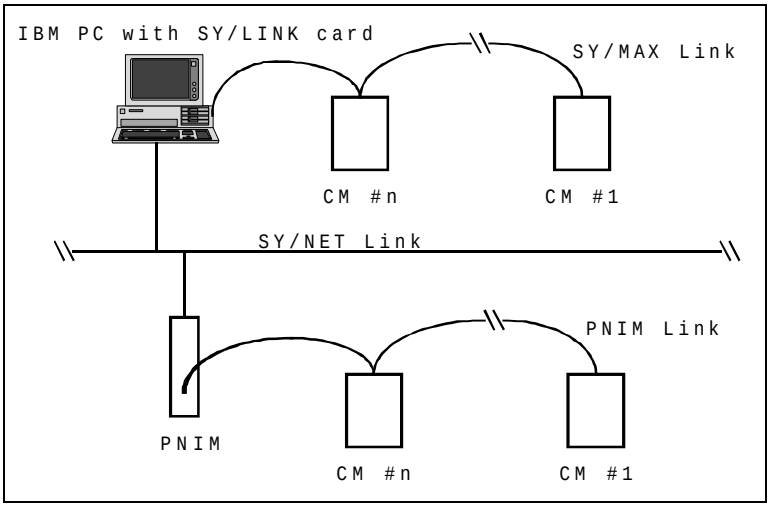
The Square D equipment listed in section 1.0 operates in a slave mode with a designated host computer. In this mode the CM's will only respond when spoken to via a valid message. The equipment listed in section 1.0 CANNOT and WILL NOT originate messages. The host computer can be any one of the following:

Item	Host Type
1	Square D PowerLogic Network Interface Module (PNIM)
2	IBM PC or compatible with a SY/LINK interface card
3	IBM PC or compatible RS-232 port with an RS-232 to RS-485 converter.
4	IBM PC or compatible with an RS-485 interface.

All of the hosts listed above except item 1 use standard SY/MAX protocol. The PNIM uses a modified SY/MAX protocol. Its differences will be described later.

1.2 SY/MAX and SY/NET Communications Concepts

The SY/MAX protocol is considered to be a point-to-point protocol. The CM's appear as end devices in any SY/NET configuration. Shown below is a network diagram with CM's.



2.0 Introduction to PowerLogic Communications

The CM's appear as end devices in the point-to-point protocol. However there is a difference; up to 32 physical CM's can be connected to a host. This type of interface is called "Multi-drop" since multiple units drop or hang off the same host device. Because of electrical considerations the CM farthest from a host must be no farther than 10,000 feet (3,048 meters) away. This distance may be less depending on the number of CM's on the link and the baud rate.

he distance of 10,000 feet has been extended in some cases by using some form of RS-485 repeaters. This practice is NOT recommended. As might well be expected the longer the link the more prone it is to time-out errors, signal level problems, and over-all link degradation.

For applications requiring maximum communications integrity, the CM farthest from the host should be configured as device #1. Every multi-drop link with CM's attached should have device #1. There should NOT be more than one device #1. The significance of having a device #1 will be explained later in this document.

3.0 SY/MAX Command Set

All CM's understand and respond to a subset of the allowable commands defined for SY/MAX communications. By using these commands correctly all operations with the CM's can be accomplished easily. The only commands recognized and processed by the CM's are the following:

Command Type	Command Opcode	Reply Opcode
Read Register	0x00	0x86
Write Register	0x02	0x80
Multiple Register Read	0x04	0x8A
Search Rung	0x0E	0x82
Read User Memory	0x14	0x88
Priority Write Register	0x1E	0x92
Priority Read Register	0x20	0x90

Although this may appear to be a limited command set with the addition of global addressing many CM's can be initialized or reset at the same time. This is very useful at initialization time. For example, setting the date/time in all CM's.

The CM's use the standard message format as described in bulletin 30598-713-01 except when attached to a PNIM. The protocol used when attached to a PNIM is actually the standard RNIM protocol described in bulletin 30598-150-01, with different default RNIM parameters. The RNIM protocol is slightly different from the standard SY/MAX protocol in several respects:

1. The RNIM/PNIM format uses a different message header.
2. No acknowledgments (ACKs) or negative acknowledgments (NAKs), inquires are sent. This reduces radio transmissions.
3. The RNIM/PNIM protocol uses a CRC error checking versus a simple checksum in the SY/MAX protocol.
4. The RNIM/PNIM protocol uses a different pad character (0xFF).

Because all CM's on a given link have similar communications logic, each will respond in a like manner to addressing, command opcodes, status register data, transmission numbers, and error checking. The Circuit Monitors, PIF-3, and PIF-85 do however have different valid register numbers. The reader should review the device instruction manual for any differences. The PIF-3 and PIF-85 do not treat reads or writes to unused registers as an error condition as specified by the SY/MAX protocol. In the case of "Write Register" commands, the data is discarded. The read commands return a zero value for non-existent registers.

The CM2 Series of Circuit Monitors return a value of -32,768 for non-existent or invalid registers. The CM2 will return a write error if any register included by the write command is a non-existent register or read only register, and none of the write request will be processed.

If a register read is performed with either the force bit or the status bit of the register address set to a 1, the CM2 will return a value of 0. If a register write is performed with either the force bit or the status bit of the register address set to a 1 the CM2 will simply not process the write and will not generate an error. The manner in which the CM2 handles invalid registers is the desired method.

The user does not have to be concerned which type of protocol (RNIM or SY/MAX) is being used since all CM's will auto configure themselves to the protocol the host is using.

The CM's treat the "Search Rung" and "Read User Memory" commands slightly different than a Programmable Logic Controller (PLC) would. The CM's will return 4 bytes in the case of the "Search Rung" command. The data for these 4 bytes is 0xcf, 0xff, 0x80, 0x00 which will satisfy the requirements for the PLC programming equipment. The "Read User Memory" command will return all zeros for the memory locations used.

4.0 Multi-Drop PowerLogic Differences with SY/MAX

Because there can be up to 32 CM's attached to a single host several modifications have been made to allow the multi-drop link to operate efficiently. For example when the host sends and inquire down the link to verify link integrity which unit should respond? Obviously not all units because the response would be garbled with up to 32 CM's trying to respond at the same time to a single host. The implementation used in the multi-drop mode is to designate a specific CM to respond to an inquire. That designated device is device #1. Device #1 was chosen for several reasons:

a) Starting with device #1 is the most logical since other units can be added easily.

b) Having device #1 the farthest from the host insures that the communications(5 wires) medium is still intact.

If there is no response on the idle line to a valid message to unit #1 or an inquire (DLE, ENQ) which device #1 should respond to there could be one of several things wrong;

a) There is no device #1 on the link.

b) If there is a device #1 on the link it may not have control power or be operating correctly.

c) The communications wires have been severed somewhere between the host and device #1.

d) One or more of the CM's on the multi-drop have had their communications wires connected improperly.

e) More than one unit has been assigned as device #1

f) Device #1 is configured at a baud rate different than the host.

g) The host is not operating properly.

h) The communication lines are not properly terminated at device #1 or the host.

If device #1 is responding correctly this tells us a great deal about the state of the multi-drop link.

Another major difference occurs when a parity or checksum error is detected on the link. In the case of these two errors there will be not be a NAK response to the host since one or more of the CM's may have seen the same error. The host will time out and resend the message. In general if the response can be made by several units, no units will respond.

All CM's on the same multi-drop link MUST be configured to operate at the same communication speed (baud rate). If a CM is configured at a baud rate different than that of the host it will NEVER recognize any messages.

Because all CM's on a link appear as slaves there is no means or need for a CM to communicate with another CM. The CM's operate in a pure master-slave mode. One reason for a pure master slave mode is that there is no mechanism for token passing to determine the link master. Another reason for the master-slave mode is that the physical layer (RS-485) does not have any collision detect logic to determine when the link is idle. Furthermore the SY/MAX protocol does allow idle time on the link in the middle of a message.

The CM's do NOT support embedded responses as described in section 7.7.11 of Square D Bulletin 30598-713-01. Only one outstanding transaction is allowed on the network at any given time. This means that a command with a given CM must be completed or timed out before another is started. This insures order on the link. A host with intelligence must be employed that will perform the queuing so that this half duplex format is enforced. In the case of a SY/MAX network, this is taken care of by the host software. In the case of a PNIM network, this is taken care of by the PNIM.

In the case of modem communications where the SY/LINK card host is connected to remote Circuit Monitors using modems, it may be required to operate without a device #1. This is due to the fact that the delays introduced by telephone switching equipment may result in the SY/LINK card sending multiple inquires before a response arrives from the remote device(s) causing data errors.

4.1 RNIM/PNIM Differences from SY/MAX

The RNIM/PNIM protocol is slightly different from the standard SY/MAX protocol in several areas. The RNIM was originally used to communicate to devices over a radio link. The default parameters of the RNIM were modified to obtain a PNIM.

The RNIM/PNIM format uses a slightly different message header. Refer to engineering document R3086.31-05. Where the SY/MAX protocol uses a DC1

and DC2 to tie message requests and responses together the RNIM protocol uses message numbers. These messages are monotonically increasing numbers that wrap around to zero when 255 is reached.

No acknowledges (ACKs or NAKs) or inquires are sent. This reduces the number of transmissions necessary to pass data. In the standard SY/MAX protocol the CM should send an acknowledge back to the host within 10 character times to indicate that the initial message (read or write request) was received and there were no errors in the body of the message. Also in the SY/MAX protocol the host acknowledges the reception of the data read or execution of the write command from the CM. Neither of these are present in the RNIM/PNIM protocol.

The RNIM/PNIM protocol uses a CRC error checking as opposed to a simple checksum in the SY/MAX protocol. Since the messages originally traveled through a less controlled medium a more stringent error checking mechanism was used. The CRC polynomial used is x**16 + x**15 + x**2 + 1. These resulting calculation is two bytes. No error correcting techniques are used.

The RNIM/PNIM protocol uses 0xFF as a pad character rather than the 0xFE used by SY/MAX.

5.0 Physical Characteristics

The multi-drop link will operate in a 4 wire, asynchronous, serial RS-485, half duplex format.

The serial data will be transmitted in an 11 bit word format consisting of 1 start bit, 8 data bits, 1 parity bit (even), and 1 stop bit.

The 5 wire communication cable (Belden 8723)to each CM will carry the following signals:

Transmitted Data -
Transmitted Data +
Received Data -
Received Data +
Signal Ground

There are no hardware flow control signals such as "Clear To Send" (CTS), and "Request To Send" (RTS) present at the CM. Also no software flow control such as "X-ON" and "X-OFF" is used because it is indeterminate which CM should issue it. Furthermore CM's cannot see what other units are transmitting.

All multi-drop links must be properly terminated. This should be done at the host and the last unit (#1) on the link. The termination network is a 100 ohm resistor in series with a 0.047uf capacitor placed across each +/- data pair.

Proper termination at the host requires the use of the Square D MCA-485 (multipoint communications adapter). The MCA-485 provides proper termination of the communication link and biases the link which is otherwise only biased if a device has activated its transmitter in response to a valid message.