2112

Expansion Module Manual

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1.1 PRODUCT OVERVIEW

Xycom's 2112 Expansion Module is an add-on module to the 2000-series Workstations. The 2000 Workstations communicate with various Programmable Logic Controllers (PLCs) and other devices through the serial port. The 2112 expansion card is used to connect to PLCs through other, non-standard data lines (non RS-232C or 422/485). The 2112 can also be used for memory expansion. For memory expansion/RAM upgrade *only*, install 2112-MEM into any 2112 for an additional 128 Kbytes of memory.

The 2112 module comes in two basic configurations:

- with a PLC communication module
- without a PLC communication module (built for 2112-mem memory expansion)

With a PLC communication module, you can communicate with a PLC or PLC network such as Allen-Bradley Remote I/O, Modbus Plus, etc. Also, an additional 128Kx8 RAM or EPROM memory device can be installed into socket U2 for memory expansion.

NOTE

The 2112 used as memory expansion is only available for OIL or SoftScreen direct connects, not for base terminal firmware. The 2112 only works with the following 2000 Series Terminals:

Terminal Part Number	Terminal Model Number
97957-001	2000
97957-101	2000T
97958	2005
98033-001	2050
98033-101	2050T
98500-001	2060
98500-101	2060T

1.2 USING THIS MANUAL

The chapters in this manual are organized as shown below:

Chapter One *Introduction*	An overview of the expansion module including specifications.
Chapter Two *Installation*	Information about configuring and installing the 2112 Module.
Appendices	Information specific to your type of PLC direct connect including specific jumper and switch settings, and commands or expressions needed for the 2000-series Workstations with OIL and SoftScreen.

1.3 SPECIFICATIONS

The specifications for the 2112 Expansion Module are shown in Table 1-1 below.

Table 1-1. 2112 Specifications

CHARACTERISTIC	SPECIFICATION
Environmental	
Temperature	
Operating	0 C to 50 C (32 to 122 F)
Non-operating	-40 C to 60 C (-40 to 140 F)
Humidity	10 to 80% relative, non-condensing
Shock	
Operating	15 g peak acceleration (11 msec duration)
Non-operating	30 g peak acceleration (11 msec duration)
Vibration	
Operating	.006" peak to peak 1.0 g peak acceleration
Non-operating	.015" peak to peak 2.5 g peak acceleration
Memory Storage	
Optional 128 Kbytes of RAM or EPROM RAM is battery backed when installed in 2000-series Workstation	

2.1 INTRODUCTION

This chapter describes various aspects of the 2112 Expansion Module, including the jumper configurations and installation procedure.

2.2 SYSTEM REQUIREMENTS

The 2112 Expansion Module is designed for use in the industrial environment and must be properly installed onto a Xycom 2000-Series Workstation. The module is compatible with the following 2000 Series Terminals and their respective part numbers.

Terminal Part Number	Terminal Model Number	
97957-001	2000	9" Amber Workstation
97957-101	2000T	2000 with Touch Screen
97958	2005	2000 with Keypads
98033-001	2050	12" Color Workstation
98033-101	2050T	12" Color Workstation with Touch Screen
98500-001	2060	12" Amber Workstation
98500-101	2060T	12" Amber Workstation with Touch Screen

These units have an external connector on which the 2112-xxx unit is connected. Units without this port do not support the 2112.

2.3 PORT CONFIGURATION

The versions of the 2112 Expansion Module that provide communication with a PLC provide a communication port. The type of port and its pinouts vary depending on the particular type of PLC communication supported. See Appendix A for information specific to your PLC.

2.4 COMPONENTS RELEVANT TO INSTALLATION

The 2112 jumpers, sockets, and connector are shown in Figure 2-1 below:

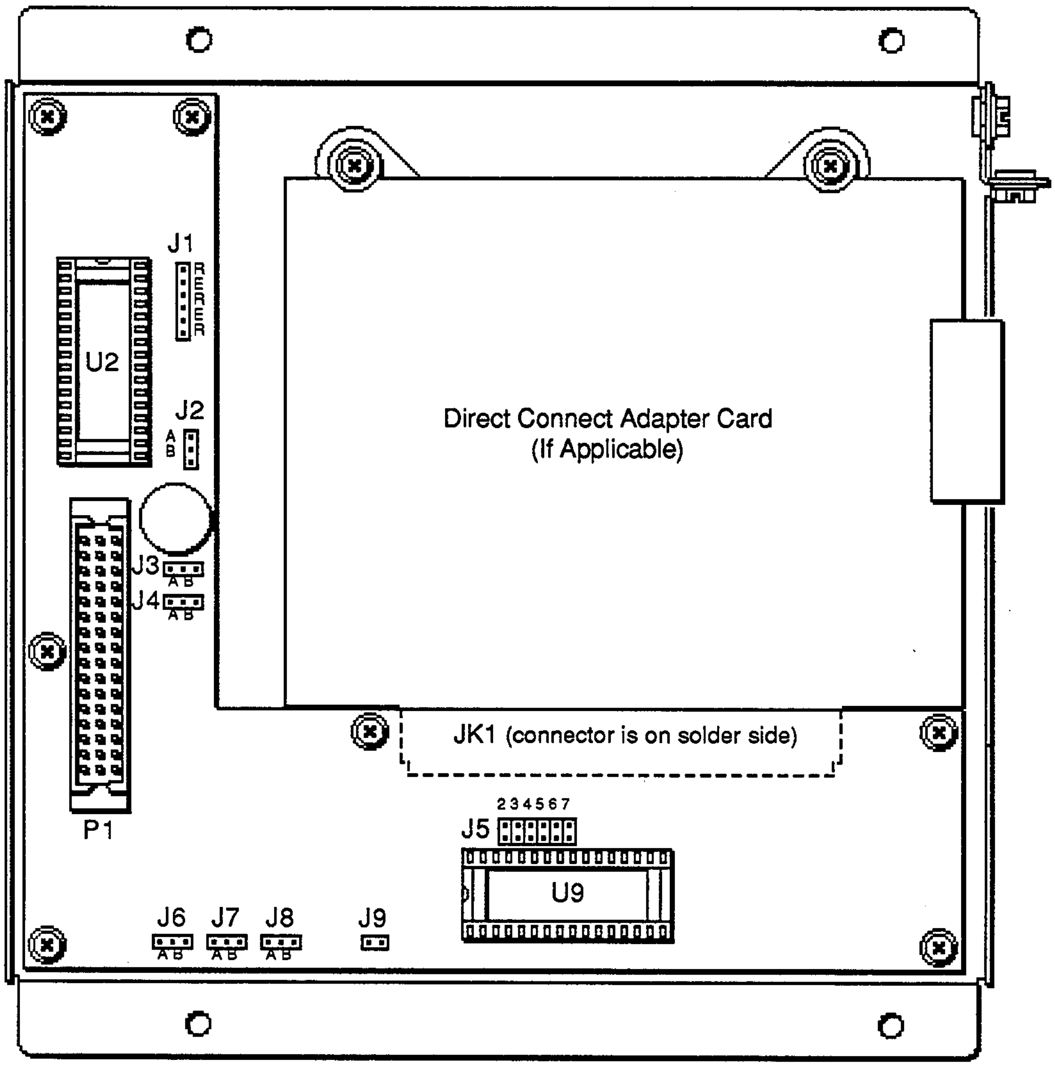


Figure 2-1. 2112 Jumpers, Sockets, and Connector

2.4.1 Jumpers

The 2112 jumpers are described in Table 2-1. If you have direct connect capability, a direct connect adapter card (which may contain its own jumpers and switches) is also installed on your 2112 Module. Refer to Appendix A for information about the jumper and switch.

Table 2-1. Jumper Settings

Jumper	Position	Function
J1	RRR✓ EE	Designates U2 to contain RAM memory Designates U2 to contain EPROM memory
J2,J3,J4	A B✓	Designates U2 to contain RAM memory Designates U2 to contain EPROM memory
J5	3✓	Not user configurable. Must remain positioned to 3.
J6,J8	A✓	Not user configurable. Must remain positioned to A.
J7	B✓	Not user configurable. Must remain positioned to B.
J9	IN✓	Not user configurable. Must remain in.

✓ Factory shipped configuration for all models except 2112-MEM which has RRR position for J1, and A for J2, J3, and J4. This configuration should also be used when adding a 2000-mem to the 2112.

2.4.2 Expansion RAM/EPROM Installation

When installed to the 2000 terminal, 128 Kbytes of RAM or an EPROM can be added to the 2112. The RAM can be purchased from XYCOM (Model#2000-MEM).

Examples of available SRAMs and EPROMs include the following:

Xycom SRAM Part Number	Manufacturers	Manufacturer Part #
94969-001	Hitachi	HM628128LP-12
"	Mitsubishi	M5M51008P-12L
"	Samsung	KM681000LP-12
Xycom EPROM Part Number	**Manufacturers**	**Manufacturer Part #**
92937-001	AMD	AM27C512-200PC
"	National	NM27C512N200

Practice static safety rules before installing the expansion RAM/EPROM, and then do the following:

1. Power-off the unit and disconnect the power cable from the unit or wall plug.
2. Remove the 2112 pan from the 2000 terminal. This is done by loosening the four thumbscrews on the 2112 and unscrewing the pan from the terminal.
3. Set J1 to RRR and Set J2-J4 to B. No other jumpers need to be changed.
4. Install the RAM/EPROM chip in socket U2, aligning pin 1 of the chip to pin 1 of the socket (see figure 2-1 for location of U2). Static protection is recommended to insure the integrity of the device.
5. If you are installing a RAM chip, position J2-J4 to A. If you are installing an EPROM, position J1 to EE.
6. Position the 2112 back on the 2000 terminal aligning the connector and the holes to the thumbscrews. Push firmly toward the terminal and tighten the thumbscrews.
7. Reconnect the power cable and turn on the power.
8. This completes the installation. The available RAM should appear in the menu or title screens.

2.4.3 Connectors

The connectors on the 2112 Module are shown in the Table 2-2:

Table 2-2. Connectors

Connector	Description
JK1	Interface for Xycom direct connect adapter card. The connector is located on the solder side of the board as indicated by the outline in Figure 2-1.
P1	Interface to the 2000 series controller board.

2.4.4 Memory Configuration (Sockets)

The 2112 Module contains two memory sites, U2 and U9. Xycom's firmware is installed in socket U9. (Even if no firmware is installed in your version of the 2112, only socket U2 can be used for memory expansion.) Socket U2 can contain 128 Kbytes of RAM or an EPROM, as explained in Section 2.4.2.

2.5 INSTALLING THE 2112 INTO THE 2000-SERIES

This section details how to install the 2112 option board into a 2000-series unit.

CAUTION

Always turn OFF power to the terminal and disconnect the power cord before installing or removing any module. Also turn OFF power to all related external power supplies.

Make sure the jumpers are set appropriately (see Section 2.4.1 for 2112 board jumpers *and* the appendices for the direct connect module jumper).

Check all connections to external devices or power supplies to make sure they comply with the specifications of the module.

The 2112 Module connects to the 2000-series workstation via a three-row, 48-pin connector and four screws that are already attached to the 2112.

To install the expansion module, perform the steps on the following page.

1. Turn OFF the power to the terminal.
2. Locate the connector on the side panel of the 2050/2060 or bottom panel of the 2000 or 2005. The connector is covered by a metal plate as shown in Figure 2-2 below.
3. Remove the four screws and hold the metal plate. The connector is now visible.
4. Connect P1 on the 2112 board to this connector on the 2000-series Workstation.
5. The screws are already in place on the 2112 module and should fit into the threaded holes on the workstation. Tighten the screws by twisting them by hand or by using a Phillips screwdriver.

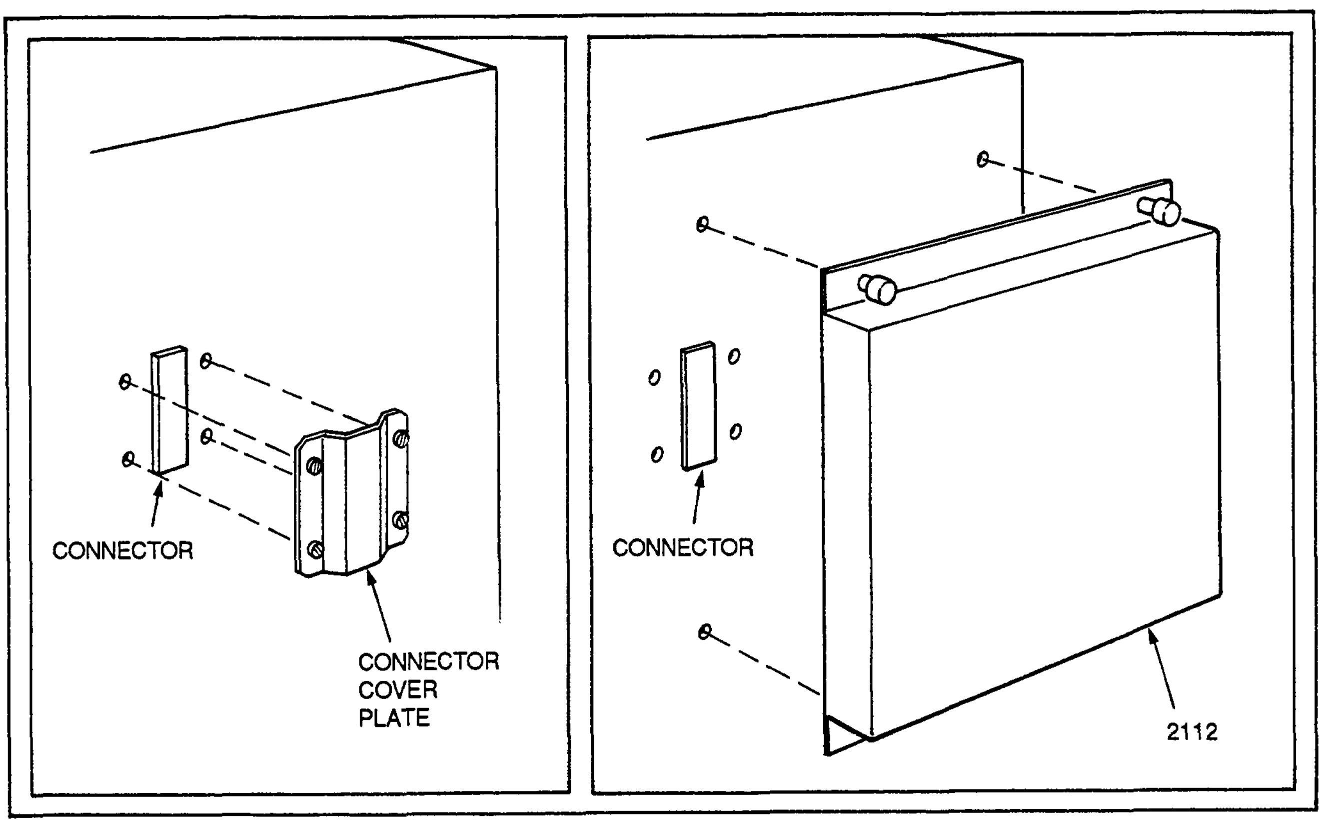


Figure 2-2. Installing the 2112

A.1 INTRODUCTION

The direct connect to Allen-Bradley's Remote I/O network is accomplished through a high-speed serial expansion card, which comes installed on the 2112-AB Expansion Module. In this manual, the expansion card is referred to as the direct connect card. The entire 2112-AB unit is referred to as the 2112.

The Remote I/O direct connect is capable of both monitoring and simulating remote I/O on the network. It can report the status of any I/O point on the Remote I/O network and it can simulate a remote I/O rack. It can also monitor block transfer reads (BTRs) and block transfer writes (BTWs) between the PLC and remote I/O racks. When simulating a remote I/O rack, it can also simulate block transfer modules. The direct connect can supply data for BTRs from the PLC and accept data from BTWs from the PLC.

This direct connect uses the double buffering capabilities of the direct connect adapter card. This ensures that the values of groups of data are kept together, and changes will be read from or sent to the PLC at the same time. All data read or written with a single expression is kept together.

A.2 PORT CONNECTOR AND LEDS

The direct connect adapter card for Allen-Bradley Remote I/O provides the following features:

Port Connector — This six-pin connector is the interface to your PLC.

Red LED — When on, the red LED indicates that the card has not been initialized. If the red LED is off after power-up, the card has been successfully initialized. The red light turns off when the 2000 is powered up.

Green LED — The green LED is on whenever the card is transmitting data over the remote I/O network

A.3 JUMPER AND SWITCH SETTINGS

This section discusses only the jumper and switch settings for the direct connect adapter card. For information on jumper settings for the 2112 Expansion Module itself, refer to section 2.4.1.

> **NOTE**
> Set the jumpers and switches before connecting to the PLC.

Jumper JB2 on the direct connect adapter card is used to enable/disable the transmitter on that card. If the Remote I/O direct connect will simulate an I/O rack, this jumper must be positioned to "Enable" (see Figure A-1). Otherwise, it should be positioned to disable. The default is enabled.

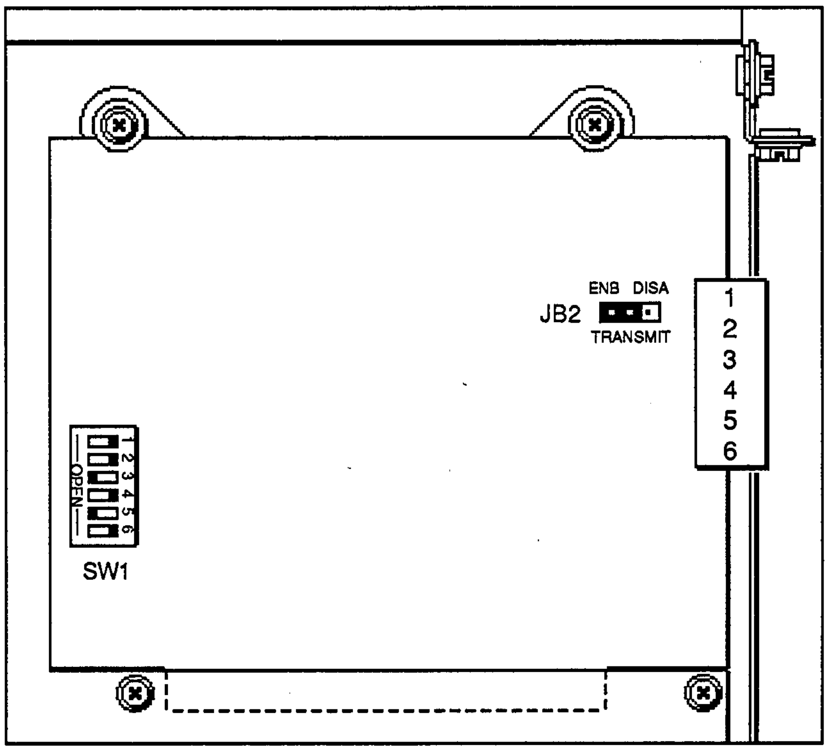


Figure A-1. Direct Connect Adapter Card Jumper and Switch

The switch should be positioned as shown above, with positions 3 and 5 OPEN and 1, 2, 4, and 6 CLOSED. §

§ *This information is taken from the Sutherland-Schultz Direct-Link Interface Reference Manual for the 5136-SD2.*

A.4 MAKING THE ELECTRICAL CONNECTION §

The Allen-Bradley Remote I/O connection is made through a daisy chain configuration, using a Belden 9463 twin-axial cable (or blue hose). The cabling is described below:

Table A-1. Allen-Bradley Remote I/O Cabling

PLC	Blue Hose	2112 Front Panel Connector
1	Blue	1 (or 4)
Shield	Shield	2 (or 5)
2	Clear	3 (or 6)

NOTE

Pin 1 (positioned farthest from the LEDs) is the top pin of the connector (the edge connector is on the bottom of the card). See Figure A-2.

The alternate connectors on the board are used for wiring the Remote I/O in a daisy chain configuration.

The 2112 module and attached direct connect card should be connected to the PLC the same way as any other remote rack. The adapter card does not have on-board termination. If a terminator is required, it should consist of a 150 ohm resistor between the blue and clear wires (1 and 3 *or* 4 and 6). In environments with high noise, two 75 ohm resistors may be used; one between blue and shield (1 and 2 *or* 4 and 5), the other between clear and shield (2 and 3 *or* 5 and 6).

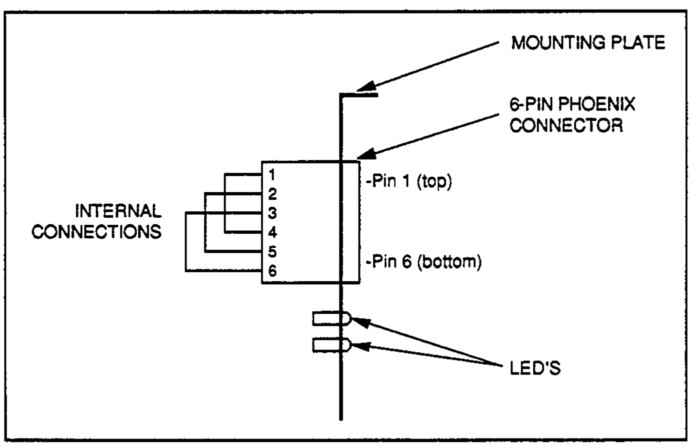


Figure A-2. Pin 1 Position

§ *This information is taken from the Sutherland-Schultz Direct-Link Interface Reference Manual for the 5136-SD2.*

A.5 CONNECTING SOFTSCREEN TO THE PLC

This section discusses the Allen-Bradley Remote I/O direct connect using the 2112 Expansion Module with a 2000-SoftScreen Workstation. This information applies *only* to the 2000-SoftScreen Workstation and not to other units in the 2000-series.

The 2112 module should already be installed into the SoftScreen Workstation as described in section 2.5. Before making the connection, jumper JB2 and switch SW1 should be set appropriately as described in Section A.3.

A.5.1 Selecting a Port on SoftScreen

Direct connects supported via the 2112 board are configured through port 2 in the SoftScreen Development System menus.

> **NOTE**
> The 2000 primary port will be disabled with the addition of this port. The 2112 now becomes port 2.

To select port 2, select Application-Load-Configuration-Edit-Ports-Port 2 in the SoftScreen Development System software.

Next, the PLC Network Type scroll list appears. Click on the arrow keys to the right of the list to scroll through the available choices. Click on AB Remote I/O so that it appears in the top box, and then click Okay.

Next, the AB Remote I/O Configuration Form appears with various selections as described below:

Base Address Defines the 2000-series memory space the 2112 uses as 0xd000. This field is read only.

I/O Address Defines the I/O address as 0x0250. This field is read only.

Baud Rate Set the baud rate to 57.6 Kbaud, 115.2 Kbaud, or 230.4 Kbaud. It must match the baud rate of the remote I/O scanner on the PLC. The default is 115.2 Kbaud.

PLC Type Choose PLC2 or PLC3/5. This must be set to the type of PLC controlling the remote I/O.

Rack Enable Set to ON or OFF. When ON, this direct connect simulates remote I/O racks. Jumper JB2 must be set to "enable" in order to simulate remote I/O racks. When OFF, the 2000-SoftScreen workstation can be used to monitor only on the Remote I/O network.

Restore Rack Set to ON or OFF. If set to OFF, the adapter card clears its RAM image of the I/O to zero at power up or when the card is reconfigured. If set to ON, the state of the inputs set in the virtual rack(s) will be restored on power-up. This option instructs the SoftScreen engine to keep a current image of the input image table so that if power cycles, the virtual rack being simulated by the adapter card will have retained the original values present before the power cycle.

Starting Rack Indicate the rack number of the first rack to simulate. For PLC2, the rack numbers are 1 through 32. For the other PLCs, *(Development System 3.5 and earlier)* the rack numbers are 0 through 31, and *(Development System 4.1 and later)* the rack numbers are 0 through 37 octal.

Starting Quarter Select which quarter of the rack (1st, 2nd, 3rd, or 4th) to start simulating. Set to 1 if simulating full racks.

Number of Quarter Racks Select the number of quarter racks to simulate, starting at the Starting Quarter rack. If simulating full racks, this value will be a multiple of four (four quarter racks per rack).

For PLC3/5, the number of quarter racks is:
128 - [(Starting Rack)*4] - (Starting Quarter -1)
128 - (Starting Rack*4) - (Starting Quarter -1)

For PLC2, the number of quarter racks is:
128 - (Starting Rack*4) - Starting Quarter
128 - [(Starting Rack -1)*4] - (Starting Quarter -1)

Number of Block Transfer Modules Select the number of block transfer modules to simulate. The first one is at module 0 of the first group of the starting quarter of the starting rack. The next one would be at module 1 of the same group. The next, would be at module 0 of the next group and so on. There can be up to four block transfer modules per quarter rack. Up to 255 block transfer modules can be specified. The rack must be enabled.

BTW Words/Module Select the maximum size for simulated BTWs (from 1 to 64).

BTR Words/Module Select the maximum size for simulated BTRs. There are 4096 words available for block transfers. This space is allocated first to our simulated block transfers, then to block transfers between the PLC and other racks on a first come, first serve basis. The range is 1 to 64.

If any part of the selected configuration is illegal, an error message states the appropriate range of values. The (Number of Block Transfer Words*2)*Number of Block Transfer Modules should be less than 8192.

A.5.2 SoftScreen Communication Status

The Communication Status Register contains the status of the message previously transferred. Register #8 will contain one of the following status conditions:

0 = Communication okay
1 = Card initialization error
2 = Communication lost
3 = Cannot write to real input racks
4 = Illegal remote I/O command

> **NOTE**
> If the READ/WRITE INPUT DATA command is used to write to inputs not being simulated by this direct connect, register #8 will equal 2.

A.5.3 Card Initialization in SoftScreen

Each time the SoftScreen Workstation powers up, the boot code is copied from the 2112 board to the direct connect adapter card and the adapter card is initialized. The adapter card is also initialized if it receives a new configuration from the SoftScreen Development System software. If the card is initialized properly, the red LED will be turned off.

Each time the direct connect adapter card is reconfigured, it takes some time to restore communication with the PLC. During this time, the expression [CS] will indicate communications are lost. If everything is configured properly, this status will eventually stop indicating an error.

A.6 SOFTSCREEN DIRECT CONNECT EXPRESSIONS

Expressions are needed in many of the SoftScreen Development System forms. Some of the variables of the expressions specific to the Allen-Bradley Remote I/O direct connect are shown below:

addr The expression for the address of a remote I/O rack/group. There are 32 possible racks. Each rack can contain eight groups of inputs and up to eight groups of outputs. Each group is 16 bits. For an octal address rrg, rr would be the rack number in octal (00 to 37), and g would be the group number (0 to 7).

rack Rack number

module Module number, 0 or 1. There are two modules per group.

These variables can be used as part of your Remote I/O expression in SoftScreen. For more information on expressions, see your SoftScreen Development System manual.

Following are expressions that perform certain functions when using the Allen-Bradley Remote I/O.

[Oaddr bit] **READ OUTPUT DATA**

Where:

addr specifies the rack/group value to be read in the form rrg, where rr is 0-37 octal and g is 0-7.

bit is an optional bit number from 0 to 17 in octal

This expression is used to read a word (16 bits) of remote I/O output data (outputs from the PLC to remote I/O). Example: [O010 3] Rack 01 Group 0 Bit 3

[Iaddr bit] **READ/WRITE INPUT DATA**

Where:

addr specifies the rack/group to read/write in the form rrg where rr is 0-37 octal and g is 0-7.

bit is an optional bit number from 0 to 17 in octal that specifies which bit is to be set or cleared for a write and which bit is to be displayed for a read.

This expression is used to read a word (16 bits) of remote I/O input data (inputs from remote I/O to the PLC). Example [I021 4] Rack 02 Group 01 Bit 4

When used as a data entry command, this expression writes a word (16 bits) or sets/resets a bit of remote I/O input data for the simulated racks. Bit writes are only allowed to inputs.

NOTE

If this command is used to write to inputs not being simulated by this direct connect, register #8 will equal 2.

[RINFrack quarter bit] **READ STATUS INFORMATION ABOUT A RACK**

Where:

rack	is the rack number, 0-37 octal.
quarter	is the starting quarter of the specified rack. The number of quarters a rack contains depends on the rack configuration. If a rack consists of four quarter racks, quarter can select any quarter of the rack from 1 to 4. If a rack consists of a quarter rack or a 3/4 rack, quarter can select either of the two starting quarters, 1 or 2. If a rack is a full rack, quarter should only be 1.

This expression returns status information about a rack in 16 bits as follows:

Bits 8 - 15:	Unused		
Bits 5 - 7:	Number of quarters in this rack (1 - 4)		
Bit 4:	1	=	This is a rack simulated by us
Bits 00 - 03:	PLC Status		
	0	=	No rack present
	1	=	PLC in run mode, rack OK
	2	=	PLC in test or program mode
	3	=	Rack error; no response from this rack

[BTRaddr module wordoffset bit] **READ BLOCK TRANSFER READ DATA**

Where:

addr	specifies the rack and group in the form rrg, where rr is 0-37 octal and g is 0-7.
module	specifies the module within the group, either 0 or 1
wordoffset	is a word offset (0 to 63) into the block transfer module to read.
bit	is optional; 0-15 decimal

This expression returns data transferred between the PLC and a block transfer read module. For example, [BTR037 0 20] reads a word of data from the block transfer module at rack 3, group 7, module 0, word offset 20.

[BTWaddr module wordoffset bit] **READ BLOCK TRANSFER WRITE DATA**

Where:

addr	specifies the rack and group in the form rrg, where rr is 0-37 octal and g is 0-7.
module	specifies the module within the group, either 0 or 1
wordoffset	is a word offset (0 to 63) into the block transfer module to read.
bit	is optional; 0-15 decimal

This expression returns data transferred between the PLC and a block transfer write module. When simulating block transfer modules, this expression is used to read the data sent to the simulated BTW module by the PLC. The PLC does a BTW command to the simulated BTW module and this expression makes the data available to SoftScreen.

[BTRaddr module wordoffset] **WRITE BLOCK TRANSFER READ DATA**

Where:

addr	specifies the rack and group in the form rrg, where rr is 0-37 octal and g is 0-7.
module	specifies the module within the group, either 0 or 1
wordoffset	is a word offset (1 to 64) into the block transfer module to write

When simulating block transfer modules, this expression returns data transferred between the PLC and a block transfer read module.

Using data entry as an example, [BTR121 1 8] writes a word of data from the block transfer module located at rack 12, group 1, module 1, word offset 8.

NOTE
This expression should not be used to write to BTR modules that are not being simulated.

[BRSaddr module] **RETURN BLOCK TRANSFER READ STATUS**

Where:

addr	specifies the rack and group in the form rrg, where rr is 0-37 octal and g is 0-7.
module	specifies the module within the group

This expression returns the number of words of data associated with a BTR module. If the value is positive, the data has been updated since the last READ_BTR. If the value is negative, the data has not been updated.

[BWSaddr module] **RETURN BLOCK TRANSFER WRITE STATUS**

Where:

addr	specifies the rack and group in the form rrg, where rr is 0-37 and g is 0-7.
module	specifies the module within the group

This expression returns the number of words of data associated with a BTW module. If the value is positive, the data has been updated since the last READ_BTW. If the value is negative, the data has not been updated.

[CS] **GET COMMUNICATION STATUS**

This expression returns the current communication status of the Remote I/O link. Two types of status can be returned:

00	Normal communication
225 (FFh)	There have been no valid messages from the PLC for 160 milliseconds

B.1 INTRODUCTION

This section describes the functional definition of the SoftScreen to Modbus Plus interface. The interface to Modbus Plus is through any Modbus Plus port on a Modicon programmable controller. The purpose of the Modbus Plus interface is to access and/or modify registers and coils of the target programmable controller from a Xycom SoftScreen Workstation engine. Thus, the user is able to monitor registers, output coils, and discrete inputs and change registers via the SoftScreen software menus.

B.2 PORT CONFIGURATION

Modicon Modbus Plus connects to the SoftScreen Workstation's SA85 port via a network cable.

B.3 CABLING TO THE MODBUS PLUS NETWORK

The network bus consists of a twisted-pair shielded cable run in a direct path between successive nodes.

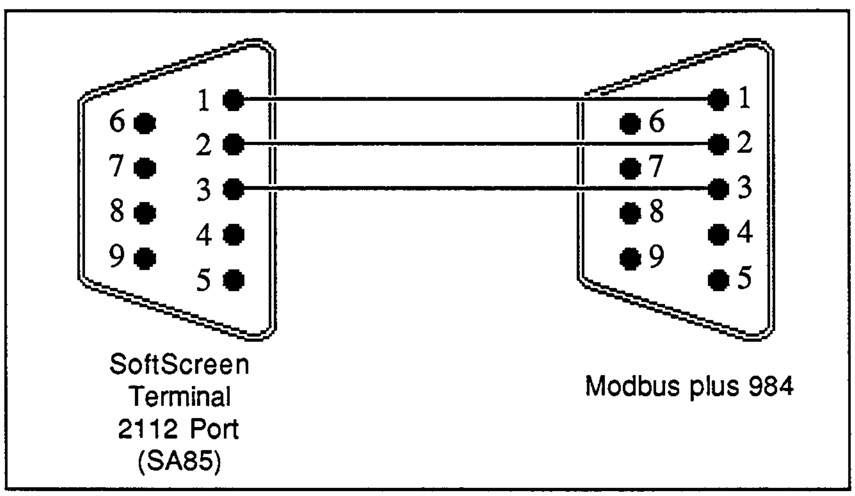


Figure B-1. Cabling to the Modbus Plus 984

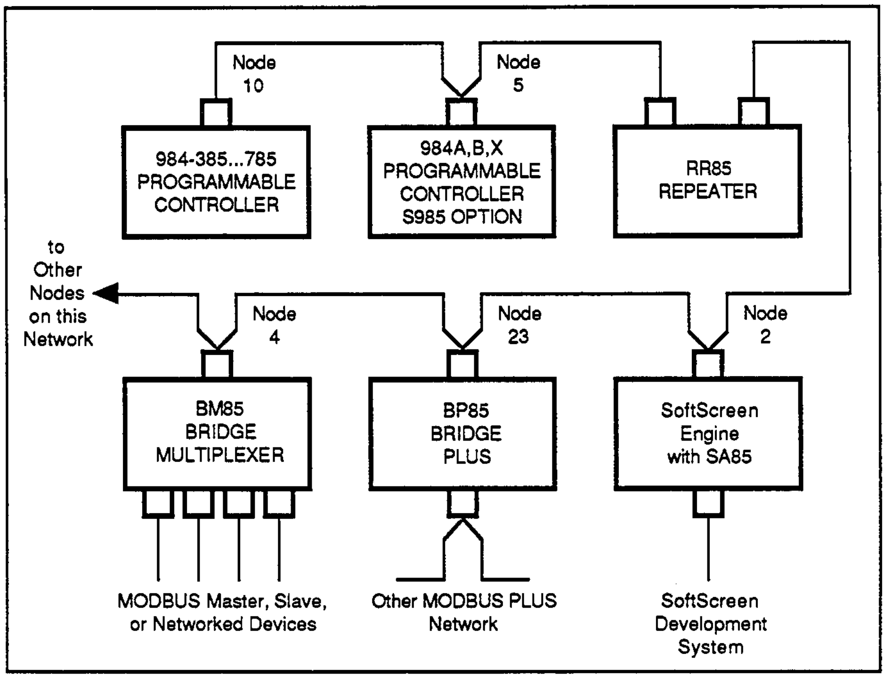


Figure B-2. Modbus Plus Network Configuration Example

B.4 MODBUS ADDRESSING

The address expression formats specific to the various Modbus PLC interfaces are shown in the tables below:

Table B-1. Modbus Plus Addressing

Device	PLC Address	Number Type	Size	R/W
Coil status	00001-09999	Binary	Bit	R
Input status	10001-19999	Binary	Bit	R
Holding register	40001-49999	Decimal	Word	R/W
Input register	30001-39999	Decimal	Word	R

Expressions follow the same format whether they are used in data display objects, data entry objects, or recipe values. For example, if the expression [PLC1:40001,SB] is entered in the development system software for a data display object, the engine reads and displays the value in signed binary of PLC1, word 40001.

For more information on expression value formats, see your SoftScreen Development System Manual.

B.5 JUMPER AND SWITCH SETTINGS

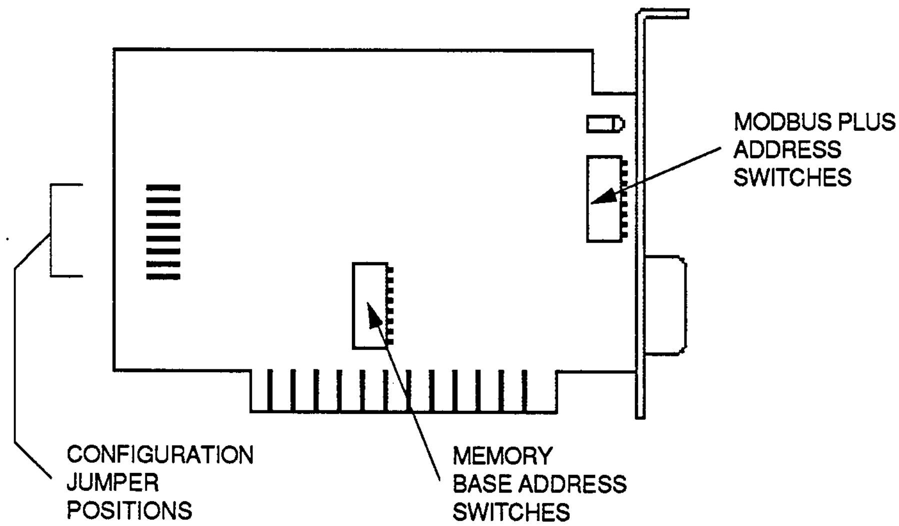
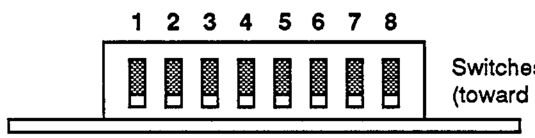


Figure B-3. SA85 Network Adapter Board Layout

B.6 SETTING THE MODBUS PLUS ADDRESS

A unique network address is required for each device on the Modbus Plus network. As shown below, set the SA85 address to one that will be used in your application. The resulting address will be one higher than the binary value you set into switches 1 through 6. Switches 7 and 8 are not used. This address should be the same as the network address used in the configuration form on the development system.



	SWITCH POSITION							SWITCH POSITION					
ADDRESS	1	2	3	4	5	6	ADDRESS	1	2	3	4	5	6
1	0	0	0	0	0	0	33	0	0	0	0	0	1
2	1	0	0	0	0	0	34	1	0	0	0	0	1
3	0	1	0	0	0	0	35	0	1	0	0	0	1
4	1	1	0	0	0	0	36	1	1	0	0	0	1
5	0	0	1	0	0	0	37	0	0	1	0	0	1
6	1	0	1	0	0	0	38	1	0	1	0	0	1
7	0	1	1	0	0	0	39	0	1	1	0	0	1
8	1	1	1	0	0	0	40	1	1	1	0	0	1
9	0	0	0	1	0	0	41	0	0	0	1	0	1
10	1	0	0	1	0	0	42	1	0	0	1	0	1
11	0	1	0	1	0	0	43	0	1	0	1	0	1
12	1	1	0	1	0	0	44	1	1	0	1	0	1
13	0	0	1	1	0	0	45	0	0	1	1	0	1
14	1	0	1	1	0	0	46	1	0	1	1	0	1
15	0	1	1	1	0	0	47	0	1	1	1	0	1
16	1	1	1	1	0	0	48	1	1	1	1	0	1
17	0	0	0	0	1	0	49	0	0	0	0	1	1
18	1	0	0	0	1	0	50	1	0	0	0	1	1
19	0	1	0	0	1	0	51	0	1	0	0	1	1
20	1	1	0	0	1	0	52	1	1	0	0	1	1
21	0	0	1	0	1	0	53	0	0	1	0	1	1
22	1	0	1	0	1	0	54	1	0	1	0	1	1
23	0	1	1	0	1	0	55	0	1	1	0	1	1
24	1	1	1	0	1	0	56	1	1	1	0	1	1
25	0	0	0	1	1	0	57	0	0	0	1	1	1
26	1	0	0	1	1	0	58	1	0	0	1	1	1
27	0	1	0	1	1	0	59	0	1	0	1	1	1
28	1	1	0	1	1	0	60	1	1	0	1	1	1
29	0	0	1	1	1	0	61	0	0	1	1	1	1
30	1	0	1	1	1	0	62	1	0	1	1	1	1
32	0	1	1	1	1	0	63	0	1	1	1	1	1
32	1	1	1	1	1	0	64	1	1	1	1	1	1

Figure B-4. Modbus Plus Network Address Switch Settings

B.7 SETTING THE MEMORY BASE ADDRESS

The SA85 board uses a memory area in your computer as a buffer for the board's status and message transactions. You must define a base address for this memory area that prevents conflict with other option boards in your computer.

Valid base address settings range from C0000 through EF800 hexadecimal. The area used in memory is a 2 Kbyte (800hex) portion starting at the base address. Select an area that will not be overwritten by your application or other options. For the 2000-Series engines, this address must be D0000.

The upper part of Figure B-5 shows the address bus range from all 0 to all 1, with the portion seen by the board's switches. The lower part of the figure shows the lowest and highest base addresses in binary and hexadecimal.

SWITCH POSITION

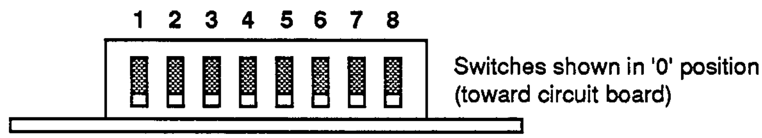
		1	2	3	4	5	6	7											
A19	A18	A17	A16	A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0
1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Always 1		Compared with SA85 Switches							2K Range of Memory Window										

C				0				0				0				0			
1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
E				F				8				0				0			

Figure B-5. Memory Window Addressing

To decode a memory address, the SA85 compares the computer's address bus bits A19 and A18 with logic 1s. Bits A17 through A11 are compared with the SA85 switch settings. The board is selected when an address matches bits A19 through A11. Bits A19 through A11 define the 2 Kbyte address range to be accessed by the application software. Locations within the 2 Kbyte range are addressed by bits A10 through A0.

The address selected must match the base address used in the port configuration form on the development system. Refer to the board layout in Figure B-6 to locate the memory base address switches. Set switches 1 through 7 as shown below to define the base address. Switch 8 is not used.



	SWITCH POSITION								SWITCH POSITION						
ADDRESS	1	2	3	4	5	6	7	ADDRESS	1	2	3	4	5	6	7
C0000	0	0	0	0	0	0	0	D2800	0	1	0	0	1	0	1
C0800	0	0	0	0	0	0	1	D3000	0	1	0	0	1	1	0
C1000	0	0	0	0	0	1	0	D3800	0	1	0	0	1	1	1
C1800	0	0	0	0	0	1	1	D4000	0	1	0	1	0	0	0
C2000	0	0	0	0	1	0	0	D4800	0	1	0	1	0	0	1
C2800	0	0	0	0	1	0	1	D5000	0	1	0	1	0	1	0
C3000	0	0	0	0	1	1	0	D5800	0	1	0	1	0	1	1
C3800	0	0	0	0	1	1	1	D6000	0	1	0	1	1	0	0
C4000	0	0	0	1	0	0	0	D6800	0	1	0	1	1	0	1
C4800	0	0	0	1	0	0	1	D7000	0	1	0	1	1	1	0
C5000	0	0	0	1	0	1	0	D7800	0	1	0	1	1	1	1
C5800	0	0	0	1	0	1	1	D8000	0	1	1	0	0	0	0
C6000	0	0	0	1	1	0	0	D8800	0	1	1	0	0	0	1
C6800	0	0	0	1	1	0	1	D9000	0	1	1	0	0	1	0
C7000	0	0	0	1	1	1	0	D9800	0	1	1	0	0	1	1
C7800	0	0	0	1	1	1	1	DA000	0	1	1	0	1	0	0
C8000	0	0	1	0	0	0	0	DA800	0	1	1	0	1	0	1
C8800	0	0	1	0	0	0	1	DB000	0	1	1	0	1	1	0
C9000	0	0	1	0	0	1	0	DB800	0	1	1	0	1	1	1
C9800	0	0	1	0	0	1	1	DC000	0	1	1	1	0	0	0
CA000	0	0	1	0	1	0	0	DC800	0	1	1	1	0	0	1
CA800	0	0	1	0	1	0	1	DD000	0	1	1	1	0	1	0
CB000	0	0	1	0	1	1	0	DD800	0	1	1	1	0	1	1
CB800	0	0	1	0	1	1	1	DE000	0	1	1	1	1	0	0
CC000	0	0	1	1	0	0	0	DE800	0	1	1	1	1	0	1
CC800	0	0	1	1	0	0	1	DF000	0	1	1	1	1	1	0
CD000	0	0	1	1	0	1	0	DF800	0	1	1	1	1	1	1
CD800	0	0	1	1	0	1	1	E0000	1	0	0	0	0	0	0
CE000	0	0	1	1	1	0	0	E0800	1	0	0	0	0	0	1
CE800	0	0	1	1	1	0	1	E1000	1	0	0	0	0	1	0
CF000	0	0	1	1	1	1	0	E1800	1	0	0	0	0	1	1
CF800	0	0	1	1	1	1	1	...	.	.	.	.	.	.	.
D0000	0	1	0	0	0	0	0	...	.	.	.	.	.	.	.
D0800	0	1	0	0	0	0	1	EE000	1	0	1	1	1	0	0
D1000	0	1	0	0	0	1	0	EE800	1	0	1	1	1	0	1
D1800	0	1	0	0	0	1	1	EF000	1	0	1	1	1	1	0
D2000	0	1	0	0	1	0	0	EF800	1	0	1	1	1	1	1

Figure B-6. Memory Base Address Switch Settings

B.8 SETTING THE BOARD CONFIGURATION

The SA85 board contains a jumper which enables a hardware interrupt. Verify the jumper setting prior to installing the board.

The jumper positions are shown in Figure B-7. Verify that the jumper is installed into the polled mode position as shown. Only one jumper should be installed. All the other jumper positions should be open. For SoftScreen, the jumper must be in the polled mode position.

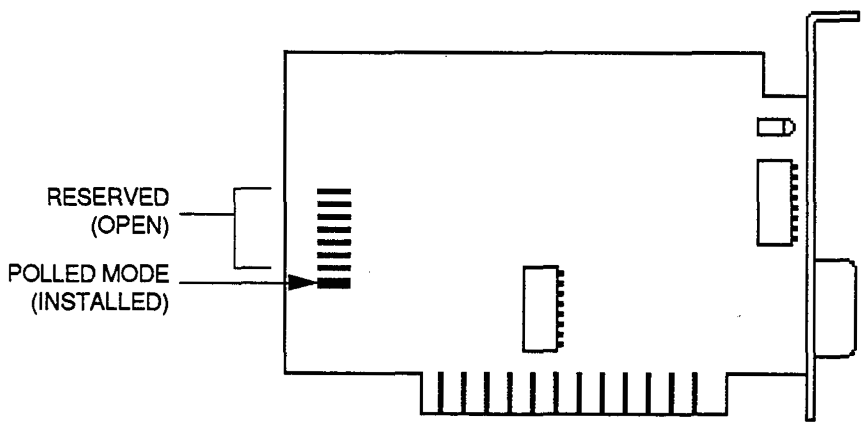


Figure B-7. SA85 Configuration Jumper Setting

B.9 READING THE NETWORK INDICATOR

The board has a rear panel indicator that shows the communication status at the Modbus Plus port. Figure B-8 shows the indicator location.

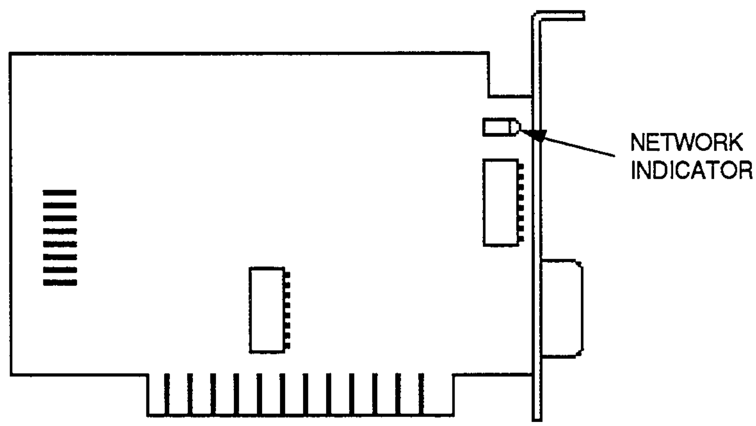


Figure B-8. SA85 Network Indicator

Modbus Plus status is shown by flashing a repetitive pattern. The patterns are described below:

Six flashes per second
The node's normal operating state. The node is successfully receiving and passing the token. All nodes on the network should be flashing this pattern.

One flash per second
The node is off-line after being powered up or after exiting the four flashes per second mode. In this state, the node monitors the network and builds a table of active nodes and token-holding nodes. It remains in this state for five seconds, then attempts to go to its normal operating state.

Two flashes, then OFF for two seconds
The node is hearing the token being passed among other nodes, but never receives it. Check the network for an open circuit or defective termination.

Three flashes, then OFF for 1.7 seconds
The node is not hearing any other nodes. It is periodically claiming the token, but finding no other node to which to pass it. Check the network for an open circuit or defective termination.

Four flashes, then OFF for 1.4 seconds
The node has heard a valid message from another node that is using the same address as this node. The node remains in this state as long as it continues to hear the duplicate address. If the duplicate address is not heard for five seconds, the node then changes to the pattern of one flash every second.

B.10 MODBUS PLUS ERROR CODES

Table B-2. Modbus Plus Error Codes

Error	Reason
1	Initialization error
2	Communications lost
3	Routing error
4	Interface command error
5	No SA85 board
6	No XT 8112 board
7	First diagnostic test failed
8	Second diagnostic test failed
9	Configured node address doesn't match SA85's
60	Node not running
64	Address error. Station address sent, doesn't match the one received
113	2.5 Second interface timeout
114	Bad interface -opcode
115	Interface data error
116	Interface test error
117	Interface transfer-done error
118	Bad interface path

Table continued on the following page.

Table B-2. Modbus Plus Error Codes (*continued*)

Error	Reason
119	Bad transfer state
120	Bad transfer length
128	Timeout - took too long to get a response
129	Illegal Modbus function for the slave
130	Illegal data address for the slave
131	Illegal data value for the slave
132	Device failure; the slave's PC has failed to respond
133	Acknowledge, a dealy is occurring because the slave's PC is processing the message
134	Busy, the PC is processing another message

APPENDIX C - ALLEN-BRADLEY DATA HIGHWAY PLUS INTERFACE TO SOFTSCREEN

C.1 INTRODUCTION

This section describes the functional definition of the SoftScreen to Allen-Bradley Data Highway Plus interface. The interface to Data Highway Plus uses the extended addressing capabilities of the PLC 5. The extended form of addressing lets the user address the entire PLC data file memory.

The areas of the PLC 5 data table that can be monitored and changed by SoftScreen include the following:

- Accumulated and preset values in timer files
- Accumulated and preset values in counter files
- Status files
- Integer files
- Floating point files
- Binary files
- Image of the I/O tables

C.2 PORT CONNECTOR AND LEDS

The direct connect adapter card for Allen-Bradley Data Highway Plus provides the following features:

Port Connector — This six-pin connector is the interface to your PLC.

Red LED — When on, the red LED indicates that the card has not been initialized. If the red LED is off after power-up, the card has been successfully initialized. The red light turns off when the 2000 is powered up.

Green LED — The green LED is on whenever the card is transmitting data over the Data Highway Plus network.

C.3 JUMPER AND SWITCH SETTINGS

This section discusses the jumper and switch settings for the direct connect adapter card. For information on jumper settings for the 2112 Expansion Module, refer to section 2.4.1.

> **NOTE**
> Set the jumpers and switches before connecting to the PLC.

Jumper JB2 on the direct connect adapter card is used to enable/disable the transmitter on that card. Since the Data Highway Plus software module must transmit, the transmission jumper (JB2) must be positioned to enable. This is the default position.

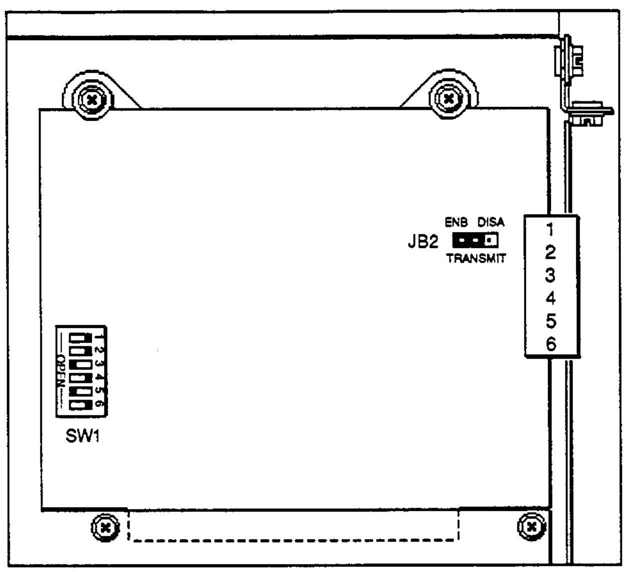


Figure C-1. Direct Connect Adapter Card Jumper and Switch

The switch should be positioned as shown above, with positions 3 and 5 OPEN and 1, 2, 4 and 6 CLOSED.§

§ *This information is taken from the Sutherland-Schultz Direct-Link Interface Reference Manual for the 5136-SD2.*

C.4 MAKING THE ELECTRICAL CONNECTION §

The Allen-Bradley Data Highway Plus connection is made through a daisy chain configuration, using a Belden 9463 twin-axial cable (or blue hose). The cabling is described below:

Table C-1. Allen-Bradley Data Highway Plus Cabling

PLC	Blue Hose	2112 Front Panel Connector
1	Blue	1 (or 4)
Shield	Shield	2 (or 5)
2	Clear	3 (or 6)

Pin 1 (positioned farthest from the LEDs) is the top pin of the connector (the edge connector is on the bottom of the card).

The alternate connectors on the board are used for wiring the Data Highway Plus in a daisy chain configuration.

The 2112 module and attached direct connect card represent a single node on the network. They should be connected the same as any other node. The adapter card does not have on-board termination. If a terminator is required, it should consist of a 150 ohm resistor between the blue and clear wires (1 and 3 *or* 4 and 6). In environments with high noise, two 75 ohm resistors may be used; one between blue and shield (1 and 2 *or* 4 and 5), the other between clear and shield (2 and 3 *or* 5 and 6).

§ *This information is taken from the Sutherland-Schultz Direct-Link Interface Reference Manual for the 5136-SD2.*

C.5 ALLEN-BRADLEY DATA HIGHWAY PLUS ADDRESSING

Address expressions specific to the Allen-Bradley Data Highway Plus interface are shown in Table C-2 on the following page. Below are the addressing forms and the legend for Table C-2:

Addressing Forms

[O:a/b]
[I:a/b]
[T f:e.acc/b]
[T f:e.pre/b]
[C f:e.acc/b]
[C f:e.pre/b]
[N f:e/b]
[F f:e]
[B f:e/b]
[B f/b]
[S:e/b]

Legend

File Types	
I	Input data image area
O	Output
T	Timer
C	Counter
N	Integer
F	Floating point
B	Binary
S	Status
Other Parameters	
a	I/O address. rrg where r = rack # and g = group #
b	bit # (optional, except for B f/b form)
e	element
f	file #

NOTE

When accessing a Floating Point File, the expression **must** contain an "FP" (i.e., [F f:e, FP] if FP is not the default format).

Table C-2. Allen-Bradley Data Highway Plus

File Type	f	a	e	b	R/W
O	-	00-377o	-	0-17o	R
I	-	00-377o	-	0-17o	R
S	-	-	0-31d	0-17o	R
B	3, 9-999d	-	0-999d	0-17o	R/W
B*	3, 9-999d	-	-	0-8191d	R/W
T	4, 9-999d	-	0-999d	0-17o	R/W
C	5, 9-999d	-	0-999d	0-17o	R/W
N	7, 9-999d	-	0-999d	0-17o	R/W
F	8-999d	-	0-999d	-	R/W

* [B f/b] form
d decimal
o octal

C.6 SOFTSCREEN DIRECT CONNECT EXPRESSIONS

Expressions are needed in many of the SoftScreen Development System forms. Some of the variables of the expressions specific to the Allen-Bradley Data Highway Plus direct connect are shown below:

addr is the expression for the address of an I/O rack/group. There are 32 possible racks. Each rack can contain eight groups of inputs and up to eight groups of outputs. Each group is 16 bits. For an octal address rrg, rr would be the rack number in octal (00 to 37), and g would be the group number (0 to 7).

bit is an optional bit number from 0 to 17 in octal

file is a file number (9-999); 3 = B, 4 = T, 5 = C, 7 = N, 8 = F

element (0-999)
(0-31) for Status file

These variables can be used as part of your Data Highway Plus expression in SoftScreen. For more information on expressions, see your SoftScreen Development System manual.

Expressions that perform certain functions when using the Allen-Bradley Data Highway Plus are listed on the following pages.

[O:addr/bit] **READ OUTPUT DATA**

Where:

addr specifies the rack/group value to read in the form of rrg, where rr is 0-37 octal and g is 0 to 7

bit is an optional bit number from 0 to 17 in octal

This expression is used to read a word (16 bits) or bit of output data (outputs from the PLC to the I/O). Example: [O:01/17] output rack 0, group 1, octal bit 17

[I:addr/bit] **READ INPUT DATA**

Where:

addr specifies the rack/group value to read in the form of rrg, where rr is 0-37 octal and g is 0 to 7

bit is an optional bit number from 0 to 17 in octal

This expression is used to read a word (16 bits) or bit of input data (inputs from the I/O to the PLC). Example: [I:01/17] input rack 0, group 1, octal bit 17

[T file:element.acc/bit] **READ/WRITE TIMER ACCUMULATED VALUE**
[T file:element.pre/bit] **READ/WRITE TIMER PRESET VALUE**

Where:

file is the timer file

element is the timer # located in the timer file

.acc specifies the accumulated value of the timer

.pre specifies the preset value of the timer

This expression is used to read or write a word or bit to the **acc**umulated or **pre**set values of a timer. Example: [T4:100.acc/5] timer file 4, element 100 accumulated value, bit 5

[C file:element.acc/bit] **READ/WRITE COUNTER ACCUMULATED VALUE**
[C file:element.pre/bit] **READ/WRITE COUNTER PRESET VALUE**

Where:

file	is the counter file
element	is the counter # located in the counter file
.acc	specifies the accumulated value of the counter
.pre	specifies the preset value of the counter

This expression is used to read or write a word or bit to the **accum**ulated or **pre**set value of the counter. Example: [C623:3.acc] counter file 623, element 3 the accumulated value

[N file:element/bit] **READ/WRITE TO AN INTEGER FILE**

Where:

file	is the integer file #
element	is the integer # located in the integer file

This expression is used to read or write to an element or bit in an integer file. Example: [N7:0/0] integer file number 7, element 0, Bit 0

[F file:element] **READ/WRITE TO A FLOATING POINT FILE**

Where:

file	is the floating point file #
element	is the floating point # located in the file

This expression is used to read or write to an element in a floating point file. Example: [F8:0] floating point file #8, element 0

[B file: element/bit] **READ/WRITE TO A BINARY FILE**

Where:

file	is the binary file #
element	is the word # located in the binary file
bit	is an octal bit number in the word (optional)

This expression is used to read or write to a word or bit in the binary file. Example: [B 999:20/10] binary file number 999, element 20, octal bit 10

[B file/bit] **READ/WRITE A BIT IN A BINARY FILE**

Where:

file	is the binary file #
bit	is a bit number from 0 to 8191 in decimal

This expression is used to read or write to a bit in a binary file. There are 16 bits per word. A file can have up to 1000 words. Example: [B3/300] binary file number 3, bit 300

S:element/bit **READ A WORD OR BIT**

Where:

element	is the offset into the status file in the range 0-31

This expression is used to read an element or bit in the PLC status file. Example:[S:12/2] status file, element 12, bit 2

APPENDIX D - ALLEN-BRADLEY DATA HIGHWAY PLUS/DATA HIGHWAY WITH EXTENDED ASCII ADDRESSING INTERFACE TO OIL

D.1 INTRODUCTION

This section describes the Operator Interface Language (OIL) to Allen-Bradley Data Highway/Data Highway Plus interface using the 2112 Expansion Module. The interface uses the extended addressing capabilities of the PLC 5. The extended form of addressing lets the user address the entire PLC data file memory.

The areas of the PLC 5 data table that can be monitored and changed by SoftScreen include the following:

- Accumulated and preset values in timer files
- Accumulated and preset values in counter files
- Status files
- Integer files
- Floating point files
- Binary files
- Image of the I/O tables

D.2 PORT CONNECTOR AND LEDS

The direct connect adapter card for the Data Highway/Data Highway Plus interface provides the following features:

Port Connector This six-pin connector is the interface to your PLC.

Red LED When on, the red LED indicates that the card has not been initialized. If the red LED is off after power-up, the card has been successfully initialized. The red light turns off when the engine is powered up.

Green LED The green LED is on whenever the card is transmitting data over the Data Highway/Data Highway Plus network.

D.3 JUMPER AND SWITCH SETTINGS

This section discusses the jumper and switch settings for the direct connect adapter card. For information on jumper settings for the 2112 Expansion Module, refer to section 2.4.1.

NOTE
Set the jumpers and switches before connecting to the PLC.

Jumper JB2 on the direct connect adapter card is used to enable/disable the transmitter on that card. Since the Data Highway/Data Highway Plus software module must transmit, the transmission jumper (JB2) must be positioned to enable. This is the default position.

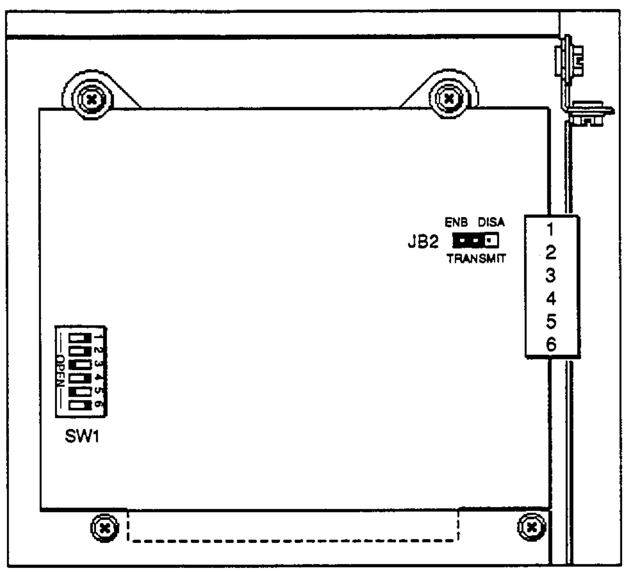


Figure D-1. Direct Connect Adapter Card Jumper and Switch

The switch should be positioned as shown on the previous page, with positions 3 and 5 OPEN and 1, 2, 4, and 6 CLOSED. §

§ *This information is taken from the Sutherland-Schultz Direct-Link Interface Reference Manual for the 5136-SD.*

D.4 MAKING THE ELECTRICAL CONNECTION §

The Data Highway/Data Highway Plus connection uses a Belden 9463 twin-axial cable (or "blue hose"). The cabling is shown below:

Table D-1. Data Highway/Data Highway Plus Cabling

PLC	Blue Hose	2112 Front Panel Connector
1	Blue	1 (or 4)
Shield	Shield	2 (or 5)
2	Clear	3 (or 6)

The alternate connectors on the board are used for wiring the Data Highway/Data Highway Plus in a daisy chain configuration.

The 2112 module and attached direct connect card represent a single node on the network. They should be connected the same as any other node. The adapter card does not have on-board termination. If a terminator is required, it should consist of a 150 ohm resistor between the blue and clear wires (1 and 3 or 4 and 6). In environments with high noise, two 75 ohm resistors may be used; one between blue and shield (1 and 2 or 4 and 5), the other between clear and shield (2 and 3 or 5 and 6).

D.5 CONFIGURATION MENU

The Configuration Menu is accessed from the 2000 Main Menu (described in Chapter 3 of the 2000-OIL manual). The Data Highway Configuration Menu is shown in Figure D-2.

```
                    -- Data Highway Configuration Menu --

1=Data Highway Plus ---- 0=Data Highway
Baud - 1=57.6K 2=115.2K 3=230.4K
1=Background Mode -- 0=Foreground Mode
Response Timeout Value (1-255 seconds)
Station Number (NNN octal)



Use <UP ARROW>, <DOWN ARROW>, <LEFT ARROW>, <RIGHT ARROW>
Use values 0 through 9.
"C" for next configuration menu, <RET> or <ENTER> to quit.
```

Figure D-2. Primary Configuration Menu

§ *This information is taken from the Sutherland-Schultz Direct-Link Interface Reference Manual for the 5136-SD.*

Baud Set the baud rate of the channel to match that of the PLC.

Mode Set the mode that the OIL commands operate in with the Data Highway/Data Highway Plus.

In Foreground Mode, the Data Highway/Data Highway Plus OIL interface command executes and returns when finished. This mode is easier to implement than Background Mode.

In Background Mode, the Data Highway/Data Highway Plus command initiates execution and gives control back to the OIL program. When this command has completed, the Busy Bit in the Communication Status Register is cleared, allowing return processing on that command. As long as the Busy Bit is set, other OIL commands (other than the Data Highway/Data Highway Plus interface commands) can execute. If the program is in Background Mode and a second Data Highway/Data Highway Plus interface OIL command is issued before the Busy Bit is cleared, an illegal situation occurs and bit #5 in the Communication Status Register is set.

> **NOTE**
> In Background Mode, Data Highway command registers change when the Busy Bit is cleared.

Response Timeout Value Set to the time the terminal will wait for response data before it signals a timeout and returns to the OIL program.

Station Number Identify the 2000 as a station on the Data Highway/Data Highway Plus network. The Data Highway interface allows a three digit octal address from 000 to 376. The Data Highway Plus interface only allows an address range from 00 to 77. However, there can be four Data Highway Plus networks linked to one Data Highway network, so the Data Highway Plus actually allows a three digit octal address from 000 to 377, with the first digit representing a network address. Refer to the PLC manual for recommended addresses.

> **NOTE**
> A different address should be used for each device on the Data Highway.

D.6 DIAGNOSTICS MENU

The Diagnostics Menu–accessed from the 2000 Main Menu (see Chapter 3 in the 2000-OIL manual)– lists the diagnostic tests that can be performed. The Diagnostics Menu specific to the Data Highway/Data Highway Plus interface is shown in Figure D-3 below:

-- Diagnostics --

1) Complete Test
2) Continuous Test
3) RAM
4) ROM Checksum
5) EPROM Test
6) Real Time Clock Test
7) RS-232 Serial Loopback
8) RS-485/Multidrop Serial Loopback
9) Printer Port Test
A) Parallel Input Test
B) Matrix Keyboard Loopback Test
C) Beeper Test
D) Battery Test
E) Dipswitch Test
F) Character Attributes
G) CRT Crosshatch Pattern
H) CRT Brightness Pattern
I) Touch Screen Test

<ESC> or <ENTER> to quit

Figure D-3. Diagnostics Menu

> **NOTE**
> Option I only appears if the optional touch screen is installed on your unit.

Refer to Chapter 3 in the 2000-OIL manual for explanations of each of the menu choices.

D.7 COMMUNICATION STATUS REGISTER

The Communication Status Register specified in a Data Highway/Data Highway Plus OIL command contains the status of the message previously transferred. If the bit number in the specified OIL register is set, the condition corresponding to that value (as described below) is true.

MSB - message status from PLC

LSB -	0	Transmit error
	1	Receive error
	2	Timeout
	3	Not used
	4	Busy Bit
	5	Cannot execute now, another DH command in progress
	6	2112 interface card error
	7	Not used

D.8 COMMANDS

This section describes the commands and instructions that are specific to the Data Highway/Data Highway Plus interface. These commands are listed below for reference:

PUT	Writes data to the PLC
GET	Reads data from the PLC
GETDIAG	Reads status information from the node interface
NODES	Reads the active node list from the 2112
FLOATD	Displays data in floating point format
FTOI	Changes stored data from floating point format to integer
ITOF	Changes stored data from integer format to floating point

The legend below lists file types for the instructions in tables D-2 and D-3.

Legend

File Types	
I	Input data image area
O	Output data image area
T	Timer
C	Counter
N	Integer
F	Floating point
B	Binary file
S	Status
A	ASCII
Other Parameters	
a	I/O address (octal). rrg where rr = rack number and g = group number
b	bit number
e	element number
f	file number
n	number of values to read/write
p	station address of remote PLC, 0-377 (octal)
r	first OIL destination/source register of data to read/write
s	Communication Status Register

D.8.1 PUT

The PUT command writes data from specified OIL registers to the PLC. Table D-2 lists PUT instructions specific to the Data Highway/Data Highway Plus interface.

Table D-2. PUT Instructions

Instruction	f	e	b	n
PUT p,"Tf:e.acc",n,r,s	4,9-999	0-999	-	1-64
PUT p,"Tf:e.pre",n,r,s	4,9-999	0-999	-	1-64
PUT p,"Cf:e.acc",n,r,s	5,9-999	0-999	-	1-64
PUT p,"Cf:e.pre",n,r,s	5,9-999	0-999	-	1-64
PUT p,"Nf:e",n,r,s	7,9-999	0-999	-	1-64
PUT p,"Ff:e",n,r,s	8-999	0-999	-	1-32
PUT p,"Bf:e",n,r,s	3,9-999	0-999	-	1-64
PUT p,"Af:e",n,r,s	9-999	0-999	-	1-64
PUT p,"Tf:e.acc/b",n,r,s	4,9-999	0-999	0-15	1
PUT p,"Tf:e.pre/b",n,r,s	4,9-999	0-999	0-15	1
PUT p,"Cf:e.acc/b",n,r,s	5,9-999	0-999	0-15	1
PUT p,"Cf:e.pre/b",n,r,s	5,9-999	0-999	0-15	1
PUT p,"Nf:e/b",n,r,s	7,9-999	0-999	0-15	1
PUT p,"Bf:e/b",n,r,s	3,9-999	0-999	0-15	1
PUT p,"Bf/b",n,r,s	3,9-999	-	0-15999	1

Example:

```
PUT 177,"B19:0",5,#30,#25
```

This command writes 5 words, starting at element 0, to binary file 19 of PLC 177. It retrieves the data from registers #30-#34. Register #25 contains the communication status.

D.8.2 GET

The GET command reads data from the PLC and stores it in specified OIL registers. Table D-3 lists GET instructions specific to the Data Highway/Data Highway Plus interface. All values are decimal, unless otherwise noted.

Table D-3. GET Instructions

Instruction	f	a	e	b	n
GET p,"O:a",n,r,s	-	0-377*	-	-	1-64
GET p,"I:a",n,r,s	-	0-377*	-	-	1-64
GET p,"Tf:e.acc",n,r,s	4,9-999	-	0-999	-	1-64
GET p,"Tf:e.pre",n,r,s	4,9-999	-	0-999	-	1-64
GET p,"Cf:e.acc",n,r,s	5,9-999	-	0-999	-	1-64
GET p,"Cf:e.pre",n,r,s	5,9-999	-	0-999	-	1-64
GET p,"Nf:e",n,r,s	7,9-999	-	0-999	-	1-64
GET p,"Ff:e",n,r,s	8-999	-	0-999	-	1-32
GET p,"Bf:e",n,r,s	3,9-999	-	0-999	-	1-64
GET p,"S:e",n,r,s	-	-	0-127**	-	1-64
GET p,"Af:e",n,r,s	9-999	-	0-999		1-64
GET p,"O:a/b",n,r,s	-	0-377*	-	0-17 octal	1-64
GET p,"I:a/b",n,r,s	-	0-377*	-	0-17 octal	1-64
GET p,"Tf:e.acc/b",n,r,s	4,9-999	-	0-999	0-15	1-64
GET p,"Tf:e.pre/b",n,r,s	4,9-999	-	0-999	0-15	1-64
GET p,"Cf:e.acc/b",n,r,s	5,9-999	-	0-999	0-15	1-64
GET p,"Cf:e.pre/b",n,r,s	5,9-999	-	0-999	0-15	1-64
GET p,"Nf:e/b",n,r,s	7,9-999	-	0-999	0-15	1-64
GET p,"Bf:e/b",n,r,s	3,9-999	-	0-999	0-15	1-64
GET p,"Bf/b",n,r,s	3,9-999	-	-	0-15999	1
GET p,"S:e/b",n,r,s	-	-	0-127**	0-15	1-64

*a=rrg, where rr = 0-37 (octal) and g = 0-7
** the size of the status file depends on the type of PLC 5

Below is an example of a GET command.

Example:

GET 10,"C14:6.pre/3",3,#50,#20

This command reads bit 3 of the preset values from counters, 6, 7, and 8 in file number 14 from PLC address 10. It stores the values in registers #50, #51, and #52 bit 0. Register #20 contains the communication status.

D.8.3 GETDIAG

Syntax:

GETDIAG,p,n,r,s

Where:

p is the station address of remote PLC, 0-377 (octal)

n is the number of values to read/write, 0-255

r is the first OIL register in which to store data

s is the Communication Status Register

The GETDIAG command reads a block of status information from the node interface.

Example:

GETDIAG 10,6,#100,#20

This command reads the first 6 status elements from the node at address 10 and stores them in OIL registers #100-#105. Register #20 contains the communication status.

D.8.4 NODES

Syntax:

NODES,r

where r is the first OIL destination register of data read

This command reads the active node list from the 2112 and stores the list in eight consecutive OIL registers (r = first of eight registers). The data will be stored in the least significant bytes (LSB) of the registers with each bit corresponding to a network address.

If the registers are displayed in increasing order, from the top to the bottom of the screen, the following matrix applies:

bit

		7	6	5	4	3	2	1	0
r	1	#38	#30	#28	#20	#18	#10	#08	#00
e	2	#39	#31	#29	#21	#19	#11	#09	#01
g	3	#3A	#32	#2A	#22	#1A	#12	#0A	#02
i	4	#3B	#33	#2B	#23	#1B	#13	#0B	#03
s	5	#3C	#34	#2C	#24	#1C	#14	#0C	#04
t	6	#3D	#35	#2D	#25	#1D	#15	#0D	#05
e	7	#3E	#36	#2E	#26	#1E	#16	#0E	#06
r	8	#3F	#37	#2F	#27	#1F	#17	#0F	#07

all addresses in hex

If the bit is set, there is an active node at the network address.

Example:

NODES,#52

This command reads the active node list from the 2112 and stores the values in OIL registers #52-#59.

D.8.5 **Floating Point Display (FLOATD)**

Syntax:

FLOATD r,j,m,f

Where:

- r — is the first of a pair of registers
- j — is justification (0 = right, 1 = left)
- m — is the total display width (maximum=10, minimum=2)
- f — is the fractional field width with a maximum of 4

This command displays an IEEE single precision number (found in two consecutive OIL registers) on the screen.

Registers r and r+1 contain the value to be displayed. This parameter (r) is a standard OIL register, but cannot be the last available register, e.g., #500 out of 500.

This command supports both left and right justification. If right justification is selected, enough space is inserted between characters so that the total number of characters output is exactly equal to the next parameter, m. If left justification is selected, the function outputs no extra characters.

The total field width (m) is the maximum number of characters that will be output by this command. This parameter has a maximum value of ten and minimum of two. This means that values greater than 99999.9999 cannot be displayed and that at least one digit left of the decimal point and the decimal point itself are always displayed. If the function detects an output overflow (i.e. significant digits are lost left of the decimal point), an additional character, " > ", is appended to the output string. If the value output is negative, a negative sign, "-", precedes the left-most digit and is counted as part of the field width m.

The fractional field width (f) is the number of characters to the right of the decimal point. This number must be at least two less than the total display field width, and must also be less than or equal to four.

Example:

FLOATD #21,1,7,1

This command displays the floating point value in registers #21 and #22 as a left justified 7-character string.

D.8.6 Floating Point to Integer (FTOI)

Syntax:

FTOI r,i,f,s

Where:

r	is the first of a pair of registers
i	is the register to receive the 16-bit integer
f	is the register to receive the fractional portion
s	is the status flag register

The FTOI command converts an IEEE single precision floating point number into an integer format that is more easily manipulated by OIL programs. This command requires the IEEE single precision number to be found in two consecutive OIL registers. The value to be converted is represented by the first parameter (r). This parameter is a standard OIL register, except that it cannot be the last available register, e.g. #500 of 500.

The value returned is a 16-bit integer. This integer represents the least significant 16-bits of the absolute value of the integer portion of the IEEE single precision number. The sign of the original number is indicated in the status flag word.

The fractional portion is expressed as an integer which represents the number of 10000ths in the original floating point value. For example, if an integer value of 1250 is returned, the fractional value would be 1250/10000 or 1/8 (.125).

The status flag register has the following values:

Bit 0

0	=	the original number was positive
1	=	the original number was negative

Bit 1

0	=	the integer value returned is correct
1	=	an overflow occurred, indicating the floating point value was greater than 65535.

Example:

```
FTOI #20,#30,#40,#41
```

This example converts the IEEE single precision floating point number in registers #20 and #21 to an integer, which is stored in register #30. Any fractional value of the integer is stored in register #40, and the status flag is stored in register #41.

D.8.7 Integer to Floating Point (ITOF)

Syntax:

```
ITOF i,f,r
```

Where:

i — is the integer portion of the number to be converted

f — is the fractional portion

r — is the first of a pair of registers

The ITOF command converts an integer to an IEEE floating point value. The integer portion is passed to a single OIL register. The number cannot be greater than 65535 because the integer conversion is limited to a 16-bit value.

The fractional portion of this number is expressed as an integer representing the number of 10000ths. For example, the fractional value 1/4 is represented by setting the f register to 2500, to represent 2500/10000. Any value greater than 9999 is considered an error.

The IEEE single precision floating point number that results from this conversion is placed in the register pair represented by r.

Example:

ITOF #31,#32,#21

This command converts the integer in register #31 and the offset fraction in register #32 into a floating point value. The value is stored in registers #21 and #22.

D.8.8 Register Ranges and Data Sizes

Each OIL register can contain one word of data. A word is two bytes or 16 bits.

The GET and PUT commands for binary, timer, counter, integer, and status* files can read/write words or bits of data to/from these files. This means that one OIL register can contain one data value. Bit values are handled the same as word values—one bit per register.

For the files listed above, the ranges are

r = #12 to (1 + maximum number of registers configured - n)

s = #12 to maximum number of registers configured

For example, if there are 400 extra registers configured, the maximum number of registers configured is 500 + 400 = 900.

So, in the example GET 10,"N7:10",20,r,s

r can be any register number between #12 and #881

($r_{top\ limit}$ = 1 + 900 - 20 = 881)

s can be any register number between #12 and #900

For the NODES,r command, the range for r = #12 to (1 + maximum number of registers configured - 8).

ASCII and floating point files are different from the above files. An ASCII file element is only one byte. This means that one OIL register can contain two data values. When reading/writing an ASCII file, the address entered (Af:e) is a byte offset address, not a word offset address. For example, the command PUT 10,"A9:2",2,#20,#40 means put the 2 bytes contained in register #20 into ASCII file 9, starting at byte 2.

* Status files are read only.

The Allen-Bradley PLC 5/10, 5/15, and 5/25 store the ASCII bytes in the following format:

Word Address	0	1	2	3	4	...
Byte Address	0 1	2 3	4 5	6 7	8 9	...

The Allen-Bradley PLC 5/20, 5/40, and 5/60 (revision A and B) store the ASCII bytes in the following format:

Word Address	0	1	2	3	4	...
Byte Address	1 0	3 2	5 4	7 6	9 8	...

Floating point data file values are two words or four bytes. This means that each floating point address requires two OIL registers for data. For example, the command GET 10,"F8:100",1,#60,#500, reads the value in the PLC floating point file 8, address 100, and stores it in registers #60 and #61.

When dealing with floating point files, the allowable range for r is

#12 to (1 + max # of registers configured - 2n)

The allowable range for s is still #12 to max # of registers configured.

E.1 INTRODUCTION

The direct connect to Allen-Bradley's Remote I/O network is accomplished through a high-speed serial expansion card, which comes installed on the 2112-AB Expansion Module. In this appendix, the expansion card is referred to as the direct connect card. The entire 2112-AB unit is referred to as the 2112.

The Remote I/O direct connect is capable of monitoring and simulating remote I/O on the network. It can report the status of any I/O point on the Remote I/O network and it can simulate a remote I/O rack. When simulating a remote I/O rack, it can simulate block transfer modules. The direct connect can supply data for Block Transfer Reads (BTRs) from the PLC and accept data from Block Transfer Writes (BTWs) from the PLC.

This direct connect uses the double buffering capabilities of the direct connect adapter card. This ensures that the values of groups of data are kept together, and changes are read from or sent to the PLC at the same time. All data read or written with a single command is kept together.

E.2 PORT CONNECTOR AND LEDS

The direct connect adapter card for Allen-Bradley Remote I/O provides the following features:

Port Connector — This six-pin connector is the interface to the PLC.

Red LED — When on, the red LED indicates that the card has not been initialized. If the red LED is off after power-up, the card has been successfully initialized. The red light turns off when the 2000 is powered up.

Green LED — The green LED is on whenever the card is transmitting data over the remote I/O network

E.3 JUMPER AND SWITCH SETTINGS

This section discusses the jumper and switch settings for the direct connect adapter card. J5 on the 2112 card must be in position 3. For information on jumper settings for the 2112 Expansion Module, refer to section 2.4.1.

NOTE
Set the jumpers and switches before connecting to the PLC.

Jumper JB2 on the direct connect adapter card is used to enable/disable the transmitter on that card. If the Remote I/O direct connect will simulate an I/O rack, this jumper must be positioned to "Enable" (see Figure A-1). Otherwise, it should be positioned to disable. The default is enabled.

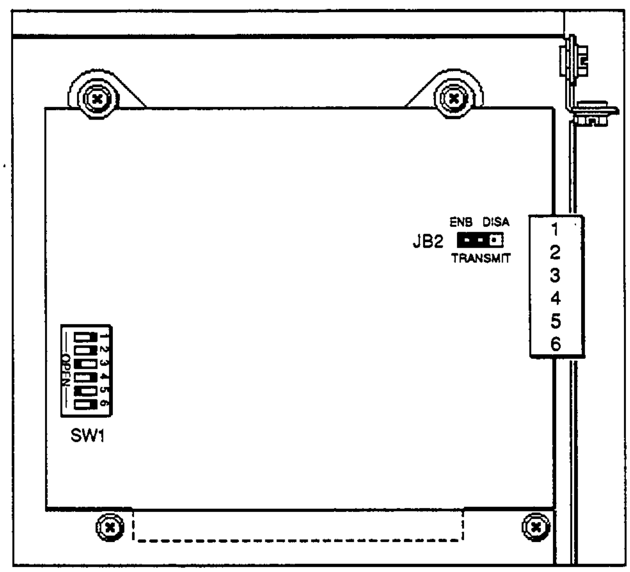


Figure E-1. Direct Connect Adapter Card Jumper and Switch

The switch should be positioned as shown above, with positions 3 and 5 OPEN and 1, 2, 4, and 6 CLOSED.§

§ *This information is taken from the Sutherland-Schultz Direct-Link Interface Reference Manual for the 5136-SD2.*

E.4 MAKING THE ELECTRICAL CONNECTION §

The Allen-Bradley Remote I/O connection is made through a daisy chain configuration, using a Belden 9463 twin-axial cable (or "blue hose"). Cabling is described in Table A-1:

Table E-1. Allen-Bradley Remote I/O Cabling

PLC	Blue Hose	2112 Front Panel Connector
1	Blue	1 (or 4)
Shield	Shield	2 (or 5)
2	Clear	3 (or 6)

> **NOTE**
> Pin 1 (positioned farthest from the LEDs) is the top pin of the connector (the edge connector is on the bottom of the card). See Figure E-2.

The alternate connectors on the board are used for wiring the Remote I/O in a daisy chain configuration.

The 2112 module and attached direct connect card should be connected to the PLC in the same way as any other remote rack. The adapter card does not have on-board termination. If a terminator is required, it should consist of a 150 ohm resistor between the blue and clear wires (1 and 3 *or* 4 and 6). In environments with high noise, two 75 ohm resistors may be used; one between blue and shield (1 and 2 *or* 4 and 5), the other between clear and shield (2 and 3 *or* 5 and 6).

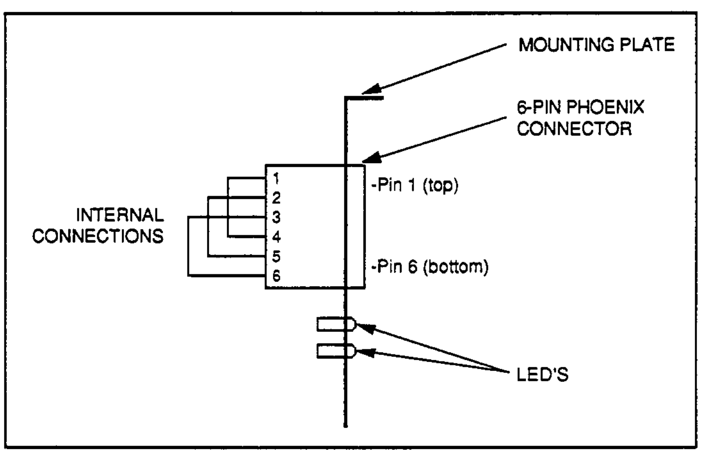


Figure E-2. Pin 1 Position

§ *This information is taken from the Sutherland-Schultz Direct-Link Interface Reference Manual for the 5136-SD2.*

E.5 CONFIGURATION MENU

The Remote I/O Configuration Menu, accessed from the 2000 Main Menu (as described in Chapter 3 of the 2000-OIL manual), is shown below:

```
                    -- REMOTE I/O Configuration Menu --

01   Rack Address (0-37 octal PLC3/5, 1-40 octal PLC2)
3    Rack Size (0 = 1/4, 1 = 1/2, 2 = 3/4, 3 = FULL)
0    Rack Starting Module group (0,2,4,6)
2    PLC Family (2, 3, or 5)
0    1=Block Transfer Enabled 0=Disabled
0    2=230.4Kbs --- 1=115.2Kbs --- 0=57.6Kbs
64   Block Transfer Write Length (1-64 words)
64   Block Transfer Read Length (1-64 words)


Use <UP ARROW>, <DOWN ARROW>, <LEFT ARROW>, <RIGHT ARROW>
Use values 0 through 9.
"C" for next configuration menu, <ESC> or <ENTER> to quit.
```

Figure E-3. Remote I/O Configuration Menu

E.6 DIAGNOSTICS MENU

The Diagnostics Menu—accessed from the 2000 Main Menu (see Chapter 3 in the 2000-OIL manual)— lists the diagnostic tests that can be performed. The Diagnostics Menu specific to the Remote I/O interface is shown in Figure E-4:

```
-- Diagnostics --

1) Complete Test
2) Continuous Test
3) RAM Test
4) ROM Checksum
5) EEPROM Test
6) Real Time Clock Test
7) RS-232 Serial Loopback Test
8) RS-485/Multidrop Serial Loopback Test
9) Printer Port Test
A) Parallel Input Test
B) Matrix Keyboard Loopback Test
C) Beeper Test
D) Battery Test
E) Dipswitch Test
F) Character Attributes
G) CRT Crosshatch Pattern
H) CRT Brightness Pattern
I) Touch Screen Test

<ESC> or <ENTER> to quit
```

Figure E-4. Diagnostics Menu

> **NOTE**
> Option I only appears if the optional touch screen is installed on your unit.

E.7 RACK EMULATION

The Remote I/O direct connect card emulates a two-slot address I/O rack. It can be configured as a 1/4, 1/2, 3/4, or full rack. If configured as a full rack, it appears to the PLC as shown below:

Table E-2. Rack Configuration

	Module Group/Slot	Function	OIL Register #
1/4 rack	0/0	Block transfer instruction	N/A
	0/1	8 bits input (status byte)	35
	1/0	16 bits output	21
	1/1	16 bits input	28
1/2 rack	2/0	16 bits output	22
	2/1	16 bits input	29
	3/0	16 bits output	23
	3/1	16 bits input	30
3/4 rack	4/0	16 bits output	24
	4/1	16 bits input	31
	5/0	16 bits output	25
	5/1	16 bits input	32
full rack	6/0	16 bits output	26
	6/1	16 bits input	33
	7/0	16 bits output	27
	7/1	16 bits input	34

E.8 I/O MAPPING

Input and output image tables are mapped into OIL registers. Table E-3 is an illustration of I/O mapping for a full rack:

Table E-3. I/O Mapping into OIL Registers

Module Group	Function	OIL Register #
1	output from PLC	21
2	output from PLC	22
3	output from PLC	23
4	output from PLC	24
5	output from PLC	25
6	output from PLC	26
7	output from PLC	27
1	input to PLC	28
2	input to PLC	29
3	input to PLC	30
4	input to PLC	31
5	input to PLC	32
6	input to PLC	33
7	input to PLC	34

If the Remote I/O direct connect is not configured for a full rack, OIL registers mapped to nonexistent outputs will not contain valid data. Data written to OIL registers mapped to nonexistent inputs have no effect.

If the direct connect is configured for a partial rack, the addresses used by the PLC must be adjusted if the starting module group is not zero. Refer to tables E-4 through E-6.

Table E-4. I/O Mapping Starting with Module Group #2

Module Group/Slot	Function	OIL Register #	Legal Rack Sizes
2/0	Master control byte	N/A	0, 1, 2
2/1	Status byte	35	0, 1, 2
3/0	Output	21	0, 1, 2
3/1	Input	28	0, 1, 2
4/0	Output	22	1, 2
4/1	Input	29	1, 2
5/0	Output	23	1, 2
5/1	Input	30	1, 2
6/0	Output	24	2
6/1	Input	31	2
7/0	Output	25	2
7/1	Input	32	2

Table E-5. I/O Mapping Starting with Module Group #4

Module Group/Slot	Function	OIL Register #	Legal Rack Sizes
4/0	Master control byte	N/A	0, 1
4/1	Status byte	35	0, 1
5/0	Output	21	0, 1
5/1	Input	28	0, 1
6/0	Output	22	1
6/1	Input	29	1
7/0	Output	23	1
7/1	Input	30	1

Table E-6. I/O Mapping Starting with Module Group #6

Module Group/Slot	Function	Register #	Legal Rack Sizes
6/0	Master control byte	N/A	0
6/1	Status byte	35	0
7/0	Output	21	0
7/1	Input	28	0

E.9 OIL REGISTERS

OIL registers #35-#37 contain communication status, error code, and PLC communication state information. Register #38 contains the BTR starting register.

E.9.1 Communication Status Register

Using Remote I/O OIL, register #35 contains the status of the message previously transferred. If the bit number in register #35 is set, the condition corresponding to that value (as described below) is true.

MSB - Not used

LSB - 0 Online
1 Block Transfer Write (BTW) command buffer full
2 BTW data buffer full
3 Block Transfer Read (BTR) data buffer full
4 Not used
5 Not used
6 Not used
7 Not used

E.9.2 Error Code Register

Using Remote I/O OIL, register #36 contains the last error that occurred on the rack. If register #36 contains a value, the error corresponding to that value (as described below) is true:

0 Error code is reset
1 Not used
2 Not used
3 Not used
4 Not used
5 No communications (160 ms time-out)

E.9.3 PLC Communication State Register

Using Remote I/O OIL, register #37 contains the current PLC communication state. The value in register #37 should correspond to one of the four possible states (as described below):

0	Initial state, communications not started
1	PLC in reset/program/test state
2	PLC in run mode
3	Communications lost

E.9.4 BTR Starting Register

Register #38 contains the number of the first OIL register to transfer when the OIL program executes a BTR command. This register usually contains the second word sent by a BTW command (see section E.10.1). If the value of register #38 is 0, OIL can write to it.

E.10 COMMANDS

This section describes the commands and instructions specific to the Remote I/O interface. The commands are listed below:

BTW	Updates block transfer write
BTR	Updates block transfer read
RINF	Returns status word for any rack on the network
READI	Returns the state of discrete inputs from a rack/group
READO	Returns the state of discrete outputs from a rack/group

E.10.1 Block Transfer Write (BTW)

Syntax:

BTW (no parameters necessary)

This command maintains the "block integrity" of block transfer data by allowing registers to be updated only when specified by the OIL program. Each time the PLC executes a BTW command, data is transferred from the PLC to a buffer on the 2000 terminal.

If the first word of the block transfer write data is 0, the remaining data is interpreted as a Remote command. If it is not 0, the first word is an OIL destination register number, the second word is an OIL source register number for block transfer reads (BTRs) which is placed in register #38, and the remaining data is for OIL registers.

E.10.1.1 **Block Transfer Write Commands**

The format of a BTW command sent to the direct connect card from a PLC is as follows:

word 0	=	0 (common indicator)
word 1(high byte)	=	Command
word 1 (low byte)	=	Command data
word 2-63	=	Not used

Available commands are

0000	Reset (no data needed)
0001	Execute program block
0002	Execute subprogram block

The execute program block and execute subprogram block commands each need one byte of data to specify the program block number. Data sent to OIL registers with a BTW that is not needed for the specified command is ignored.

Example:

If BTW data sent by the PLC is

0	270...
word 0	word 1...

then the OIL program in block 14 will be executed.

word 1	=	270 (decimal)	
	=	010E (hex)	
	=	0000 0001 high byte = 1	0000 1110 low byte = 14

E.10.1.2 **Block Transfer Write Data**

When the PLC executes a BTW, the data is sent to an engine buffer. Bit 2 of the Communication Status Register (#35) is set to indicate that the buffer is full. When the OIL program executes its BTW command, the data is transferred from the buffer to the OIL registers and bit 2 is reset to indicate that the data was received.

The format of BTW data sent to OIL registers from a PLC is as follows:

word 0	=	BTW starting register (pointer; binary format)
word 1	=	BTR starting register (pointer; binary format) for register #38
word 2-63	=	BTW data (binary or BCD format)

Word 0 specifies the first OIL register in a block of consecutive registers in which to store the BTW data. The direct connect card reads from the PLC the number of words set by the length parameter in the PLC BTW command. OIL then reads from the direct connect card the number of words specified in the OIL Configuration Menu and places them into OIL registers. If the number of words specified by the length parameter in the PLC is 0, the direct connect card reads 64 words from the PLC. However, OIL still reads from the direct connect card the number of words set by the OIL Configuration Menu and places them into OIL registers.

Word 1 specifies the starting address of the first OIL register to use for BTRs. This is the value stored in register #38. This value is not put into the register until the OIL program executes the BTW command.

Example:

If BTW data sent by the PLC is

200	300	1	5	7
word 0	word 1	word 2	word 3	word 4

then the data will be stored in the following OIL registers:

#38	=	300 (BTR data will be read starting at #300, per word 1)
#200	=	1 (Store BTW data starting at #200, per word 0)
#201	=	5
#202	=	7

NOTE

When writing the PLC program, a BTW must be requested before a BTR instruction if the PLC is to set register #38 to a value other than 0.

> **NOTE**
> It is possible for the OIL BTW command to fill less or more OIL registers than were updated by the PLC BTW command.

E.10.2 Block Transfer Read (BTR)

Syntax:

BTR (no parameters necessary)

This command maintains the "block integrity" of block transfer data by allowing registers to be copied only when specified by the OIL program. When the OIL program executes the BTR command, data is copied from OIL registers to the direct connect card. Bit 3 of the Communication Status Register (#35) is set to indicate that the buffer is full of new data. The data is then transferred to the PLC when the PLC executes its BTR command. Bit 3 is reset to indicate that the data was received. The BTR command copies data from consecutive OIL registers starting with the register number specified in register #38.

> **NOTE**
> If the PLC program specifies the BTR starting register, the OIL program must execute a BTW command after the PLC does a BTW in order for register #38 to contain a valid register number.

> **NOTE**
> If a BTR starting register is not specified by the PLC program, the OIL program can specify it by writing to register #38.

The number of words transferred from OIL registers to the direct connect card is set in the OIL Configuration Menu. The number of words transferred from the direct connect card to the PLC is specified in the PLC BTR command. If the specified length in the PLC BTR instruction is 0, the PLC reads 64 words.

> **NOTE**
> It is possible for the PLC to read less or more data from the buffer than was stored there by the OIL BTR command.

The format of data transferred to the PLC is

word 0	=	BTR register (value from register #38)
word 1-63	=	BTR data

When doing a BTR, the PLC must check the first word to make sure the data received is the data requested. The first word should be the starting OIL register number of the data requested by the PLC.

Example:

If OIL registers contain the following data

#38 = 300	#301 = 3
#300 = 2	#302 = 4

and the OIL BTR length is 4, then OIL will copy its registers to the data buffer in the following format:

300	2	3	4
word 0	word 1	word 2	word 3

E.10.3 **Read Status Information (RINF)**

Syntax:

RINF, p,r

Where:

p is the rack number, 0 - 40 octal
r is the OIL register in which to store data

This command returns a status word for any rack on the network. Bits 0 and 1 are the status bits for a rack starting at the first quarter at the rack address. Bits 2 and 3 are the status bits for a rack starting at the second quarter at the rack address. Bits 4 and 5 are for a rack starting at the third quarter at the rack address and bits 6 and 7 are for a rack starting at the fourth quarter. Bits 8 through 15 are not used and will always be zero.

The value of the bits and there meaning are as follows:

0	No rack present
1	PLC in run mode, rack is okay
2	PLC in test or program mode
3	Rack error, PLC sees no response from this rack

The bits have meaning only if there is a rack starting in the quarter corresponding to the bit position.

Example:

RINF 07,#300

This example reads the rack status for rack seven octal and places the result into OIL register #300.

E.10.4 **Read Inputs (READI)**

Syntax:

READI pg,r

Where:

p is the rack number, 0-40 octal
g is the group number, 0-7
r is the OIL register in which to store data

This command returns the state of discrete inputs from a rack/group.

Example:

READI 163,#50

This example reads the state of the inputs from rack 16 octal, group 3, and places it into OIL register #50.

E.10.5 **Read Outputs (READO)**

Syntax:

READO pg,r

Where:

p is the rack number, 0-40 octal
g is the group number, 0-7
r is the OIL register in which to store data

This command returns the state of discrete outputs from a rack/group.

Example:

READO 112,#60

This example reads the state of the inputs from rack 11 octal, group 2, and places it into OIL register #60.