Data Highway Plus Interface Module

(M/N 57C442)

Instruction Manual J2-3067-5

Rockwell Automation

The information in this user's manual is subject to change without notice.

ATTENTION: Only qualified electrical personnel who are familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, and/or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: The user is responsible for conforming with all applicable local, national, and international codes. Wiring practices, grounding, disconnects, and over-current protection are of particular importance. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: The user must provide an external, hardwired emergency stop circuit outside the controller circuitry. This circuit must disable the system in case of improper operation. Uncontrolled machine operation may result if this procedure is not followed. Failure to observe this precaution could result in bodily injury.

ATTENTION: Inserting or removing a module may result in unexpected machine motion. Power to the machine should be turned off before inserting or removing the module. Failure to observe these precautions could result in bodily injury.

ATTENTION: This module contains static-sensitive components. Careless handling can cause severe damage. Do not touch the connectors on the back of the module. When not in use, the module should be stored in an anti-static bag. The plastic cover should not be removed. Failure to observe this precaution could result in damage to or destruction of the equipment.

Table of Contents

Appendices

List of Figures

1.0 INTRODUCTION

The products described in this manual are manufactured or distributed by RelianceElectric Industrial Company.

The Data Highway Plus Interface module (MN 57C442) provides a direct connection for the AutoMax system to the Allen Bradley Data Highway Plus network. The Data Highway Plus interface module can be placed in any slot in an AutoMax rack that contains at least one AutoMax Processor, and can communicate with up to four AutoMax Processors in that rack. The AutoMax rack containing the Data Highway Plus interface module appears as a single station on the Data Highway Plus network. Figure 1-1 illustrates an AutoMax system connected to a Data Highway Plus network.

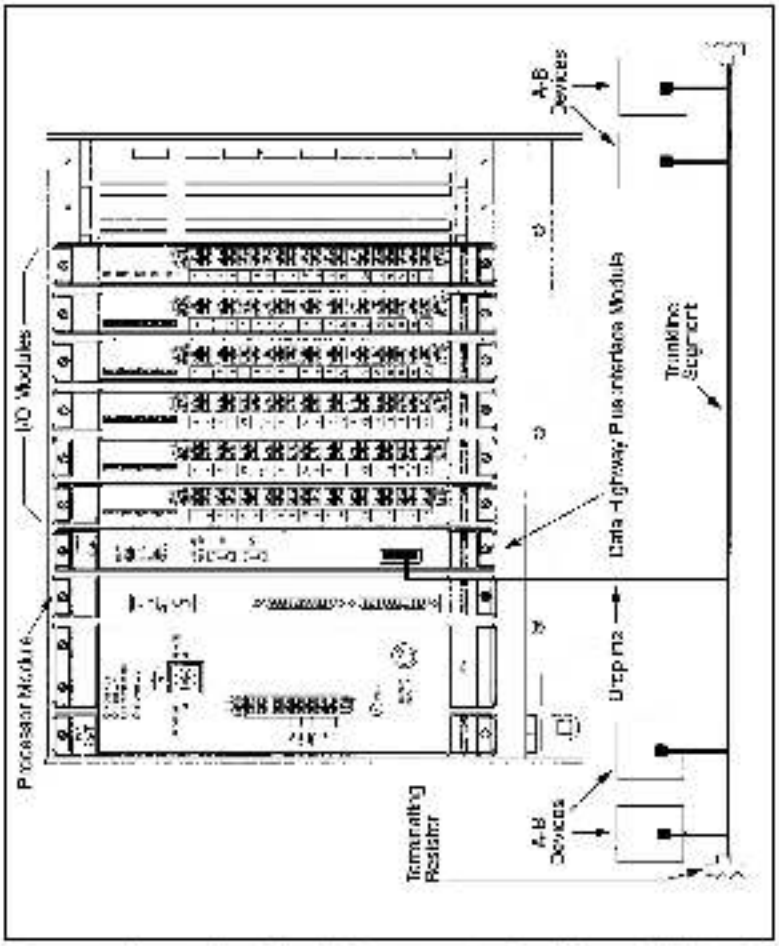


Figure 1-1 Connecting the AutoMax System to the Data Highway Plus Network

Each AutoMax Processor has access to the look alike PLC-5 or SLC registers through the AutoMax rack backplane. The Data Highway Plus Interface module transfers data between the PLC-5 look alike image and remote Allen Bradley equipment using the Word Range Read, Word Range Write, and Read Modify Write commands. The module is capable of responding directly to these commands as well as typed read and write commands from the PLC-5 command set and eight other commands from the basic command set. These commands are described in section 4.2. The individual command formats are described in the various Allen Bradley instruction manuals.

The remainder of this manual describes the functions and specifications of the Data Highway Plus Interface module. It also includes a detailed description of module installation and troubleshooting procedures, as well as programming methods.

1.1 Additional Information

You must be familiar with all the instruction manuals that describe your system configuration. This may include, but is not limited to, the following:

- J-3636 COMMON MEMORY MODULE INSTRUCTION MANUAL
- J-3649 AutoMax CONFIGURATION TASK INSTRUCTION MANUAL
- J-3650 AutoMax PROCESSOR MODULE INSTRUCTION MANUAL
- J-3689 AutoMax POCKET REFERENCE
- J-3675 AutoMax ENHANCED BASIC LANGUAGE INSTRUCTION MANUAL
- J-3676 AutoMax CONTROL BLOCK LANGUAGE INSTRUCTION MANUAL
- J2-3093 AutoMax LADDER EDITOR INSTRUCTION MANUAL
- J2-3094 AutoMax ENHANCED LADDER LANGUAGE INSTRUCTION MANUAL
- J-3677 AutoMax LADDER LOGIC LANGUAGE INSTRUCTION MANUAL
- IEEE-518 GUIDE FOR THE INSTALLATION OF ELECTRICAL EQUIPMENT TO MINIMIZE ELECTRICAL NOISE INPUTS TO CONTROLLERS
- Your ReSource AutoMax PROGRAMMING EXECUTIVE INSTRUCTION MANUAL
- 1770-6.5.16 Allen Bradley Data Highway/Data Highway Plus/DH 485 Communication Protocol and Command Set
- Data Highway Cable Assembly and Instruction Manual
- Your personal computer and DOS operating system manuals
- Other instruction manuals applicable to your hardware configuration

1.2 Related Hardware and Software

M/N 57C442 contains one Data Highway Plus interface module. The module can be used with the following hardware and software:

1. M/N 57C430A, 57C431, 57C435 Automax Processor.
2. IBM AT compatible computer running DOS version 3.1 or later.
3. M/N 9-1317 RS 232C ReSource Interface cable. This cable is used to connect the personal computer to the AutoMax Processor module.
4. M/N 57C415 or 57C423 Common Memory module. This module is used when there is more than one AutoMax Processor in a rack.
5. (various model numbers) ReSource AutoMax Programming Executive software.
6. A-B Data Highway Plus cabling hardware.

The thick black bar shown on the right hand margin of this page will be used throughout this instruction manual to signify new or revised text or figures.

2.0 MECHANICAL/ELECTRICAL DESCRIPTION

This section describes the mechanical and electrical characteristics of the Data Highway Plus Interface module.

2.1 Mechanical Description

The Data Highway Plus Interface module is a printed circuit assembly that plugs into the backplane of an AutoMax rack. The module consists of a printed circuit board, faceplate, and protective enclosure. The faceplate contains ejector tabs at the top and bottom to simplify removing the module from the rack. See figure 2-1 for an illustration of the module faceplate.

The 6 pin Phoenix Combicon connector on the faceplate is used to make the connection to the Data Highway Plus network by means of a standard twin axial cable. Refer to Appendix C or to Data Highway Plus documentation for the cable connections.

The two thumbwheel switches on the faceplate are used to set the module's station number (octal) on the Data Highway Plus network. The upper thumbwheel switch represents the most significant digit; the lower thumbwheel switch represents the least significant digit. If you set the switches to invalid octal digits (8 or 9), the station number will not be accepted and module error code 6 will be displayed on the seven segment LED.

For diagnostic purposes, the faceplate contains a seven segment LED which displays error codes. The error codes are defined in Appendix D. A green status LED (labeled "OK") on the faceplate indicates when the module is operational (ON) or when it should be replaced (OFF).

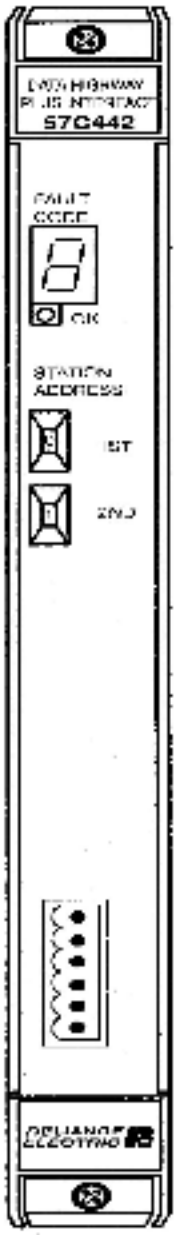


Figure 2.2 Data Highway Plus Interface Module Faceplate

2.2 Electrical Description

The Data Highway Plus Interface module contains an 8 MHz microprocessor that shares 32K of dual port memory with the AutoMax rack backplane. This memory is accessible to both the on board microprocessor and AutoMax Processors in the rack. A block diagram is shown in Appendix B. The module contains a watchdog timer which is enabled when power is turned on to the module. The microprocessor must reset the watchdog timer within a specified time or the microprocessor will shut down and the status LED labeled 'OK' on the faceplate will turn off.

At power up, the on board microprocessor runs diagnostics on the microprocessor, EPROM, RAM and dual port memory, as well as performing system level diagnostics. As each test is run, a number is written out to the seven segment display. If there is a fault during these tests, the microprocessor halts, the watchdog times out, and the seven segment LED displays the code of the failed diagnostic. See Appendix D for a list of error codes.

3.0 INSTALLATION

This section provides instructions on how to install the Data Highway Plus interface module.

3.1 Wiring

ATTENTION: The user is responsible for conforming with all applicable local, national, and international codes. Wiring practices, grounding, disconnects, and over current protection are of particular importance. Failure to observe this precaution could result in severe bodily injury or loss of life.

To reduce the possibility of electrical noise interfering with the operation of the control system, exercise care when installing the wiring from the control system to the external devices. For detailed recommendations refer to IEEE 518.

3.2 Initial Installation

Use the following procedure to install the module:

Step 1. Stop any application tasks that may be running.

ATTENTION: This equipment is at line voltage when AC power is connected. Disconnect and lock out all ungrounded conductors of the AC power line. Failure to observe these precautions could result in severe bodily injury or loss of life.

ATTENTION: Inserting or removing a module may result in unexpected machine motion. Power to the machine should be turned off before inserting or removing the module. Failure to observe these precautions could result in bodily injury.

Step 2. Turn off power to the rack. All power to the rack as well as all power loading to the rack should be off.

ATTENTION: This module contains static sensitive components. Careless handling can cause severe damage. Do not touch the connectors on the back of the module. When not in use, the module should be stored in an anti-static bag. The plastic cover should not be removed. Failure to observe this precaution could result in damage to or destruction of the equipment.

Step 3 Take the module out of its shipping container. Take it out of the anti-static bag, being careful not to touch the connectors on the back of the module.

Step 4 Insert the module in the desired slot in the rack, making sure it is well seated in the rack. The module may reside in any slot in the rack. Use a screwdriver to secure the module in the rack.

Step 5 Set the station number of the Data Highway Plus interface module (in octal) using the two thumbwheel switches on the module faceplate. The upper switch is the most significant digit and the lower switch is the least significant digit. The station number is read from the thumbwheel switches only at power up. Therefore, make sure each device on the network has a unique station number (0 - 77 octal) before power is applied. If more than one device on the network is given the same station number, the module will not be able to communicate and an error will be displayed.

Step 6 Connect the module to the Data Highway Plus network. Refer to Appendix C for information on cabling and termination.

Step 7 Turn on power to the rack. An internal diagnostic routine is automatically executed by the module. If an error is detected, an error code is displayed on the seven segment LED. If the green status LED is OFF and no seven segment error code is displayed, a local watchdog failure has occurred. If a diagnostic fault code other than "5", "4", "9", "A", or "C" is displayed for more than 5 seconds, the Data Highway Plus interface module must be replaced.

If the thumbwheel switches are set to an invalid station number, fault code "6" will be displayed on the seven segment LED on the module faceplate after power up. To clear the invalid station number fault code, refer to section 5.2.

Step 8 After power up diagnostics are complete, the green status LED will go on. Verify the installation by monitoring registers on the module. Refer to Appendix I.

3.3 Module Replacement

Use the following procedure to replace the Data Highway Plus interface module:

Step 1. Stop any application tasks that may be running.

ATTENTION: This equipment is at line voltage when AC power is connected. Disconnect and lock out all ungrounded conductors of the AC power line. Failure to observe these precautions could result in severe bodily injury or loss of life.

ATTENTION: Inserting or removing a module may result in unexpected machine motion. Power to the machine should be turned off before inserting or removing the module. Failure to observe these precautions could result in bodily injury.

Step 2. Turn off power to the rack. All power to the rack as well as all power leading to the rack should be off.

Step 3. Disconnect the cable from the module faceplate.

Step 4. Use a screwdriver to loosen the screws that hold the module in the rack. Take the module out of the slot in the rack.

ATTENTION: This module contains static-sensitive components. Careless handling can cause severe damage. Do not touch the connectors on the back of the module. When not in use, the module should be stored in an anti-static bag. The plastic cover should not be removed. Failure to observe this precaution could result in damage to or destruction of the equipment.

Step 5. Take the new module out of its shipping container. Take it out of the anti-static bag, being careful not to touch the connectors on the back of the module.

Step 6. Insert the module in the rack, making sure that it is well-seated in the rack.

Step 7. Set the station number of the new module to the same number as the old module by using the two thumbwheel switches on the module faceplate. The upper switch is the most significant digit and the lower switch is the least significant digit.

Step 8. Attach the Data Highway Plus cable to the module faceplate.

Step 9. Turn on power to the rack.

Step 10. After power-up diagnostics are complete, the green status LED will go on. Verify the installation by monitoring registers on the module. Refer to Appendix I.

4.0 PROGRAMMING

The Data Highway Plus network is a token passing network, which means that any device on the network can initiate communication with any other device. Each node can also pass one word of global data with the token. This global data is available to all other nodes on the network.

Up to 64 devices can be connected directly to the network, with station numbers ranging from 0 to 77 octal. Duplicate addresses are not allowed. The network communication rate can be 57.6, 115.2 or 230.4 Kbaud, depending upon the user configuration.

This section describes how the data is organized in the module and provides examples of how the module is accessed by the application software. For more detailed information on programming, refer to the AutoMax Programming Language manuals.

4.1 Register Organization

The Data Highway Plus interface module contains dual port memory that can be accessed through the AutoMax rack backplane by application tasks running on the AutoMax Processor as well as by the microprocessor on the module. The memory organization is as shown in the following diagram. The following sections describe the different register areas in more detail.

Registers	Description
0-3	Reserved
4-63	Status and control registers
64 - 1063	Binary file B3
1064 - 1097	Reserved
1098 - 3097	Binary file B4
3098 - 5097	Binary file B5
5098 - 5693	Reserved
5694 - 4095	Reserved
4096 - 4352	Global data registers
4353 - 4393	Reserved
4394 - 10393	Integer files N7 - N18

Figure 4.1 Dual Port Memory Map

ATTENTION: Registers and bits in the data highway plus interface module that are described as "read only" or for "system use" only must not be written to by the user. Writing to these registers and bits may result in improper system operation. Failure to observe this precaution could result in bodily injury.

4.1.1 Status and Control Registers

The status and control registers are described in figure 4-2. Registers 4-31 are read/write registers from the host (AutoMax Processor) registers 32-63 are read only.

R/W	Reg#	Description
R/W	4	Clear Diagnostic Counters. If this register is set to a non-zero value, the module software will clear the contents of the Data Highway Plus diagnostic counters (registers 40-57). The module software will then clear this register to indicate the counters have been cleared. This register can be written to at any time.
R/W	5	Module Control. When set to 1, bit 0 of this register is used by the user to enable the module. No communication can take place until this bit is set. You should wait at least two seconds after enabling the module before you send any messages on the network. Bit 0 will be reset by the module on a hardware or software reset. Bits 1-15 are reserved for future use.
R/W	6	Message Timeout (in 100 msec. increments). The default value is 100 (5 seconds). The value can range from 1 to 254. If a reply to a message is not returned within this time period, the module will return an error to the GATEWAY_CMD_CKSM function. This value can be changed at any time.
R/W	7	Data Highway Plus options. Bits in this register must be set before you go on-line. Use bits 0 and 1 to set the Data Highway Plus baud rate. For this baud: Set 57.6 Kbaud bit 0 to 0 bit 1 to 0 115.2 Kbaud bit 0 to 1 bit 1 to 0 230.4 Baud bit 0 to 0 Bit 6 is used to enable transmission of this station's global data. If this bit is set to 1, the station's global data is transmitted with the token. The default is 0 (transmission of global data disabled). If bit 12 is set to 1, messages to stations which are off-line are not transmitted on the network, but are returned immediately to the module with an error code '17'. This minimizes disruptions to the network. The default for this bit is 0 (transmission to off-line stations enabled), which is consistent with the operation of A-B PLCs. In this case, the module will not return an error "12" when a message is sent to an off-line station. The remaining bits are reserved for future use.
R/W	9-12	Station Name. The user can write a station name consisting of up to eight ASCII characters plus a null terminator. If the name is eight characters long, the terminator is not required. However, if the name contains fewer than eight characters, the terminator must be included. The default station name is 'AutoMax.'
	13-21	Not used.
R/W	22	Response Poll Period (in units of 1/8 seconds). This register is used by the GATEWAY_CMD_CKSM function to compute the time interval to poll for command complete. The default value is 1 which corresponds to a response polling period of 0.125 second.
	23-31	Not used.

Figure 4-2 – Status and Control Register Assignments

R/W	Reg#	Description
R/O	32	Data Highway Plus station address (0-77 octal). This value comes from the thumbwheel switches on the backplane and is updated only on power-up. The module will not begin to communicate on the network until the station address is properly set and bit 0 in register 5 is set by the user. Note that the on line Monitor function in the AutoMax Programming Executive software will display the station address in decimal or hexadecimal notation.
R/O	33	Data Highway Plus extended Status (EXT STS) error code. Refer to Appendix H.
R/O	34-37	Data Highway Plus active station list. This is an array of 64 bits representing the status (1=active, 0=inactive) of each station on a Data Highway Plus network. Refer to Appendix F for information on how this list is mapped to these registers. The local station does not appear on this list.
	38-39	Not used
R/O	40-57	Data Highway Plus Diagnostics Counters. Refer to Appendix G.
	58-60	Not used.
R/O	61	Module Software Revision Level. A value of 100 indicates version 1.00, and so on.
R/O	62-63	Interface module ID (ASCII "G", "W").

Figure 4-2 Status and Control Register Assignments

4.1.2 Data Registers

The data image in the dual port memory appears as a subset of the PLC-5 data table. The equivalent AutoMax and Modicon registers on the module are shown in figure 4-3.

Multibus Access (AutoMax application tasks)		Data Highway Plus Access
Read Only	Binary file #3 Data Highway Plus addresses 3:0 - 3:999 AutoMax Registers 64-1063	Read/Write
Read/Write	Binary file #4 Data Highway Plus addresses 4:0 - 4:999 AutoMax Registers 1064-2087	Read Only
Read/Write	Binary file #5 Data Highway Plus addresses 5:0 - 5:999 AutoMax Registers 2088-3087	Read/Write
	Command Buffer Area AutoMax Registers 3584-4095	
	Globa Registers Area AutoMax Registers 4096-1552	
Read/Write	Integer file N7 Data Highway Plus addresses N7:0 - N7:999 AutoMax Registers 4331-5333	Read/Write

Figure 4-3 – PLC-5 Data Image

Read/Write	Integer file N8 Data Highway Plus addressee N8:0 - N8:999 AutoMax Registers 6384-6385	Read/Write
Read/Write	Integer file N9 Data Highway Plus addressee N9:0 - N9:999 AutoMax Registers 6384-7385 User mailbox for communication with a SLC 500 Processor	Read/Write
Read/Write	Integer file N10 Data Highway Plus addresses N10:0 - N10:999 AutoMax Registers 7384-8383	Read/Write
Read/Write	Integer file N11 Data Highway Plus addresses N11:0 - N11:999 AutoMax Registers 8384-9383	Read/Write
Read/Write	Integer file N12 Data Highway Plus addresses N12:0 - N12:999 AutoMax Registers 9384-10383	Read/Write
Read/Write	Integer file N13 Data Highway Plus addresses N13:0 - N13:999 AutoMax Registers 10384-11383	Read/Write
Read/Write	Integer file N14 Data Highway Plus addresses N14:0 - N14:999 AutoMax Registers 11384-12383	Read/Write
Read/Write	Integer file N15 Data Highway Plus addresses N15:0 - N15:999 AutoMax Registers 12384-13383	Read/Write
Read/Write	Integer file N16 Data Highway Plus addresses N16:0 - N16:999 AutoMax Registers 13384-14383	Read/Write
Read/Write	Integer file N17 Data Highway Plus addresses N17:0 - N17:999 AutoMax Registers 14384-15383	Read/Write
Read/Write	Integer file N18 Data Highway Plus addresses N18:0 - N18:999 AutoMax Registers 15384-16383	Read/Write

Figure 4.3 – PLC-5 Data Image

Mapping is handled transparently by the Data Highway Plus Interface module software. For example, if another node writes to this node at address N7:0, the data is written starting at AutoMax register 4384, and so on.

4.1.3 Global Data Registers

Registers 4096-4159 contain all of the global data that can exist on a Data Highway Plus network. Each station is assigned one register. Particular locations are meaningful only if the corresponding station is writing global data. All registers are read only from the point of view of the AutoMax Processor except for register 4352, which is read/write.

The global data update rate depends on the number of stations on the network, whether the stations have global data transmission enabled, and the communication traffic on the network.

Register	Description	Register	Description
4096	Global data station 00 (00)	4130	Global data station 42 (34)
4097	Global data station 01 (01)	4131	Global data station 43 (35)
4098	Global data station 02 (02)	4132	Global data station 44 (36)
4099	Global data station 03 (03)	4133	Global data station 45 (37)
4100	Global data station 04 (04)	4134	Global data station 46 (38)
4101	Global data station 05 (05)	4135	Global data station 47 (39)
4102	Global data station 06 (06)	4136	Global data station 50 (40)
4103	Global data station 07 (07)	4137	Global data station 51 (41)
4104	Global data station 10 (08)	4138	Global data station 52 (42)
4105	Global data station 11 (09)	4139	Global data station 53 (43)
4106	Global data station 12 (10)	4140	Global data station 54 (44)
4107	Global data station 13 (11)	4141	Global data station 55 (45)
4108	Global data station 14 (12)	4142	Global data station 56 (46)
4109	Global data station 15 (13)	4143	Global data station 57 (47)
4110	Global data station 16 (14)	4144	Global data station 60 (48)
4111	Global data station 17 (15)	4145	Global data station 61 (49)
4112	Global data station 20 (16)	4146	Global data station 62 (50)
4113	Global data station 21 (17)	4147	Global data station 63 (51)
4114	Global data station 22 (18)	4148	Global data station 64 (52)
4115	Global data station 23 (19)	4149	Global data station 65 (53)
4116	Global data station 24 (20)	4150	Global data station 66 (54)
4117	Global data station 25 (21)	4151	Global data station 67 (55)
4118	Global data station 26 (22)	4152	Global data station 68 (56)
4119	Global data station 27 (23)	4153	Global data station 69 (57)
4120	Global data station 30 (24)	4154	Global data station 70 (58)
4121	Global data station 31 (25)	4155	Global data station 71 (59)
4122	Global data station 32 (26)	4156	Global data station 72 (60)
4123	Global data station 33 (27)	4157	Global data station 73 (61)
4124	Global data station 34 (28)	4158	Global data station 74 (62)
4125	Global data station 35 (29)	4159	Global data station 75 (63)
4126	Global data station 36 (30)	4160 - 4351	Note user: Reserved for future use.
4127	Global data station 37 (31)	4352	The station's global data
4128	Global data station 40 (32)		
4129	Global data station 41 (33)		

Note that station numbers are noted with decimal equivalents in parentheses.

Figure 4-4 – Global Data Register Assignments

Register 43b2 is a Read/Write register from Multibus. To transmit global data, you must set bit 8 in the Data Highway Plus options register (register 0) before you go on line. The module will then pass the value in register 43b2 when it passes the token.

4.2 AutoMax Application Programming

The sections that follow describe how to configure registers in the Data Highway Plus Interface module's dual-port memory and how to initiate commands from the module. Link configuration and application programming examples are provided.

4.2.1 Variable Configuration

AutoMax application tasks communicate with the Data Highway Plus Interface module by referencing registers in the dual-port memory. These registers must first be configured using the AutoMax Programming Executive software. In AutoMax Programming Executive Version 3.0 and later, you define these registers using the Variable Configurator. Specific screens are available for each module. If you are using AutoMax Programming Executive Version 2.1 or earlier, you define these registers using IODEF statements in the rack configuration task. Note that IODEF statements cannot be used with the Data Highway Plus Interface Module.

The format for the IODEF statement (used only in V2.1 and earlier) is as follows:

nnnn IODEF variable name [SLOT=slot number, &
REGISTER=register number BIT=bit number]

where:

nnnn = configuration task line number

variable_name = integer or boolean variable. Double integer variables can be used but should be avoided because of the possibility that all 32 bits will not transfer in one operation.

WARNING

IF YOU USE DOUBLE INTEGER VARIABLES IN THIS INSTANCE, YOU MUST IMPLEMENT A SOFTWARE HANDSHAKE BETWEEN THE TRANSMITTER AND RECEIVER TO ENSURE THAT BOTH THE LEAST SIGNIFICANT AND MOST SIGNIFICANT 16 BITS HAVE BEEN TRANSMITTED BEFORE THEY ARE READ BY THE RECEIVING APPLICATION PROGRAM. FAILURE TO OBSERVE THIS PRECAUTION COULD RESULT IN BODILY INJURY.

slot number = slot number of the Data Highway Plus Interface module in the rack. This number may range from 0 to 15.

register number = Multibus register number on the Data Highway Plus Interface module. Register numbers correspond to 16 bit words on the module.

bit number = bit number of the I/O point in the register. Bit numbers range from 0 to 15. Bit numbers are specified for boolean variables only.

Any variables contained in the rack configuration are accessible by any task on any AutoMax Processor in the rack. When AutoMax variables are referenced in AutoMax tasks, the data is directly obtained from or written to the register image on the module. The data storage for an AutoMax variable mapped to an A-B register will always exist in the Data Highway Plus module's dual port memory.

The registers in the Data Highway Plus Interface module's A-B register image may be displayed using the AutoMax Programming Executive Monitor I/O function. Refer to Appendix H for the method used to convert A-B register numbers so that they can be viewed using the monitor.

4.2.2 Application Programming

Read and write commands from the Data Highway Plus Interface module are initiated from a BASIC application task by executing the GATEWAY_CMD_OK@ function:

```
GATEWAY_CMD_OK@(status%, cmd_code%, slave_drop%,          &
                slave_reg$, master_var!, num_regs%)
```

where:

status% is an integer variable representing the location where the status resulting from the operation is stored. Refer to Appendix E for a list of status values.

cmd_code is a variable name or expression of type integer representing the Data Highway Plus command sent by the module. The commands are described in section 4.3.4. Any other commands result in a status of 1 (invalid operation) being returned.

slave_drop is variable name or expression of type integer containing the destination station number (in decimal or hexadecimal). This is the station number on your Data Highway Plus network. In the case where off link addressing is used, this is the address of the bridge node on the local Data Highway Plus network. See section 4.2.6 for more information.

slave_reg is a variable name or expression of type string that specifies the starting register number on the target device. For commands 3, 4 and 5, this is a logical address represented as an ASCII string for PLC 3 and PLC 5 controllers. It can also be a 5-digit octal number. For commands 1 and 2, this argument should be an octal number. This field can also contain Data Highway Plus routing information. Refer to section 4.2.6. For command 5 (Read Modify Write), this argument can contain up to ten addresses separated by commas. The address must exist at the target station.

master_var is a variable name or expression (usually via the BASIC language VARPTR function) of type double integer, representing the physical address of the starting register on the Data Highway Plus module to be read from/written to.

num_regs is a variable name or expression of type integer that defines:

- for Word Range Read/Write (commands 3 or 4), the number of registers to be transferred, from 1 to 1000;
- for Read Modify Write (command 5), the number of addresses to be written, in the range 1 to 10;
- for Unprotected Read/Write (command 1 or 2), the number of registers to be transferred, from 1 to 100.

The GATEWAY_CMD_OK@ function will be true if the command was successfully completed. If the function is false, the returned status will be an error code. See Appendix E for the error codes returned by the GATEWAY_CMD_OK@ function.

Multiple tasks can access the module. Note, however, that if more than four tasks try to initiate messages at the same time, error code 22 will be returned to the additional tasks attempting accesses.

4.2.3 Enabling the Data Highway Plus Interface Module

The connection between the Data Highway Plus interface module and the Data Highway Plus network is configured through an AutoMax BASIC task. The task must set the network baud rate and whether global data for this node is enabled by setting the appropriate bits in register 7. Values can also be set for message timeout (register 6) and response poll period (register 22), if desired. Note that values for registers 6 and 22 can be set at any time. The final step required to put the module on line is to set bit 0 in register 5. Wait at least two seconds after writing to this register before sending messages on the network.

If you are using AutoMax Programming Executive software version 2.1 or earlier, any required registers must be defined using ODEFs in the configuration task. If you are using AutoMax Programming Executive software version 3.0 or later, these registers are defined using the Variable Configurator within the Programming Executive. The following example illustrates one method of enabling the module.

Example 1:

In the configuration, define register 5, bit 0 as ENABLE@.

ENABLE@ [SLOT=4, REGISTER=5, BIT=0]

The application task would use the following statement to enable the module:

```
10 ENABLE@=1 ' put module on line
```

Example 2:
In the configuration, define the following registers:

```
ENABLE@ [SLOT=4, REGISTER=5, BIT=0]
TIMEOUT% [SLOT=4, REGISTER=6]
RESP_TIME% [SLOT=4, REGISTER=22]
OPTIONS% [SLOT=4, REGISTER=7]
```

The application could enable the module as follows:

```
10 OPTIONS = 3      ' Baud rate = 57.6 kbd, no global      &
                    ' data, transmits, transmit to         &
                    ' vacant nodes enabled
20 TIMEOUT% = 50    ' message timeout 5 seconds
30 RESP_TIME% = 2   ' GATEWAY CMD OK@should poll &
                    ' for response every 250 ms
40 ENABLE@=1        ' put module on-line
50 DELAY 2 SECONDS
```

Example 3: Global Data

If an application is passing global data, it must enable global data and write to the local global data register. In the configuration, define the following registers:

```
ENABLE@[SLOT=4, REGISTER=5, BIT=0]
OPTIONS% [SLOT=4, REGISTER = 7
GDS%[SLOT=4, REGISTER = 4592]
```

The application task could contain the following statements:

```
!% OPTIONS% = 256 !  enable global data, baud rate =      &
                     57.6 Kbaud, transmit to vacant      &
                     nodes enabled.
!% GD% = 15          !  set global data
!% ENABLE% = 1       !  put module online
!% DELAY 2 SECONDS
```

4.2.4 Commands Initiated by the Data Highway Plus Interface Module

The commands described in figure 4.5 can be used by the AutoMax Processor in the GATEWAY_CMD_OK@ function to initiate a command on the Data Highway Plus Interface module. See section 4.2.2 for more information on the GATEWAY_CMD_OK@ function.

GATEWAY CMD OK@ Command Code	Description	Data Highway Plus Function
1	Unprotected Read	CMD = 01, FNC = n/a
2	Unprotected Write	CMD = 08, FNC = n/a
3	Word Range Read	CMD = 0F, FNC = 01
4	Word Range Write	CMD = 0F, FNC = 00
5	Read Modify Write	CMD = 0F, FNC = 26

Figure 4.5 Commands Used with GATEWAY_CMD_OK@

Commands 1 and 2 come from the basic command set and are accepted by PLC 2,PLC 3, PLC 5 and SLC 500 processors. For PLC 2 controllers, addresses will be 5 digit octal numbers. For PLC 3 and PLC 5 processors, compatibility files must exist. Refer to A.B documentation for more information.

For communication with a SLC 500 processor, use only commands 1 and 2 and only file N9 for data transfers.

Command 1, Unprotected Read, transfers a block of data from the target registers at the remote address to the specified AutoMax registers on the Data Highway Plus interface module. Data can be transferred to any file in the PLC 5 data image area. The data is stored in the specified registers on the Data Highway Plus Interface module. A maximum of 100 registers can be transferred in a single request. The transfer cannot cross file boundaries.

Command 2, Unprotected Write, transfers a block of data from the specified AutoMax registers on the Data Highway Plus Interface module to the target registers at the destination address. The data must already exist in the registers on the Data Highway Plus Interface module. Data can be transferred from any file in the PLC 5 data image area. A maximum of 100 registers can be transferred in a single request. The transfer cannot cross file boundaries.

Commands 3, 4 and 5 come from the PLC 5 command set. Commands 3 and 4 are accepted by PLC 3 and PLC 5 processors. Command 5 is accepted only by PLC 5 processors. For commands

3, 4, and 5, only logical addresses represented as ASCII strings are supported.

Command 3, Word Range Read, transfers a block of data from the target registers at the remote address to the specified AutoMax registers on the Data Highway Plus interface module. Data can be transferred to any file in the PLC-5 data image area except the B4 file. The data is stored in the specified registers on the Data Highway Plus interface module. A maximum of one file (1000 registers) can be transferred in a single request. The transfer cannot cross file boundaries.

Command 4, Word Range Write, transfers a block of data from the specified AutoMax registers on the Data Highway Plus interface module to the target registers at the destination address. The data must already exist in the registers on the Data Highway Plus interface module. Data can be transferred from any file in the PLC-5 data image area. The data is stored in the specified registers on the Data Highway Plus interface module. A maximum of one file (1000 registers) can be transferred in a single request. The transfer cannot cross file boundaries.

Command 5, Read-Modify-Write, sets or resets specified bits in specified registers in the data table at the remote address. The data (AND and OR masks) must already exist in the registers on the Data Highway Plus interface module. A maximum of ten registers can be modified in a single request. The transfer cannot cross file boundaries.

Note: The A-B controller at the remote address may change the states of the original bits in memory before this command (command 5) can write the word back to memory. Therefore, some bits may unintentionally be overwritten. To help prevent this, we suggest that you use this command to write into the storage area of a programmable controller's data table, and have the controller read the word only, not control it.

In cases where any of the commands above generates multiple messages on the network, for example, reading or writing more registers than can fit in one Data Highway Plus message, the module takes care of formatting and generating the messages required. The GATEWAY_CMD_OK@ command is complete when a reply is received for the last message.

4.2.5 Commands from Remote Stations

The Data Highway Plus interface module will respond to the following incoming commands from remote stations:

Command	Function	Description
CF	68	Typed Read / Read Block
CF	67	Typed Write / Write Block
CF	01	Word Range Read / Read Block
CF	00	Word Range Write / Write Block
CF	26	Read Modify Write / Write Bit
CF	02	Bit Write

Figure 4.6 PLC-5 Command Set

For the commands shown in figure 4.6, both logical binary and logical ASCII addresses are supported.

Command	Function	Description
06	07	Diagnostic Counters Reset
06	01	Diagnostic Read
06	03	Diagnostic Status

Figure 4.7 Privileged Commands in the Basic Command Set

The Diagnostic Read command returns the values for counters as shown in Appendix G. The Diagnostic Status command returns 17 bytes containing the following information:

Byte	Value	Meaning
1	FE	Terminal
2	1B	Terminal
3	A3	Module identifier
4		Active station list pointer low byte
5		Active station list pointer high byte
6		Diagnostic counters pointer low byte
7		Diagnostic counters pointer high byte
8		Reserved
9		Reserved
10-17		Terminal name (automatically padded with blanks)

Figure 4.8 Diagnostic Status Command Data

Byte	Value	Meaning
02	n/a	Protected Bit Write
00	n/a	Protected Write
05	n/a	Unprotected Bit Write
01	n/a	Unprotected Read
08	n/a	Unprotected Write

Figure 4.9 Non-Privileged Commands in the Basic Command Set

The commands shown in figure 4.9 write directly to or read directly from file N7 in the module. The address field is used as an offset into the file. If the address does not exist, an error is returned.

Unprotected writes will be processed in the same manner as Protected writes and will not be permitted to store data in the protected areas of the PLC 5 image in the dual port memory.

4.2.6 Off-link Routing Paths

This section describes using a Data Highway network as a bridge to link two Data Highway Plus networks using A-B 1785-KA modules. If you need information about other bridge networks, refer to A-B documentation.

The routing information is added to the 'slave_reg' parameter of the GATEWAY_CMD_OK@ function. A leading exclamation mark (!) is used to signify that routing information is included. The routing information is added to the beginning of the string as hexadecimal bytes separated by periods. See figure 4.10.

For a 1785-KA Data Highway bridge, the twelve routing bytes are:

Byte	Value	Meaning
1	LSAP	1 for a 1785-KA bridge
2		24h
3	DID_LO	see below
4	DID_HI	see below
5	DNDE_LO	see below
6	DNDE_HI	see below
7	LPETIME	50h for a 1785-KA bridge
8	SID_LO	see below
9	SID_HI	see below
10	SNDE_HI	see below
11	SNDE_LO	see below
12	NSAP3	for a 1785-KA bridge

Figure 4.10 - Off-link Message Routing Bytes

where:

DID is the destination node's link ID; see A-B documentation. This is 0 for a 1785-KA bridge.

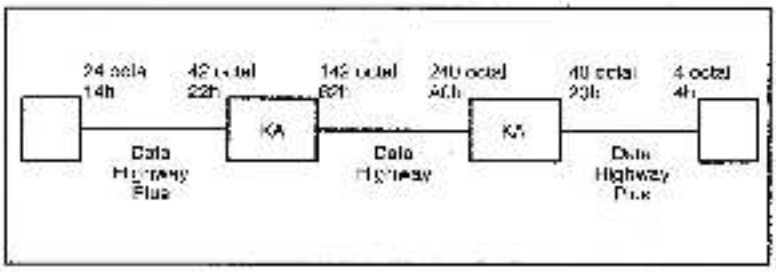
DNDE is the station address of the destination on the destination link. For the Data Highway bridge, only the low byte is used. It consists of the upper two bits of the Data Highway address of the remote bridge (1785-KA) and the lower six bits of the Data Highway Plus address of the final Data Highway Plus station.

SID is the link ID of the local network; see A-B documentation. This is 0 for a 1785-KA bridge.

SNDE is the station address of this station on the local Data Highway Plus network.

4.2.6.1 Example of Bridging Two Data Highway Plus Networks using 1785-KA modules

In the following example, the Data Highway Plus interface module is station 24 octal on a Data Highway Plus network. The first 1785-KA bridge module is at address 42 octal on the Data Highway Plus network and 142 octal on the Data Highway network. The remote bridge module is at station address 240 octal on the Data Highway network and 40 octal on the Data Highway Plus network. The final destination node is at station address 4 on the remote Data Highway Plus network.



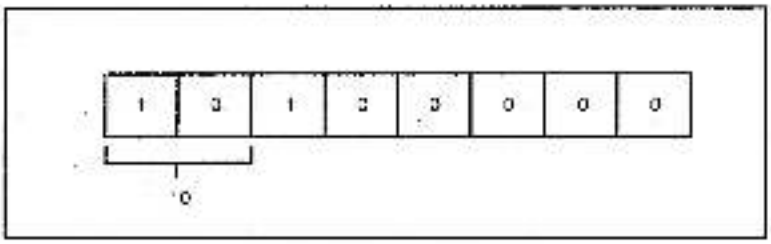

```
05 REM                                  The variables that follow define      &
                                        parameters for the                    &
                                        GATEWAY CMD OK@ function
10 COMMON BSBASE%,!                     Represents the physical address of    &
                                        starting register on the Data Highway &
                                        Plus module to be read from
20 LOCAL DST%           %!              The address of the bridge node on     &
                                        the local Data Highway Plus network
21 LOCAL STS%           %!              The location where the status         &
                                        resulting from the operation is stored
22 LOCAL SIZE%          %!              The number of registers to be         &
                                        transferred
23 LOCAL CMD%           %!              The Data Highway Plus command         &
                                        sent by the module

30 DST% = 31
31 STS% = 0
32 SIZE% = 100
33 CMD% = 3
40 IF NOT GATEWAY_CMD_OK@(STS%, CMD%, DST%,                                  &
       "01,21,00,00,81,00,80,20,00,**,00,00,N7:0",                           &
       VARPTR(BSBASE%), SIZE%) THEN 20000 ' process errors
```

In the example above, the routing bytes were determined as follows. Recall that the last item in the actual "slave_req" parameter is the destination file address.

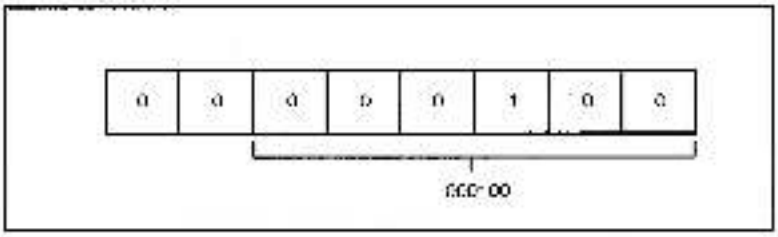
Byte	Value	Meaning
1	LSAP	01 for a 1785-KA bridge
2		21h
3	DID_LO	00 for a 1785-KA bridge
4	DID_HI	00 for a 1785-KA bridge
5	DNDE_LO	81h (see below)
6	DNDE_HI	00 for a 1785-KA bridge
7	LIFETIME	80h for a 1785-KA bridge
8	SID_LO	00 for a 1785-KA bridge
9	SID_HI	00 for a 1785-KA bridge
10	SNDE_HI	01h is the station number of the Data Highway Plus module
11	SNDE_LO	00 for a 1785-KA bridge
12	SSAP	00 for a 1785-KA bridge

Byte 0 in the routing path (DNDE_LO) is determined as follows:

The station address of the remote bridge is 240 octal (10100000).



The station address of the link. Data Highway Plus station is 4 (00000100).

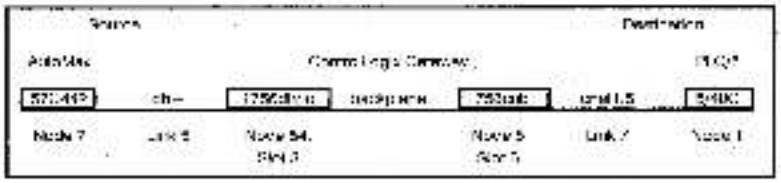


DNDE combines the upper two bits of the remote bridge station address with the lower six bits of the final Data Highway Plus station address (10000100). This is equivalent to 84h.

4.2.6.2 Example of Bridging the DH+ Link to a ControlNet Network

Using AutoMax and its 57C442 Data Highway Plus interface module to send and receive data file values to a ControlNet PLC through a ControlLogix gateway. Knowledge Base Document 10020 defines the network layout and network routing table set ups. This document will show the network and which parameters relate to the AutoMax.

Network Configuration



The 57C442 AutoMax Data Highway Plus module has the ability to perform "Off-Link Routing". This routing is used to move data from one network to another network. This is covered as a separate subject in the modules instruction manual. Twelve bytes of data are required in order to program this function in the AutoMax. For the network configuration shown above, they are:

Byte	Value	Function
1	01h	LSAP
2	24h	Network Control Byte
3	01h	Dest. Link ID - Lo
4	00h	Dest. Link ID - Hi
5	01h	Dest. Node Address - Lo
6	00h	Dest. Node Address - Hi
7	80h	Lifetime
8	03h	Source Link ID - Lo
9	00h	Source Link ID - Hi
10	04h	Source Node Address - Lo
11	00h	Source Node Address - Hi
12	00h	NSAP

The Destination and Source Link IDs and Node Addresses come from the network configuration. The values for LSAP, Network Control Byte, Lifetime and NSAP are constants. The twelve parameter values, in the order shown, are used with the AutoMax GATEWAY_CMD_OK@ function to program the AutoMax. They are the same for either writing (CMD%=4) and reading (CMD%=0) data across the network.

An example of the GATEWAY_CMD_OK@ function in a basic task which is used to either read or write to integer file N7 in the PLCSAC is:

```
NNNN        IF NOT GATEWAY_CMD_OK@
(STS%, CMD%, DST%, I01,24,07,00,01,00,80,03,00,07,00,00,N7:00,
            VARPTR(N7:BASE%), SZE%) THEN XXXX
```

Parameters STS%, CMD%, DST%, SZE% and N7:BASE% are discussed in the manual and are defined as LOCAL variables in the basic task. NNNN is the line number for the function and XXXX is a line number in the task where code to address errors is located.

4.2.7 Programming Examples

This section contains examples of initiating commands by using the GATEWAY_CMD_OK@ function within an AutoMax task. In the following examples, each register is defined in the configuration for the rack as follows. For example,

```
B3[BASE%,(SLOT=4, REGISTER=64]
N7:BASE%,[SLOT=4, REGISTER=4:64]
```

The statements above are used in the following examples. The VARPTR function is used to return a double integer value for the address of the specified argument.

Example 1: Command 3, Word Range Read

In the example below, the Data Highway Plus interface module is reading 100 words from file N7:0 in the PLC at station address 0. The data read is stored in the local B3 file. The variable B3BASE% is defined in the rack configuration.

```
10 COMMON B3BASE%,...      Represents the physical address of &
                           the starting register on the      &
                           Data Highway Plus module to be
                           read from
20 LOCAL DST%              % The address of the destination node &
                           on the local Data Highway Plus network
21 LOCAL STS%              % The location where the status
                           resulting from the operation is stored
22 LOCAL SZE%              % The number of registers to be   &
                           transferred
23 LOCAL CMD%              % The Data Highway Plus command   &
                           sent by the module

30 DST% = 0
31 STS% = 0
32 SZE% = 100
33 CMD% = 3
40 IF NOT GATEWAY_CMD_OK@(STS%, CMD%, DST%, "N7:0", &
     VARPTR(B3BASE%), SZE%) THEN 20000 ' process errors &
     in line 20000
```

Example 2: Command 4, Word Range Write

In the example below, the Data Highway Plus interface module is writing 100 words from the local N7 file to the file address N7:0 10 in the PLC at station address 0. The variable N7BASE% is defined in the rack configuration.

```
10 COMMON N7BASE%,...      Represents the physical address of &
                           the starting register on the      &
                           Data Highway Plus module to be    &
                           written to
20 LOCAL DST%              % The address of the destination node
                           on the localData Highway Plus network
21 LOCAL STS%              % The location where the status   &
                           resulting from the operation is stored
22 LOCAL SZE%              % The number of registers to be   &
                           transferred
23 LOCAL CMD%              % The Data Highway Plus command sent
                           by The module

30 DST% = 0
31 STS% = 0
32 SZE% = 100
33 CMD% = 4
40 IF NOT GATEWAY_CMD_OK@(STS%, CMD%, DST%, "N10:10", &
     VARPTR(N7BASE%), SZE%) THEN 20000 ' process errors &
     line 20000
```

Example 3: Command 5, Read-Modify-Write

In the example below the Data Highway Plus interface module writes to three addresses in a PLC, N7:0, N7:2, and N7:4. The AND/OR mask pairs are stored in three consecutive pairs of registers starting at B3BASE%. The variable B3BASE% is defined in the rack configuration.

```
10 COMMON B3BASE%,I%    Represents the physical address of &
                        the starting register on the      &
                        Data Highway Plus module to be    &
                        read from
20 LOCAL DST%           'I  The address of the destination node &
                            on the local Data Highway Plus network
21 LOCAL STS%           'I  The location where the status       &
                            resulting from the operation is stored
22 LOCAL SIZE%          'I  The number of registers to be       &
                            transferred
23 LOCAL CMD%           'I  The Data Highway Plus command       &
                            sent by the module

30 DST% = 0
31 STS% = 0
32 SIZE% = 6
33 CMD% = 5
40 IF NOT GATEWAY_CMD_OK@(STS%, CMD%, DST%,          &
      "N7:0,N7:2,N7:4", VARPTR(B3BASE%), SIZE%)      &
THEN 20000 'If process errors at line 20000
```

Example 4: Command 1, Unprotected Read

In the example below the Data Highway Plus interface module is reading 100 words from address 2000 octal in the PLC at station address 7. The data read is stored in the local N9 file. The variable B3BASE% is defined in the rack configuration.

```
10 COMMON B3BASE%,I%    Represents the physical address of &
                        the starting register on the      &
                        Data Highway Plus module to be    &
                        read from
20 LOCAL DST%           'I  The address of the destination node &
                            on the local Data Highway Plus network
21 LOCAL STS%           'I  The location where the status       &
                            resulting from the operation is stored
22 LOCAL SIZE%          'I  The number of registers to be       &
                            transferred
23 LOCAL CMD%           'I  The Data Highway Plus command       &
                            sent by the module

30 DST% = 7
31 STS% = 0
32 SIZE% = 100
33 CMD% = 1
40 IF NOT GATEWAY_CMD_OK@(STS%, CMD%, DST%, 2000,  &
     VARPTR(B3BASE%), SIZE%) THEN 20000 'If process errors &
     at line 20000
```

Example 5: Command 2, Unprotected Write

In the example below, the Data Highway Plus interface module is writing 100 words from the local N7 file to the file address 1234 octal in the PLC at station address 7. The variable N7BASE% is defined in the rack configuration.

```
10 COMMON N7BASE%,I                 Represents the physical address of &
                                    the starting register on the      &
                                    Data Highway Plus module to be    &
                                    written to
20 LOCAL DST%          %I           The address of the destination node &
                                    on the local Data Highway Plus network
21 LOCAL STS%          %I           The location where the status     &
                                    resulting from the operation is stored
22 LOCAL SZE%          %I           The number of registers to be     &
                                    transferred
23 LOCAL CMD%          %I           The Data Highway Plus command     &
                                    sent by the module

30 DST% = 7
31 STS% = 0
32 SZE% = 100
33 CMD% = 2
40 IF NOT GATEWAY_CMD_OK@(STS%, CMD%, DST%, "1234",&
     VARPTR(N7BASE%), SZE%) THEN 20000 ' process errors &
     on line 20000
```

5.0 DIAGNOSTICS AND TROUBLESHOOTING

This section describes how to troubleshoot the Data Highway Plus Interface module. See Appendix D for a list of error codes that can be displayed by the module. If the problem cannot be corrected using the procedures below, the unit is not user serviceable.

ATTENTION: Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

5.1 The OK LED Is OFF

Problem: The green status LED (labeled "OK") on the Data Highway Plus Interface module faceplate is off. The LED should be on when the module has passed its internal diagnostics after power up. If the green OK status LED is off, and no error code is displayed, a local watchdog failure has occurred. Try cycling power to the rack. If the OK status LED remains off, replace the module.

5.2 Invalid Station Address

Problem: Error code "3" or "6" appears on the Data Highway Plus Interface module's LED display at power up. Error code "3" indicates a duplicate station address. Error code "6" indicates an invalid station address. To clear the error code, change the thumbwheel switch settings and cycle power on the module.

5.3 Transmission Link Failures

Problem: Error codes "12", "13", "14", "15", or "17" are returned by the GATEWAY_CMD_OK@ function. These error codes indicate various network errors.

Verify that the cable connection to each device are secure. Check the cable connection at the module faceplate and at the remote device. Check the network cabling and terminator.

5.3.1 Rack Failure

If the AutoMax Processor in the rack that contains the Data Highway Plus Interface module fails or issues a BOARD RESET command (clears all outputs in the rack), the entire image in the Data Highway Plus Interface module's dual port memory is cleared. The module will remain off line for at least 1 second to allow application tasks to recognize that the module went off line.

5.3.2 Remote Station and Link Failure

When the Data Highway Plus interface module is not initiating messages, but is simply responding to unsolicited commands from remote stations, a failure in the remote stations cannot be detected by the module itself except by monitoring the active station list (registers 34-37).

When the module is initiating messages, a link failure is indicated by a Response Timeout error.

5.4 Bus Error

Problem: Error codes "01" appears on a Processor module's LED display. This error indicates the system has a problem accessing a module in the rack through the backplane bus. A bus error may be caused by removal of a module, a module failure, or a rack backplane failure.

Use the following procedure to isolate a bus error:

Step 1 Verify that all modules are in the correct slot.

Verify that the slot number being referenced in the application tasks agrees with the slot number defined during configuration.

Step 2 Verify the station address is correct.

The thumbwheel switches used to set the station address can be changed while the module is on line without having any effect on the system. On the next power up, if the thumbwheel switches define a station that is valid, the Processor will accept it as a valid station.

Step 3 Verify that the application software is correct.

Verify that the application software is not attempting to write to READ ONLY registers on the module.

Step 4 Verify that the hardware is working correctly.

ATTENTION: This equipment is at line voltage when AC power is connected. Disconnect and lockout all ungrounded conductors of the AC power line. Failure to observe this precaution could result in severe bodily injury or loss of life.

Make certain that power is off before removing any module from the rack. Systematically replace the Data Highway Plus interface module, the Processor module(s), and the rack/backplane, one at a time, with a corresponding module or assembly known to be operating correctly. After replacing each module or assembly, if the problem is not corrected, replace the original item before going on to the next item.

Appendix A

Technical Specifications

Ambient Conditions

- Storage Temperature: -40° C to 81° C
- Operating Temperature: 0° C to 60° C
- Humidity: 5% to 95%, non-condensing
- Altitude: 1,000 meter (3300 feet) without derating

Dimensions

- Height: 29.85 cm (11.75 inches)
- Width: 3.18 cm (1.25 inches)
- Depth: 18.75 cm (7 3/8 inches)
- Weight: 0.9 kg (2 pounds)

Maximum Power Dissipation

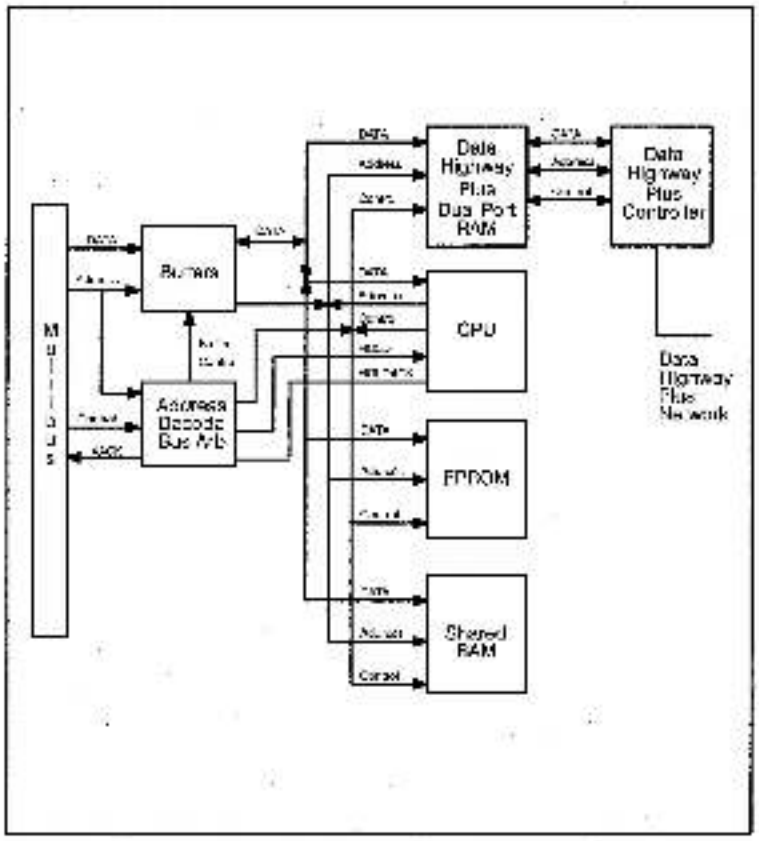
- 9.25 W

System Power Requirements:

- +5 VDC 650 mA
- +12 VDC (not used)
- -12 VDC (not used)

Appendix B

Module Block Diagram



Appendix C

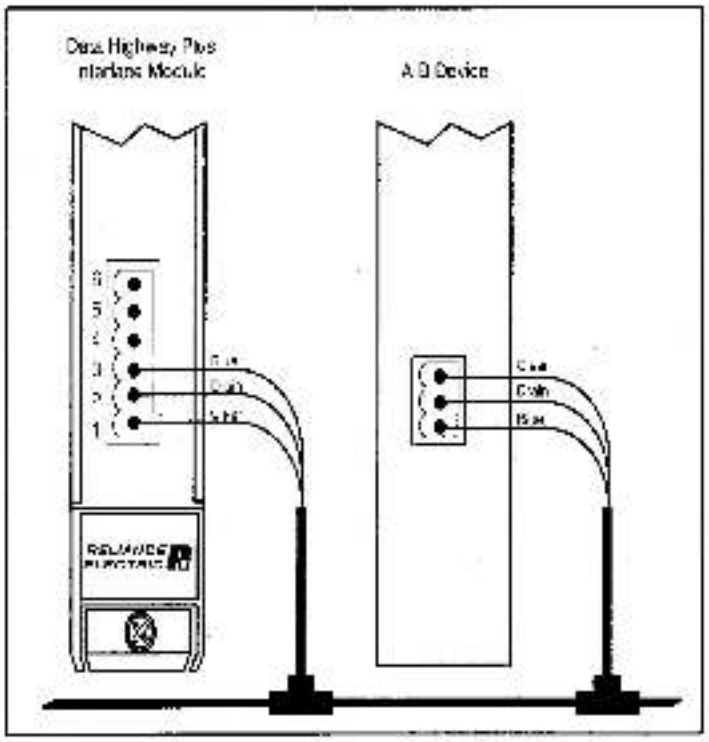
Network Connector Pin Assignments

This appendix assumes the network cable system has been installed using the appropriate A-B Data Highway Plus instruction manual.

The faceplate of the Data Highway Plus interface module contains a Phoenix Combicon connector for connection to the Data Highway Plus network. Each station is connected to the Data Highway Plus network trunk line using a drop. The construction of Belden 9463 twin axial cable (or equivalent).

The connector has 6 pins, which are numbered from the bottom. The bottom pin is pin 1, the top pin is pin 6. Pin 1 is internally connected to 4, pin 2 to pin 5, and pin 3 to pin 6. Any connections to pins 1, 2 or 3 could also be made to 4, 5 or 6 respectively.

The CLEAR wire of the twin axial cable should be connected to Pin 1 or 4 (bottom pin or pin 4) of the Phoenix connector, the DRAIN (bare) wire to Pin 2 or 5 and the BLUE wire to Pin 3 or 6. The color wire that is at the top on the three pin connector on the A-B device is the color you connect to pin 1 on the connector on the Data Highway Plus Interface module faceplate. See the figure below.



Appendix D

Data Highway Plus Interface Module

7-Segment LED Error Codes

The following error codes may be displayed on the 7-segment display:

.0	EPROM checksum failure
0	Gateway parameter error
.1	RAM checksum failure
1	Reply TNS error
.2	RAM AA failure
.3	RAM 55 failure
3	Duplicate station detected
.4	RAM address line failure
4	Module not ready
.5	RAM address line clear failure
5	Invalid station address on thumbwheels
.6	Module has not been enabled (register 5, bit 0)
.6	Data Highway Plus initialization failure
6	Module restart in progress
.A	Board Reset signal
.b	Local watchdog failure
C	Local port disconnected
.c	AutoMax Processor watchdog failure
.E	Power failure
.F	Module failure

All errors except 3, 4, 5, 6, .A, and C are fatal errors and indicate a malfunctioning module.

Appendix E

GATEWAY _CMD_OK@ Status Codes

The following codes are written to the variable defined as the "status" parameter in the GATEWAY _CMD_OK@ function used to initiate Data Highway Plus network data transfers from an AutoMax application task.

0 Operation successful
1 Invalid operation
3 Invalid length
4 Invalid offset
5 Invalid length + offset
6 Invalid destination (0 or > octal)
9 Invalid data type
9 Invalid route (equal to own address)
B Inconsistent response
C Module not enabled
20 Parameter specifying destination address is invalid
21 Data Highway Plus module not found or inaccessible
22 No available data path

Data Highway Plus Local and Remote Status (STS) error codes are written to the upper byte. If the first digit is "1", the STS code is local; if the first digit is "2", the STS code is remote.

11 Destination memory full, cannot accept command now
12 Destination did not acknowledge command
13 Network contention, possible duplicate station or bad cabling
14 Local Data Highway Plus port is disconnected, or no other station found
15 Timeout waiting for a reply message
16 Duplicate station detected
17 Station is off line
18 Hardware fault
1D Transaction number mismatch
1F Duplicate transaction number
31 Illegal command or format
32 Host is malfunctioning and will not communicate
33 Remote station host is missing, disconnected, or shut down
34 Host could not complete function due to hardware fault
35 Addressing problem or memory protection range
36 Function disallowed due to command protection selection
37 A-B Processor is in program mode
38 Compatibility mode file missing or communication zone problem
39 Remote station cannot buffer command
3A (not used)
3B Remote station problem due to download
3C Cannot execute command due to active IPBs
3D not used;
3E (not used)
3F There is an error code in the Extended Status register (register 33 on the Data Highway Plus interface module). See appendix H.

Appendix F

Mapping of Active Station List

The following table shows the mapping between active station addresses and the status reported in registers 34-37.

Register	Byte	Bit #							
		7	6	5	4	3	2	1	0
34	LO	70	60	50	40	30	20	10	00
	HI	71	61	51	41	31	21	11	01
35	LO	72	62	52	42	32	22	12	02
	HI	73	63	53	43	33	23	13	03
36	LO	74	64	54	44	34	24	14	04
	HI	75	65	55	45	35	25	15	05
37	LO	76	66	56	46	36	26	16	06
	HI	77	67	57	47	37	27	17	07

Appendix G

Register Map for Diagnostic Counters

This area contains statistics for the network as a whole and also for this station. These values are returned to any remote station which requests them from this station. This is also the format of data in counters returned from remote stations to this station. These registers are read only.

Register	Byte	Meaning
40	LO	Received ACK with bad CRC
	HI	(not used)
41	LO	Timeout retries with no ACKs received
	HI	Transmit retries exhausted
42	LO	NAK/illegal protocol operation received
	HI	NAK/bad LSAP received
43	LO	NAK/no memory received
	HI	Received ACK/NAK too short
44	LO	Received ACK/NAK too long
	HI	Something other than ACK/NAK received
45	LO	Token pass timeout
	HI	Token pass retries exhausted
46	LO	Claim token sequence entered
	HI	Token claimed
47	LO	Bad CRC in received frame
	HI	NAK/illegal protocol operation sent
48	LO	NAK/bad LSAP sent
	HI	NAK/no memory sent
49	LO	Received frame too small
	HI	Received frame too long
b0	LO	Received a re-transmission of a frame
	HI	Received frame aborted (line noise)
b1		Message successfully sent
b2		Message successfully received
b3		Command successfully sent
b4		Reply successfully received
b5		Command successfully received
b6		Reply successfully sent
b7	LO	Reply could not be sent
	HI	Number of active nodes

Cr2

Appendix H

Extended Status (EXT STS) Codes for Command 0F

If the value in the upper byte of the GATEWAY_CMD_OK@ 'status' parameter variable is 0F, then there is a value in the upper byte of the extended status register (register 33 on the Data Highway Plus interface module) which supplies further information. The following table shows possible values for the extended status error code.

0	(not used)
1	A field has an illegal value
2	Less levels specified in address than minimum for any address
3	More levels specified than system supports
4	Symbol not found
5	Symbol is of improper format
6	Address doesn't point to something usable
7	File is wrong size
8	Cannot complete request: situation has changed since the start of the command
9	Data or file is too large
A	Transaction size plus word address is too large
B	Access denied: improper privilege
C	Condition cannot be generated: resource is not available
D	Condition already exists; resource is already available
E	Command cannot be executed
F	Histogram overflow
10	No access
11	Illegal data type
12	Invalid parameter or invalid data
13	Address reference exists to deleted area
14	Command execution failure for unknown reason; possible PLC-3 histogram overflow
15	Data conversion error
16	Scanner not able to communicate with 1771 rack adapter
17	Adapter cannot communicate with module
18	1771 module response was not valid
19	Duplicated label
1A	File is open; another node owns it
1B	Another node is the program owner
1C FF	(not used)

Appendix I

Converting A-B Register Numbers to AutoMax Register and Bit Numbers for Monitoring

The A-B registers in the dual port memory of the Data Highway Plus interface module may be displayed using the Monitor I/O function in the AutoMax Programming Executive. This appendix provides a method for converting the A-B register number to a register number recognized by the Monitor I/O application.

The following table shows the correspondence between A-B register numbers and AutoMax register numbers.

A-B File Address	AutoMax Register
B3:n	64 + n
B4:n	1088 + n
B5:n	2089 + n
N7:n	4384 + n
N8:n	5384 + n
N9:n	6384 + n
N10:n	7384 + n
N11:n	8384 + n
N12:n	9384 + n
N13:n	10384 + n
N14:n	11384 + n
N15:n	12384 + n
N16:n	13384 + n
N17:n	14384 + n
N18:n	15384 + n

Appendix J

Recommendations For Reducing Noise On The Cable System

We recommend that all drive systems using 57C442 Data Highway Plus Interface Modules and/or 57C443 AutoMax Allen Bradley Remote I/O Scanner Modules should be provided with 1770 SC station connectors installed per item 2 below. All drives which are connected using Data Highway Plus or Allen Bradley Remote I/O should include part number 43625 TC ferrite cores installed per item 3 below.

Installation recommendations:

1. When installing either the 57C442 or 57C443 module into the card rack, make sure that its holddown screws are properly tightened at all times. The basic design of the AutoMax has a floating ground on the backplane rather than a solid DC ground like the PLC 5 does on its backplane. In AutoMax, it has always been the case that the cards retaining screws have always had to be tightened down tightly so that we could insure a good ground connection. Also make sure that the AutoMax rack is properly grounded.

2. Always install an AB 1770 SC station connector box near the AutoMax rack so that the drop cable from the AutoMax to the station connector box does not exceed a length of 10 feet. Connect the drop cable and the trunkline cables as specified in the installation manual for the station connector box. This will result in the shield of the drop cable being isolated from the network in the Station Connector box. Make sure that the station connector box is grounded as specified. Follow the installation Guideline documents that AB has for Data Highway Plus and RIO networks as well as the Station Connector Box. Guideline documents are AB publications 1770 2.20C for the 1770 SC Station Connector Box, 1770 4.1 for Industrial Automation Wiring and Grounding Guidelines and 1770 6.2.2 for Data Highway/Data Highway Plus/Data Highway II/Data Highway 485 Cable.

3. The AB drives group recommends that a common mode choke be installed at each drive. The common mode choke is a ferrite core, part number 185492. It is made by Dexter Perma and is Dexter Perma part number 43625 TC. The drives group recommends that 4 turns of the network cable be pressed through this ferrite core.

Where poor installation and wiring practices are suspected and problems exist after items 1, 2 and 3 have been implemented, additional ferrite beads, Fair Rite Products Corporation number 2643626502, as discussed in publication 1770 4.1 can be added. In some cases, slowing the network speed down from 230 kbaud to 115 kbaud has helped, as well.

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