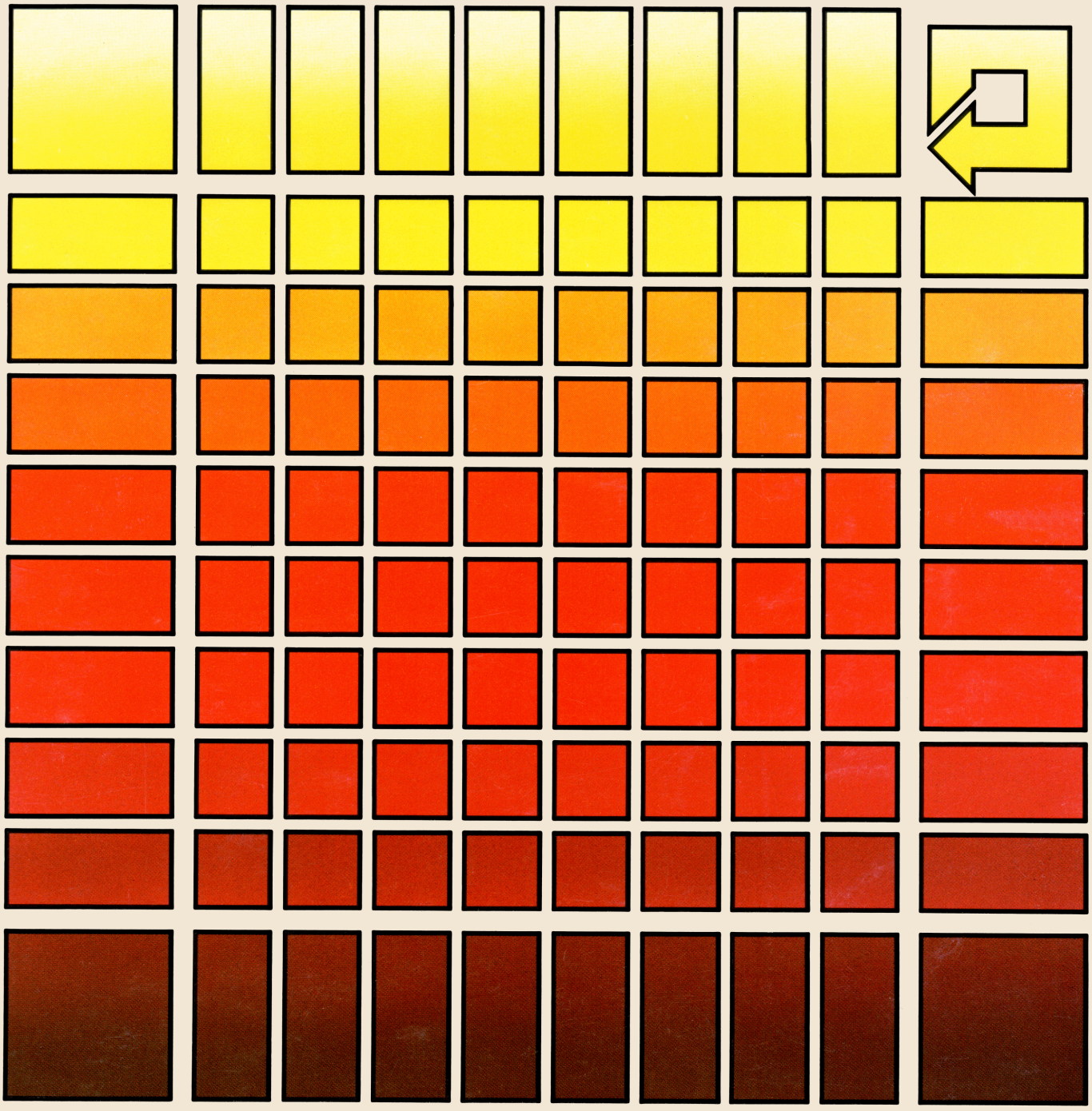
HEWLETT-PACKARD

HP 82169A

HP-IL/HP-IB Interface

OWNER'S MANUAL



HP 82169A
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This manual for the HP 82169A HP-IL/HP-IB Interface must be used in conjunction with the manuals for other components in your HP-IL/HP-IB system. In particular, the manuals for your HP-IL or HP-IB controller and its I/O (input/output) enhancements will describe how you'll control the interface and the devices connected to it. It is important to recognize that the main content in this manual describes the capabilities of only the interface, and that you'll need to refer to other manuals for additional information. For example, you'll need to refer to the manuals for HP-IL or HP-IB devices to determine their operating characteristics.

To best learn how to use the interface in your HP-IL/HP-IB system, read these parts of this manual in the order shown:

1. **Section 1, "General Information."** It gives basic information about connecting the HP-IL/HP-IB system and gives an overview ot the system's operation. It should help you decide how you'll set up your system.

   Note: If you aren't familiar with how your HP-IL controller performs HP-IL operations, look through the appendix that corresponds to your controller. This shows how you'll control the interface and HP-IB devices. (The appendix refers to features of the interface that are described in the body of this manual, so you may not understand some details at this time.)

2. **The section that corresponds to your system setup.** It depends upon the operating mode of the interface and whether you have an HP-IL controller, HP-IB controller, or both. This section presents technical information about the interface's operation. (You may be interested in more than one setup.)

3. **The appendix that corresponds to your HP-IL controller.** It defines the capabilities of your system that your HP-IL controller can use, describes how your controller interacts with the interface and HP-IB system, and gives several examples that show typical operation.

If you have an HP-IL controller that isn't discussed in an appendix, refer to sections 2 through 4 for information about how the interface operates using HP-IL in general. If the controller is manufactured by Hewlett-Packard and you need information about using it with the interface, you can write to:

Hewlett-Packard Company
Corvallis Division Customer Support
1000 N.E. Circle Blvd.
Corvallis, OR 97330

Section 1

General Information

Introduction

The HP 82169A HP-IL/HP-IB Interface provides the capability to interconnect Hewlett-Packard Interface Loop (HP-IL) and Hewlett-Packard Interface Bus (HP-IB) systems. (HP-IB is the Hewlett-Packard implementation of the IEEE Standard 488.)

The interface makes the interconnection of the two systems easy. Once the addressing schemes of the systems are understood, you can usually run existing programs with little or no modification.

The HP 82169A HP-IL/HP-IB Interface is packaged with the following accessories:

- One HP-IL cable.
- An ac adapter.

Additional HP-IL cables are available in the following lengths:

- ½ meter (1½ feet)—model number HP 82167A.
- 1 meter (3 feet)—model number HP 82167B.
- 5 meters (16 feet)—model number HP 82167D. (This length may not be available in all countries.)

HP-IB cables are available in the following lengths:

- ½ meter (1½ feet)—model number HP 10833D.
- 1 meter (3 feet)—model number HP 10833A.
- 2 meters (7 feet)—model number HP 10833B.
- 4 meters (13 feet)—model number HP 10833C.

This manual gives information about the interface's modes of operation, interaction with HP-IL and HP-IB systems, and its usage under various system configurations.

Installation

The following paragraphs describe how to set up the HP 82169A HP-IL/HP-IB Interface in an HP-IL/HP-IB system.

Power

The HP-IL/HP-IB interface is powered by an ac adapter. Because the interface does not have a battery, it can operate only when the adapter is connected to the interface and a proper ac outlet. To install the adapter, insert the ac adapter plug into the proper ac outlet and insert the power connector into the power receptacle in the rear of the interface.

HP-IB Connection

To connect the interface to the Hewlett-Packard Interface Bus (HP-IB), disconnect the power from the interface and plug the male connector from an HP-IB cable to the female HP-IB connector on the interface's rear panel.

HP-IL Connection

To connect the HP 82169A HP-IL/HP-IB Interface to the loop, first turn off the controller. Then disconnect the loop in the place where the interface will go, and connect the interface into the loop at that location. (In some instances, the interface may be the only peripheral in the loop.)

All HP-IL cables must form a continous loop. All connections are designed to ensure proper orientation.

The interface's position in the loop depends upon the operating mode you select. If the interface will be operating in Translator mode, it must be the last device in the loop (its OUT receptacle connected to the controller's IN receptacle). If the interface will be operating in Mailbox mode, it may be connected anywhere in the loop.

Keyboard

The keyboard on top of the interface contains controls that help you to set and monitor the interface's operation.

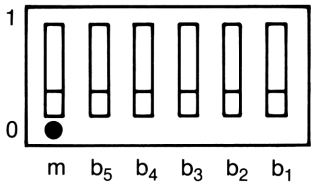
RESET Key. The RESET key is a momentary switch that returns the interface to its startup conditions, including all options set to their disabled conditions.

PWR Light. The PWR (*power*) light is on whenever the ac adapter supplies power to the interface.

T/R Light. The T/R (*transmit/receive*) light turns on each time data or commands are transferred across the HP-IB data lines. The light is lit only for the duration of the transfer, so it will often appear to flash or blink.

Mode/Address Switch

The mode/address switch is a six-position switch located on the interface's back panel. The switch controls the mode of operation and the HP-IB address of the interface (used when control is on HP-IB). The HP-IB address is defined according to the following table.



m	Mode
0	Translator
1	Mailbox

b_5	b_4	b_3	b_2	b_1	HP-IB Address
0	0	0	0	0	0
0	0	0	0	1	1
0	0	0	1	0	2
0	0	0	1	1	3
0	0	1	0	0	4
0	0	1	0	1	5
0	0	1	1	0	6
0	0	1	1	1	7
0	1	0	0	0	8
0	1	0	0	1	9
0	1	0	1	0	10
0	1	0	1	1	11
0	1	1	0	0	12
0	1	1	0	1	13
0	1	1	1	0	14
0	1	1	1	1	15
1	0	0	0	0	16
1	0	0	0	1	17
1	0	0	1	0	18
1	0	0	1	1	19
1	0	1	0	0	20
1	0	1	0	1	21
1	0	1	1	0	22
1	0	1	1	1	23
1	1	0	0	0	24
1	1	0	0	1	25
1	1	0	1	0	26
1	1	0	1	1	27
1	1	1	0	0	28
1	1	1	0	1	29
1	1	1	1	0	30
1	1	1	1	1	(test/invalid)

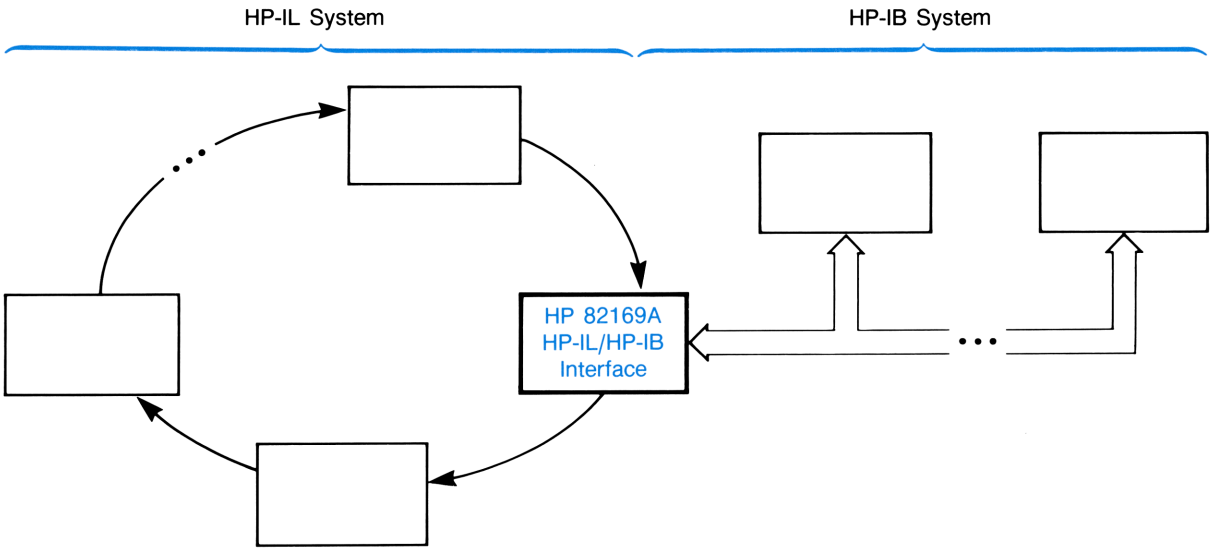
Note: When the interface is placed in Translator mode ($m = 0$) and the HP-IB address is set to 31, the interface executes a continuous diagnostic test. Refer to "Verifying Proper Operation" in appendix A for additional information.

An Overview of the Interface's Operation

The following terms are used throughout this manual:

controller	A device capable of issuing interface commands.
active controller	The device that is currently issuing interface commands.
system controller	The device responsible for interface startup and for maintaining system integrity.
talker	A device that is assigned to source data.
listener	A device that is assigned to receive data.

Consider the system shown below. The HP-IL system can contain a controller (such as a computer), perhaps one or more additional HP-IL devices, and the HP-IL/HP-IB interface. The HP-IB system can contain a controller, perhaps one or more additional HP-IB devices, and the HP-IL/HP-IB interface. The interface essentially links the two systems. The nature of this link is determined by the interface's operating mode.

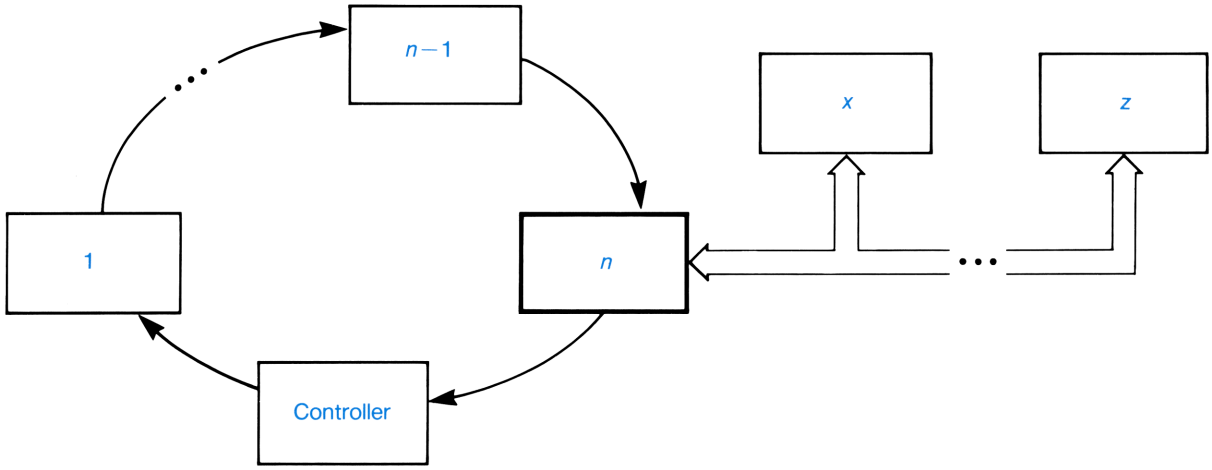


When the interface is acting as a "translator" (*m* set to "0"), a controller essentially works "through" the interface to interact with a device on the other side. In this mode, the controller essentially controls *all* devices—HP-IL devices and HP-IB devices. The interface ensures that instructions and data from each system are transferred to the other system according to the other system's standards. There can be a device on each side capable of a being controller, but there can be only one active controller at a time. These controllers can pass control between themselves—the interface will keep track of where the system controller and active controller are located.

When the interface is acting as a data "mailbox" (*m* set to "1"), a controller essentially interacts with the interface itself—not with devices on the other side. In this mode, the HP-IL and HP-IB systems are joined by the interface, but neither system controls the other system. There must be active controllers on both the HP-IL side and the HP-IB side. The HP-IL controller can place data in one of the interface's buffers; the HP-IB controller can retrieve that data when needed. Similarly, the HP-IB controller can make data available to the HP-IL side.

Translator Mode With Control on HP-IL

In the system shown below, the active controller is on the HP-IL side. The complete operation of this system configuration is described in section 2.



Addressing With Control on HP-IL

The HP-IL controller accesses HP-IB devices using their HP-IB addresses. The addresses of HP-IB devices are determined by their address switches. For this system, *no HP-IB address may be the same as any HP-IL address.*

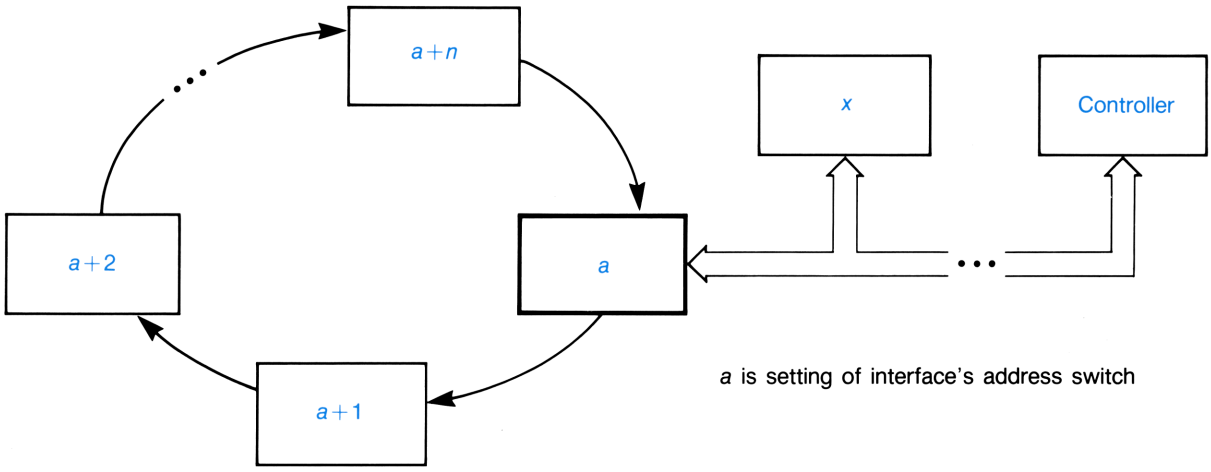
If the controller needs to send data to an HP-IB device, the controller first makes that device a listener by sending the device's HP-IB listen address. The interface will accept data from HP-IL and pass it to HP-IB one byte at a time as it is received by the interface—there is no data buffering.

If the controller needs an HP-IB device to send data to listeners on HP-IL or HP-IB, the controller first makes that device the talker by sending the device's HP-IB talk address. The controller then directs the device to start sending data. The interface will accept data from the HP-IB device and pass it to the HP-IL devices according to how fast the data passes around HP-IL.

An HP-IL controller usually performs these operations using I/O functions or statements that automatically implement all of the necessary HP-IL instructions. For specific examples of I/O programming with a Hewlett-Packard controller, refer to the appendixes at the back of this manual or to the owner's manual of the controller you're using.

Translator Mode With Control on HP-IB

In the system shown below, the "active controller" is on the HP-IB side. The complete operation of this system configuration is described in section 3.



Addressing With Control on HP-IB

The HP-IB controller accesses HP-IL devices using their HP-IL addresses assigned by the interface. An HP-IL device's address is determined by adding its position (relative to the interface) to the interface's HP-IB address (as determined by its address switch). For this system, *no HP-IL device's address may be the same as any HP-IB device's address.*

If the controller needs to send data to an HP-IL device, the controller first makes the device a listener by sending the device's HP-IL listen address. The interface will accept data from the HP-IB device and pass it to HP-IL.

A typical computer sends data using an output statement of the form OUTPUT *device address,data string or variable.* Some computers allow you to define the location of a device using DEVICE=*device address*; the output statement can then be a LIST statement.

If the controller needs an HP-IL device to send data to listeners on HP-IB or HP-IL, the controller first makes the device the talker by sending the device's HP-IL talk address. The controller then directs the device to start sending data. The interface will accept data from the HP-IL device and pass it to HP-IB one byte at a time. The interface will slow down the HP-IL device according to how fast the HP-IB devices accept the data.

The typical computer retrieves data using an input statement of the form ENTER *device address,data format or variable.*

For specific examples of I/O programming using a Hewlett-Packard controller, refer to the owner's manual of the controller you are using.

Translator Mode With Controllers on HP-IL and HP-IB

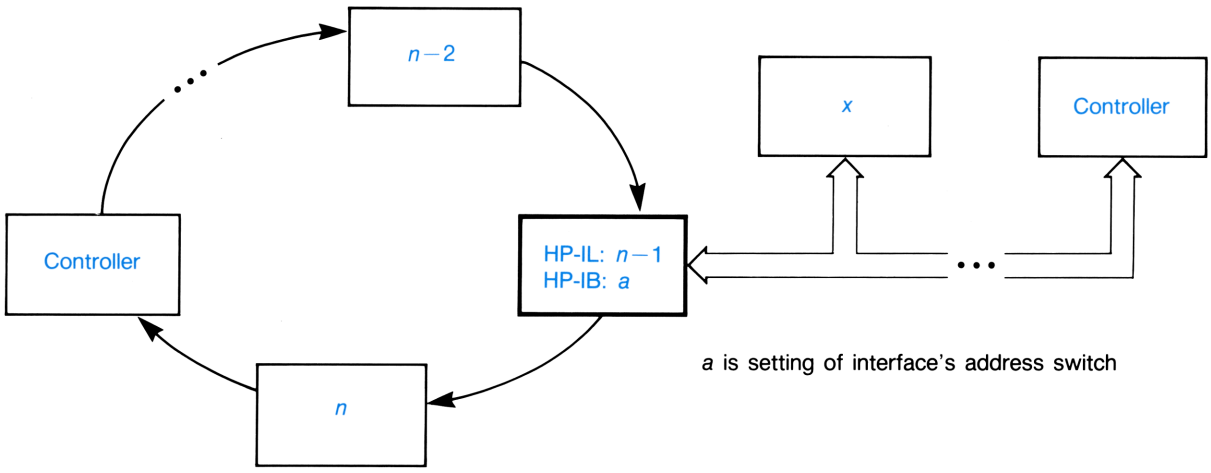
Operating in Translator mode with controllers on both HP-IL and HP-IB is a special case of the two situations described above. Although each side of the system may have a controller, only one can be an active controller at any time in Translator mode. Two controllers can never be active simultaneously in Translator mode.

The interface assumes that the system controller is on the side where *the first command is received after startup or keyboard reset*. The system controller and the active controller are the same device until control is passed to another device.

The system controller side is the only side from which the interface will accept the Interface Clear and Remote Enable commands.

When active control is passed from the HP-IL side to the HP-IB side, the interface will always assign new addresses to HP-IL devices. No matter which side the active controller is on, the HP-IB device addresses never change because they are determined by their address switches.

Mailbox Mode



Addressing in Mailbox Mode

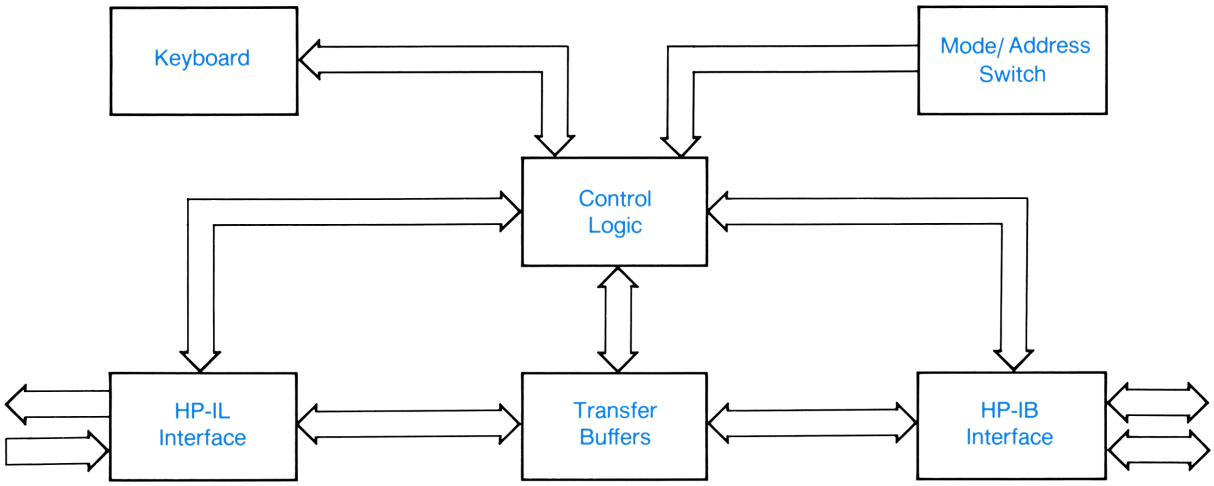
Mailbox mode enables two active controllers to transfer data between the two systems.

The interface behaves like a single HP-IL device on the HP-IL side and a single HP-IB device on the HP-IB side. The HP-IL address of the interface is its assigned auto-address, and the HP-IB address is set by the switch on the rear panel.

The interface contains two 110-byte buffers for full-duplex operation. Both controllers can make the interface a talker or listener to send or receive data. A full description of operation in Mailbox mode is given in section 4.

Internal Design

The HP-IL/HP-IB interface has six primary features that are important for understanding the interface's operation: the HP-IL interface, the HP-IB interface, the transfer buffers, the control logic, the keyboard, and the mode/address switch. In Translator mode, the interface doesn't use the transfer buffers; they are used in Mailbox mode only.



HP-IL Interface

The HP-IL interface portion of the interface performs standard operations required by the interface loop, such as maintaining the interface's talker or listener status, and accepting and passing HP-IL messages around the loop. The physical connection to HP-IL consists of standard HP-IL receptacles—one for incoming messages and one for outgoing messages.

HP-IB Interface

The HP-IB interface portion of the interface performs standard operations required by the interface bus, similar to that of the HP-IL interface portion. The physical connection to HP-IB consists of the standard IEEE-488 connector.

Control Logic

The control logic stores operation information, implements various operating modes that can be selected, and controls the flow and interpretation of data and commands within the interface. It ensures that the protocol of each interfacing system is preserved.

The control logic includes registers that store operating information: the option registers, the HP-IB device address registers, and the status registers. This operating information comes from the HP-IL controller, the HP-IB controller, the interface's keyboard, and the interface's mode/address switch.

Transfer Buffers

The interface contains two transfer buffers that are used to store data while in Mailbox mode. One buffer is called the HP-IL → HP-IB ("HP-IL to HP-IB") buffer and contains the data being transmitted to the HP-IB system. The other buffer is called the HP-IL ← HP-IB ("HP-IL from HP-IB") buffer and contains the data received from the HP-IB system.

Each buffer is capable of holding 110 bytes. (Each byte consists of eight bits.) The buffers pass data in the order it was received—first in, first out.

Mode/Address Switch

The mode/address switch provides operating information to the control logic. It lets you define the interface's operating mode and HP-IB address.

Section 2

Translator Mode Operation With Control on HP-IL

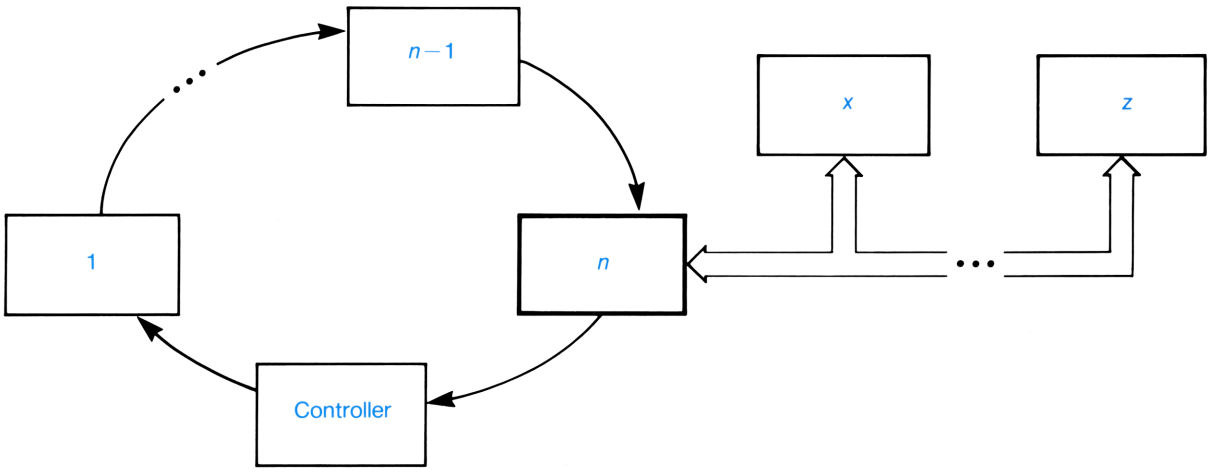
This section describes the operation of the HP-IL/HP-IB interface in Translator mode in a system that has its controller on the HP-IL side.

System Startup and Addressing

If bit *m* of the mode/address switch is set to "0" at startup or keyboard reset, the interface is set to Translator mode. If the interface receives the first command from the HP-IL side, it considers the HP-IL controller to be the system controller and waits for command messages from it. The interface's HP-IL address is 15 until the controller assigns an auto address.

The HP-IL controller accesses devices using their HP-IL addresses. For each HP-IB device, its HP-IL address is the same as its HP-IB address, which is set by its address switch. *For both of the addressing options discussed below, the addresses of HP-IB devices must be different from the addresses of the HP-IL devices.* (The interface is itself an HP-IL device with an HP-IL address of its own—its address switch isn't used in this system.)

Default Addressing



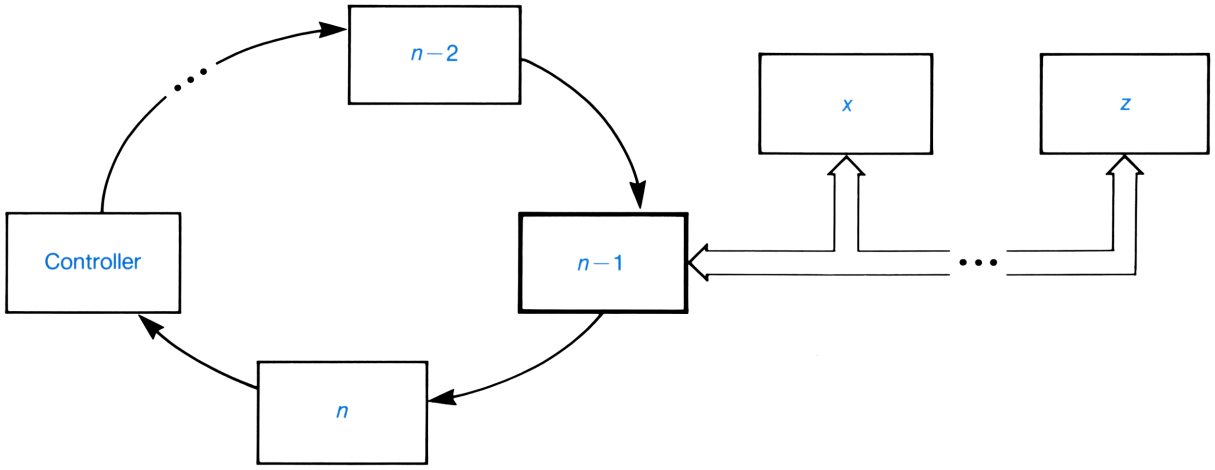
At startup or keyboard reset the interface operates using *default addressing.* Default addressing is designed for maximum convenience and for controllers that can access only devices that use auto addresses. With default addressing the interface must be the last loop device.

When using default addressing, the interface takes the first auto address it receives as its own address and retransmits an Auto Address 31 message. This reserves for HP-IB devices all auto addresses from the address after the interface's address up to address 30. This would leave any HP-IL devices downstream from the interface with no auto addresses (since they would receive an Auto Address 31 message). You use the interface's address only for setting interface options and sending interface status.

All HP-IB device address switches should be set within the range of the next address after the interface's and address 30, inclusive. (The HP-IL address of an HP-IB device is the same as its HP-IB address.)

Default addressing limits the location of the interface on the loop. Any HP-IL device downstream from the interface would either act as if it were not there, or could possibly interfere with loop operation by responding to its default address if it has one (which may be the same as another legitimately addressed device).

General Addressing



The general addressing option allows the interface to be placed anywhere on the loop. The interface takes one auto address, which is used to select interface options and send interface status. The only restriction on device addressing is that no HP-IL address be the same as any HP-IB address.

At startup or keyboard reset the interface assumes default addressing. You can select general addressing in two ways using the "E6" instruction. (The "E6" instruction is described on page 24.)

The first way is to access the interface using its default address, which is address 15. The interface must be sent a Listen Address 15 message and then option "E6" selected.

The second way is to initially address the loop, whereupon the interface takes all auto addresses from its own to 30. All devices downstream from the interface remain unaddressed. The interface must be made a listener and option "E6" selected. The interface must then be canceled as a listener and the loop addressed again. At this point the interface will take only one auto address.

Listeners on HP-IB

The controller specifies and uses listeners in the same way, regardless of whether the interface is using default addressing or general addressing. In the HP-IB and HP-IL systems, a listener is any device which is set to receive data (printers, plotters, monitors, etc.).

When the controller wishes to send data to HP-IB and HP-IL devices, it must first make the devices listeners by sending the devices' listen addresses.

After the devices have been made listeners, the controller can start sending data, which the interface will transfer to HP-IB byte by byte. The interface does not keep track of whether an HP-IB device is a listener. If the talker is not on HP-IB, the interface will transfer data bytes sourced on HP-IL to HP-IB (enabling listen-only devices to get the data).

> **Note:** The interface will not transfer any data to HP-IB if the interface itself has been made a listener (for the purpose of selecting interface options).

Initiating Talkers on HP-IB

In the HP-IB and HP-IL systems a talker is any device that is set to send data (voltmeters, oscilloscopes, computers, etc.). While listeners are handled the same for default and general addressing, talkers are not.

HP-IB Talkers With Default Addressing

If an HP-IL controller needs an HP-IB device to send data, the controller must first send the device's talk address. The interface assumes an HP-IB device is the talker when the last talk address sent was greater than its own.

The HP-IL controller instructs the device to start sending data by sourcing a Send Data message. When the interface receives a Send Data message and an HP-IB device is the talker, it sets the HP-IB ATN and NRFD lines false and waits for the HP-IB talker to respond with data available. The interface will wait for data until an Interface Clear message is received from the system controller.

When the interface receives a Send Data message and the last talk address was not that of an HP-IB device, the interface will set the NRFD and ATN lines false and hold the Send Data message for 1 second waiting for an HP-IB device to respond with data. If an HP-IB device responds, then the interface starts transferring data from HP-IB to HP-IL; otherwise the NRFD line is set true and the Send Data message is passed to the next HP-IL device (the controller). For normal operations with default addressing, the interface won't receive a Send Data message unless the last talk address was that of the interface or an HP-IB device (since the interface is the last device in the loop).

If the configured option has been enabled, the interface will hold a Send Data message only if it follows a talk address that was greater than the interface's address; otherwise, the Send Data message is immediately passed on to the next device (the controller). (The configured option is selected by the "E5" instruction—refer to page 24.)

When the interface transfers data from HP-IB to HP-IL, it does half of the HP-IB handshake, sources the data on HP-IL, waits for its return, checks it for errors, and (if it has no errors) finishes the HP-IB handshake and starts over. If an error occurs, the interface will finish the HP-IB handshake (and not start another) and terminate data transmission (as described on page 20).

HP-IB Talkers With General Addressing

With general addressing the interface has no way of knowing what addresses are those of HP-IB devices (unless you store that information using the "A" instruction—refer to page 24).

When the interface receives a Send Data message, one of three conditions exists: there is a talker on HP-IB waiting to source data, the Send Data message is meant for a talker on HP-IL downstream from the interface, or the Send Data message was retransmitted by an unresponsive talker on HP-IL upstream from the interface.

The interface always stores the talk address that was most recently sent. When it receives a Send Data message, it compares the last talk address to an internal table of HP-IB device addresses. (This table is loaded using the "A" ASCII instruction—refer to page 24).

If there is no match in the table, the interface will set the NRFD and ATN lines false and hold the Send Data message for 1 second waiting for an HP-IB device to respond with data. If the HP-IB device responds, then the interface starts transferring data from HP-IB to HP-IL; otherwise, the NRFD line is set true and the Send Data message is passed to the next HP-IL device.

If there is a match in the table, then the interface sets the ATN and NRFD lines false and waits for the HP-IB talker to respond with data available. The interface will wait for data until an Interface Clear message is received from the system controller.

If the configured option has been enabled, the interface will hold a Send Data message only if the last talk address matches a table address; if there is no match, the Send Data message is immediately retransmitted. (The configured option is selected by the "E5" instruction—refer to page 24.)

After the HP-IB device starts sending data, the interface transfers data in the same way that it does using default addressing.

Terminating Transmission

The end of a data transmission is indicated differently by HP-IL protocol and HP-IB protocol. HP-IL protocol requires an End Of Transmission message at the end of every data transmission. The HP-IL controller must receive either an End Of Transmission—Error or End Of Transmission—OK message after the talker's last data byte. HP-IB has no required method for identifying the end of data transmission.

Most HP-IL controllers send a Not Ready For Data message after they have received either a set number of bytes or a line feed character. After receiving a Not Ready For Data message, the interface completes the current HP-IB handshake and follows HP-IL protocol by sending the required End Of Transmission message.

If the controller does not send Not Ready For Data messages, you have two options for providing an End Of Transmission message on HP-IL:

- Some HP-IB devices that send binary-coded data (such as mass storage devices) set the EOI (End Or Identify) line true on their last data byte. In its default condition, the interface transfers a data byte for which the EOI line is true, completes the current HP-IB handshake and sends an HP-IL End Of Transmission message.
- Some HP-IB devices that send ASCII-coded data do not set the EOI line true on the last byte, but always end their transmissions with an ASCII line feed character. If the LF → EOT option has been enabled, the interface will consider a line feed transferred from HP-IB to HP- IL as the last byte and will follow that byte with an End Of Transmission message. (The LF → EOT option is selected by the "E1" instruction—refer to page 24.)

Whenever the interface detects a transmission error in a data byte that it transferred to HP-IL, it completes the current HP-IB handshake, sets the HP-IB NRFD line true (to prevent the talker from sending more data), and sends an HP-IL End Of Transmission—Error message.

Service Requests

The interface enables HP-IB devices to request service from the HP-IL controller and enables the controller to determine the status of HP-IB devices. In addition, the interface itself requests service and provides status information to the controller.

Setting Service Requests

The interface will request service on HP-IL whenever an HP-IB device sets the HP-IB SRQ line true (meaning it is requesting service) and whenever an interface error has occurred. Requesting service on HP-IL consists of setting the service request bit in HP-IL Data, End, or Identify messages and also setting the parallel poll response bit in Identify messages (if the interface has been enabled to respond to a parallel poll).

When an interface error condition occurs, the interface keeps requesting service until its status is read. The status byte is then cleared.

The interface supports the HP-IL Enable Asynchronous Requests message. When an HP-IL controller needs to let the loop go idle but must also be ready to acknowledge devices that need service, it sources an Enable Asynchronous Requests message. This allows a device to source Identify—Service Request messages until a universal command message is received (for example, an Auto Address Unconfigure message). If the interface has been enabled for asynchronous service requests, it will source Identify—Service Request messages if the HP-IB SRQ line is true.

Serial Poll Response

If the interface is the talker and receives an HP-IL Send Status message, it sends one byte of internal status information and then clears the internal status byte. This status byte shows whether an internal error condition has occurred. (Refer to page 22.)

If the interface is not the talker and it receives a Send Status message, then the interface performs an HP-IB serial poll. To perform an HP-IB serial poll the interface sources an HP-IB SPE (Serial Poll Enable) command, sets the ATN and NRFD line false so an HP-IB talker can send its status, transfers the status byte to HP-IL (followed by an End Of Transmission message), and sources a HP-IB SPD (serial poll disable) command. If an HP-IB device does not respond to the serial poll within 1 second, then the Send Status message is retransmitted and an HP-IB SPD command is sourced.

If the configured option has been enabled, the interface will immediately retransmit the Send Status message unless the talker is on HP-IB (the last talk address transferred was greater than the interface's address for default addressing or it matches a table address for general addressing). (The configured option is selected by the "E5" instruction—refer to page 24.)

Parallel Poll Response

The interface supports an HP-IL parallel poll. If the interface is enabled to repond to an HP-IL parallel poll and service is requested by the interface or an HP-IB device, the interface will set the proper response bit in an Identify message. (Refer to the table below.) This parallel poll response indicates to the HP-IL controller that an HP-IB device or the interface is requesting service.

The following table defines the response to an HP-IL parallel poll (Identify message) according to the particular message that enabled the response.

Parallel Poll Response to an Identify Message

Enable message...	designates bit...	and sets that Identify bit if...
Parallel Poll Enable 0	D_0	service is not requested*
Parallel Poll Enable 1	D_1	
Parallel Poll Enable 2	D_2	
Parallel Poll Enable 3	D_3	
Parallel Poll Enable 4	D_4	
Parallel Poll Enable 5	D_5	
Parallel Poll Enable 6	D_6	
Parallel Poll Enable 7	D_7	
Parallel Poll Enable 8	D_0	service is requested*
Parallel Poll Enable 9	D_1	
Parallel Poll Enable 10	D_2	
Parallel Poll Enable 11	D_3	
Parallel Poll Enable 12	D_4	
Parallel Poll Enable 13	D_5	
Parallel Poll Enable 14	D_6	
Parallel Poll Enable 15	D_7	

* Otherwise, the designated Identify bit isn't changed. Also, control bit C_0 is set if service is requested.

Notice that the interface's response to an HP-IL parallel poll is determined in part by HP-IB service requests—but not by an HP-IB parallel poll. The interface allows you to obtain the results of an HP-IB parallel poll by using the "E7" instruction (refer to page 24). To obtain the results of an HP-IB parallel poll, the controller must make the interface a listener, send the "E7" instruction, make the interface the talker, and send it a Send Data message.

For every Send Data message the interface receives while it is a talker and this option is enabled, it will perform an HP-IB parallel poll and return the resulting byte followed by an End Of Transmission message. The "D7" instruction disables the parallel poll option.

Interface Status

The interface's HP-IL status byte indicates two error conditions. The interface sets one bit in its status byte for each error condition and also sets bit 6 to indicate that service has been requested.

HP-IL Status Byte—Translator Mode

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Service Request	0	0	0	Address Table Overflow	Unrecognized ASCII Instruction	0
Value = 128	Value = 64	Value = 32	Value = 16	Value = 8	Value = 4	Value = 2	Value = 1

Bit 1 is set when an unrecognized ASCII instruction is received or when an inappropriate ASCII sequence is received while selecting interface options. Once an unrecognized ASCII instruction is received, no other instructions will be recognized until a "terminator" is received (either an ASCII semicolon or line feed.)

Bit 2 is set when more than 15 HP-IB device addresses are entered into the interface's address table. This table is cleared only at startup, at keyboard reset, or when an ASCII "I" instruction is received.

Bit 6 is set whenever bit 1 or 2 is set. It indicates that service has been requested on HP-IL.

The interface clears the status byte after it responds to a Send Status message or after a keyboard reset.

Passing Control

If the first command received by the interface after startup or keyboard reset is from the HP-IL side, the interface assumes that the system controller is on the HP-IL side. When the system controller is on the HP-IL side, the interface will accept Interface Clear and Remote Enable messages from the HP-IL side only.

Active control is passed from HP-IL to HP-IB by sending a suitable HP-IB device (a computer or other device that can accept active control) its talk address followed by the HP-IL Take Control message. When the interface is using default addressing, the interface passes control when a Take Control message is received and the last talk address is greater than the interface's address. When the interface is using general addressing, the interface will pass control only if a Take Control message is received and the last talk address matches an address in the address table. Otherwise, the Take Control message is retransmitted on HP-IL.

If accepted by the interface, the Take Control message is translated to the HP-IB TCT command and sourced on HP-IB. Once the HP-IB device has accepted the TCT command, the interface sets the HP-IB ATN line false, allowing the HP-IB device to start sending commands. At this point the interface will expect commands from the HP-IB side (as described in section 3).

Control can be passed back to HP-IL either by the HP-IB controller executing a take control sequence or by the HP-IL system controller sourcing an Interface Clear message.

HP-IL Options and Instruction Set

The interface responds to a set of ASCII-coded instructions. The "D" and "E" instructions disable and enable several options that determine how the interface operates. Following startup, keyboard reset, or receipt of the "I" instruction, these options are disabled.

Interface options are selected by sending the interface's listen address followed by ASCII-coded bytes that are interpreted as interface instructions. All instruction strings must be followed by a terminator, which is either an ASCII semicolon or line feed.

Certain instructions direct the interface to send status information. These instructions are two-letter ASCII instructions starting with the letter "S". Once these instructions have been accepted by the interface, you should send the interface's talk address followed by a Send Data message to start the interface sending the information.

If the interface has not received an instruction directing it to send status, then the interface sends all its status information: the 15 address table registers (empty registers are represented with the value 31) and the enable status byte.

The following table lists the ASCII instructions that the interface recognizes.

ASCII Instruction Set

Instruction	Meaning
A1 ⋮ A30	Add HP-IB address 1 to address table. ⋮ Add HP-IB address 30 to address table.
D1	Disable LF → EOT option.
D2	Disable DDL/DDT ↔ SAD option.
D3	Disable SAI on ATN false option.*
D4	Disable SDI on ATN false option.*
D5	Disable configured option.
D6	Disable general addressing.
D7	Disable HP-IB parallel poll option.
E1	Enable LF → EOT option.
E2	Enable DDL/DDT ↔ SAD option.
E3	Enable SAI on ATN false option.*
E4	Enable SDI on ATN false option.*
E5	Enable configured option.
E6	Enable general addressing.
E7	Enable HP-IB parallel poll option.
I	Disable all options and clear address table, enable status register, and excess status registers.
SA	Send addresses from HP-IB address table.
SE	Send enable status byte.
SS	Send excess status bytes.*

* Can be enabled from HP-IL, but has effect only when control is on HP-IB. Refer to section 3 for detailed information.

Several "A", "D", or "E" instructions may be combined by separating the appropriate numbers by commas and omitting all letters but the first. For example, the instruction string

A2,3,7,17,25,5;E1,5,6;SA (CR)(LF)

does the following:

1. Puts 2, 3, 5, 7, 17, and 25 into HP-IB address table registers.
2. Enables HP-IB line feed to HP-IL End Of Transmission message option, configured option, and general addressing option.
3. Instructs the interface to send HP-IB device addresses that are set up in its HP-IB address table registers.

The "A" instruction enables you to load the interface's HP-IB address table registers, which are used during general addressing operation (HP-IL active control). A maximum of 15 HP-IB addresses (from 0 to 30) can be stored. The address table is cleared only at startup, keyboard reset, or by the "I" instruction. Each new address entry is checked for duplication and entered if it is not already in the table. This means that as devices are added to the HP-IB side, only the new addresses must be entered.

The "D" instruction is used to reset (disable) specific interface options, which are described under the "E" instruction.

The "E" instruction is used to select (enable) specific interface options, which are described next.

The "E1" option causes the interface to look for a line feed during a data transfer from an HP-IB talker. This option causes the interface to leave the HP-IB NRFD line true on the HP-IB side and source an End Of Transmission message on the HP-IL side after the line feed has been transferred. If this option is not enabled, the interface leaves the HP-IB NRFD line true on the HP-IB side and sources an End Of Transmission message on the HP-IL side after a byte is transferred with the HP-IB EOI line true.

The "E2" option causes the interface to convert HP-IL Device Dependent Listener and Device Dependent Talker messages to HP-IB secondary addresses and vice versa. When this option is enabled, HP-IL secondary addresses are ignored. If this option is not enabled, HP-IL Device Dependent Listener and Device Dependent Talker messages are not transferred to HP-IB and secondary addresses are transferred unchanged.

The "E5" option causes the interface to retransmit Send Data and Send Status messages immediately unless the last talk address was greater than the interface's (when using default addressing) or matches an HP-IB device address stored in the address table (when using general addressing). The configured option is useful because it can speed system operation for normal system configurations.

The "E6" option directs the interface to use general addressing. When using general addressing, the interface takes only one auto address, which is used for the interface itself.

The "E7" option directs the interface to perform an HP-IB parallel poll and send the response followed by an End Of Transmission message for every Send Data message received when the interface is the talker.

The "I" instruction directs the interface to initialize its enable status register, the 15 HP-IB address table registers, and the 8 excess status byte registers (described on page 31). All options are disabled.

The "SA" instruction directs the interface to source the contents of the HP-IB address table registers. After the interface receives its talk address and a Send Data message, it sends the defined addresses encoded as ASCII numerals. For example, it might send

2 , 3 , 5 , 7 , 1 7 , 2 5 (CR)(LF)

The "SE" instruction directs the interface to source the contents of the enable status byte. The enable status byte describes the active interface options.

Enable Status Byte

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	E7	E6	E5	E4	E3	E2	E1
Value = 128	Value = 64	Value = 32	Value = 16	Value = 8	Value = 4	Value = 2	Value = 1

After the interface receives its talk address and a Send Data message, it sources ASCII numerals that represent the decimal value of the enable status byte. For example, if interface options "E6", "E5", and "E1" are active, then the enable status byte has a decimal value of 49, and the interface returns the ASCII characters 4 9 (CR)(LF).

Response to HP-IL Messages

The table below describes the interface's response to each HP-IL message. Following each message name is the 11-bit pattern that defines the message:

$$C_2\ C_1\ C_0\quad D_7\ D_6\ D_5\ D_4\ D_3\ D_2\ D_1\ D_0.$$

(An X indicates that the bit may be "0" or "1".)

Almost all HP-IL command group messages with bit D_7 set to "0" are transferred to HP-IB. That is, the last eight bits are transferred to HP-IB as a command (the ATN line is true). The exception is the Enable Asynchronous Requests command message, which is not transferred because it conflicts with the HP-IB SPE command. HP-IL command group messages with bit D_7 set to "1" are *not* transferred to HP-IB. Ready group messages not listed below receive no response from the interface.

HP-IL Message	Interface Response
Command Group	
Auto Address Unconfigure 100 10011010	Interface address is set to 15. Interface is ready to be auto addressed. Not transferred to HP-IB.
Device Clear 100 00010100	No interface status change. Transferred to HP-IB.
Device Dependent Listener 0–31 100 101XXXXX	No interface status change. If option is selected by "E2" instruction, converted to HP-IB secondary address (011XXXXX) and transferred to HP-IB. Otherwise, not transferred to HP-IB.
Device Dependent Talker 0–31 100 110XXXXX	No interface status change. If option is selected by "E2" instruction, converted to HP-IB secondary address (011XXXXX) and transferred to HP-IB. Otherwise, not transferred to HP-IB.
Enable Asynchronous Requests 100 00011000	Enables the interface to source an HP-IL Identify—Service Request message if the HP-IB SRQ line goes true. This capability is disabled by the next universal command message received by the interface. This command message is not transferred to HP-IB.
Go To Local 00000001	No interface response. Transferred to HP-IB.
Group Execute Trigger 100 00001000	No interface response. Transferred to HP-IB.
Interface Clear 100 10010000	Interface talker or listener status removed and HP-IB IFC line held true for at least 100 microseconds.

HP-IL Message	Interface Response
Command Group (Continued)	
Listen Address 0–31 100 001XXXXX	Transferred to HP-IB. If the address is the same as the last talk address sent, an UNT command is sourced on HP-IB before the listen address is transferred. If the address is the interface's address, then the interface is removed from talker status and becomes a listener. (If the interface is a listener, it transfers no data to HP-IB.) If the address is 31, the interface is removed from listener status and UNL command is sourced on HP-IB.
Loop Power Down 100 10011011	No interface response. Not transferred to HP-IB.
Not Remote Enable 100 10010011	No interface status change. If the system controller is on the HP-IL side, the HP-IB REN line is set false. Not transferred to HP-IB.
Parallel Poll Disable 100 0000101	If listener, disables interface response to HP-IL parallel poll. Transferred to HP-IB.
Parallel Poll Enable 0–15 100 1000XXXX	If listener, enables interface response to HP-IL parallel poll according to parallel poll conventions. (Refer to page 21.) Not transferred to HP-IB.
Parallel Poll Unconfigure 100 00010101	Disables interface response to HP-IL parallel poll. Transferred to HP-IB.
Remote Enable 100 10010010	No interface status change. If the system controller is on the HP-IL side, the HP-IB REN line is set true. Not transferred to HP-IB.
Secondary Address 0–30 100 011XXXXX	No interface status change. If option is selected by "E2" instruction, not transferred to HP-IB. Otherwise, secondary address transferred to HP-IB.
Selected Device Clear 100 00000100	No interface response. Transferred to HP-IB.
Talk Address 0–31 100 010XXXXX	Transferred to HP-IB. If the address is the interface's address, then the interface is removed from listener status and becomes a talker. (If the interface is an HP-IL talker, all data is sourced to HP-IL, not to HP-IB.) If the address doesn't match interface's address, interface is removed from talker status. If the address is 31, UNT command is sourced on HP-IB.
Unlisten 100 00111111	The interface is removed from listener status and UNL command is sourced on HP-IB.
Untalk 100 01011111	The interface is removed from talker status and UNT command is sourced on HP-IB.
Ready Group	
Auto Address 0–31 101 100XXXXX	If the message address is less than 31 and the interface doesn't have an earlier assigned address, then the interface's HP-IL address is set to the message address. With default addressing, Auto Address 31 is retransmitted. With general addressing, the message address is incremented by one and transmitted. If the interface has a previously assigned address, no esponse. If the message address is 31, no response.
Not Ready For Data 101 01000010	If the interface or an HP-IB device is talker, then the previous data byte sourced by the interface becomes the last byte. If the talker is on HP-IB, then the NRFD line is left true.
Ready For Command 101 00000000	Retransmitted by the interface after all HP-IB devices have accepted the last command sent.
Send Accessory ID 101 01100011	If the interface is talker, then it sends one byte with the value of 67 followed by an End Of Transmission message.
Send Data 101 01100000	If the interface is talker, then it sends status information followed by carriage return, line feed, and an End Of Transmission message. If an HP-IB device is talker, then the interface sets the ATN line false and allows the HP-IB device to start sourcing data.
Send Device ID 101 01100010	If the interface is talker, then it sends the eight ASCII-coded bytes "HP82169A" followed by carriage return, line feed, and an End Of Transmission message.

HP-IL Message	Interface Response
Ready Group (Continued)	
Send Status 101 01100001	If the interface is talker, then it sends one byte of status infomation and an End Of Transmission message and clears its internal status byte. If an HP-IB device is talker, then the interface sources an HP-IB SPE (Serial Poll Enable) command, sets the ATN line false so the HP-IB device can send its status, transfers the status byte to HP-IL (followed by an End Of Transmission message), and sources an HP-IB SPD (Serial Poll Disable) command. If the HP-IB device does not respond to the serial poll within 1 second, then the Send Status message is retransmitted and an HP-IB SPD command is sourced.
Take Control 101 01100100	If the interface is using default addressing, then it accepts the HP-IL Take Control message only if the last talk address is greater than its own address. For general addressing, the interface accepts the HP-IL Take Control message only if the last talk address matches one in the address table. If it accepts the message, it converts the message to an HP-IB TCT command, sends it onto the bus, sets the NRFD and NDAC lines true, sets the ATN line false, and starts accepting command messages from the HP-IB side. If the interface doesn't accept the message, the message is retransmitted.
Identify Group	
Identify 110 XXXXXXXX Identify—Service Request 111 XXXXXXXX	If the interface is set to respond by a previous Parallel Poll Enable message and if the interface or an HP-IB device is requesting service, then the interface will modify the message according to the parallel poll conventions (refer to page XX). The service request control bit is always set by the interface if service is requested. No action taken on HP-IB.
Data/End Group	
Data Byte 000 XXXXXXXX Data Byte—Service Request 001 XXXXXXXX	If the interface is listener, then the interface accepts data as ASCII instructions; the data is not transferred to HP-IB. If the interface is not listener and there is no talker on HP-IB, then data bytes are transferred to HP-IB and retransmitted on HP-IL when the HP-IB handshake is complete. If there is a talker on HP-IB (the data byte came from the interface), it is checked for errors and the HP-IB handshake is completed. (The service request bit has no effect).
End Byte 010 XXXXXXXX End Byte—Service Request 011 XXXXXXXX	If the interface is listener, then the interface accepts the end byte as an ASCII instruction; the data is not transferred to HP-IB. If the interface is not a listener and there is no talker on HP-IB, then the interface transfers the data to HP-IB and sets the HP- IB EOI (End Or Identify) line true during the duration of the handshake and retransmits it on HP-IL. When there is a talker on HP-IB and the HP-IB EOI line goes true, the interface converts the HP-IB End Byte into an HP-IL End Byte message and sources it on HP-IL. (The service request bit has no effect.)

Section 3

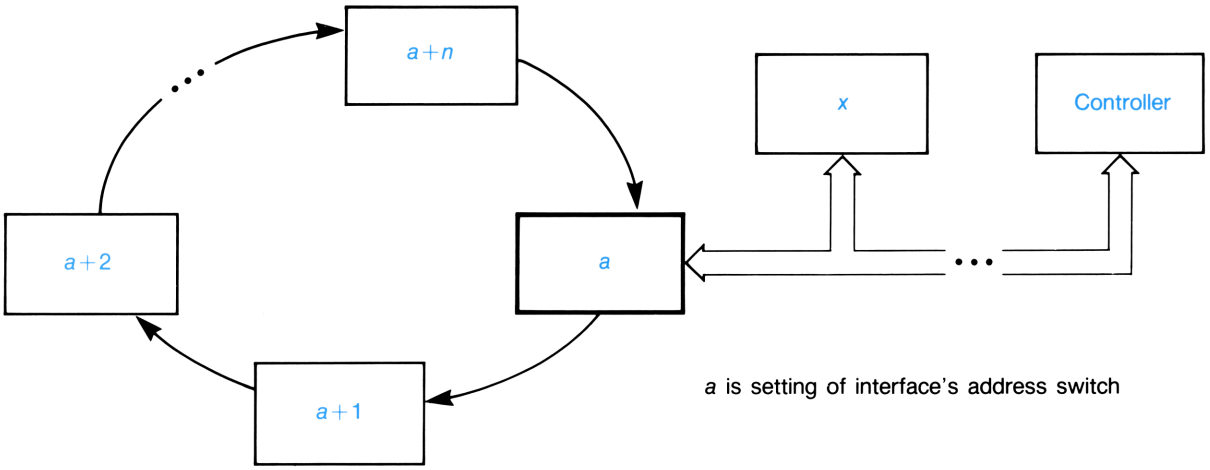
Translator Mode Operation With Control on HP-IB

This section describes the operation of the HP-IL/HP-IB interface in Translator mode in a system that has its controller on the HP-IB side.

System Startup and Addressing

If bit *m* of the mode/address switch is set to "0" at startup or keyboard reset, the interface is set to operate in Translator mode. If the interface receives the first command from the HP-IB side, it assigns auto addresses to HP-IL devices, sources a Not Remote Enable or Remote Enable message according to the state of the HP-IB REN line, and then transfers the command message to HP-IL.

The interface assigns auto addresses to the HP-IL devices starting at the first auto address after its own HP-IB address. (The interface's HP-IB address is set by the address switch on the rear panel.)



The HP-IB controller accesses HP-IB devices using their HP-IB addresses, which are set by their address switches. It accesses HP-IL devices using their HP-IL auto addresses. *You must be sure that none of the HP-IB device addresses are the same as any of the HP-IL auto addresses.* The HP-IB address of the interface is used to access the interface for sending instructions and retrieving status.

The interface assigns addresses to all devices in the loop whenever one of these conditions occurs:

- Following startup or keyboard reset, when the first HP-IB command is received.
- After transferring an HP-IB Interface Clear command to HP-IL.
- After control has been passed from HP-IL to HP-IB.
- After the loop has been disconnected for 100 milliseconds.

Listeners On HP-IL

If the HP-IB controller wishes to send data to an HP-IL device, it must first make that device a listener by sending the device's listen address.

The interface will transfer data from HP-IB to HP-IL byte by byte. If the HP-IB EOI line is true, then the interface will convert a Data Byte message to an End Byte message. However, it does not source HP-IL End Of Transmission messages at the end of HP-IB transmissions.

If there is no talker or listeners on HP-IL, then data bytes sourced on HP-IB are not transferred to HP-IL if the system controller is on the HP-IB side. If no bytes are transferred to HP-IL, the HP-IB transfer speed is greatly increased.

Talkers on HP-IL

Transferring Data

If the HP-IB controller needs an HP-IL device to send data to listeners on HP-IB or HP-IL, the controller first makes the device a talker by sending the device's talk address. The controller then directs the device to start sourcing data by setting the HP-IB ATN line false.

When the HP-IB ATN line goes false, the interface sources a Send Data message on HP-IL and transfers to HP-IB the data sourced by the HP-IL device. If the HP-IL device does not respond to the Send Data message, then the interface sets its "no response" status bit and sets the HP-IB SRQ line true.

During the HP-IL data transmission, if the HP-IL talker sources an End Of Transmission—Error (indicating an HP-IL error), then the interface terminates the transmission, sets its "transmission error" status bit, and sets the HP-IB SRQ line true.

An HP-IL End Of Transmission—OK message notifies the interface that the transmission is complete and there were no errors.

If the HP-IB controller raises the ATN line before an HP-IL End Of Transmission message is received by the interface ("asynchronous take control"), then an HP-IL Not Ready For Data sequence is initiated and completed on HP-IL before the pending HP-IB handshake is started. Depending upon when the ATN line is asserted, an HP-IL data byte may be lost on HP-IB, but HP-IL protocol will be maintained.

Transferring Device Information

The interface provides the capability for the HP-IB controller to obtain the accessory ID and device ID of HP-IL devices. This is made possible by having the interface source either a Send Accessory ID or Send Device ID message when the HP-IB ATN line goes false after an HP-IL device has been made a talker.

Normally, when the HP-IB ATN line goes false, the interface sends a Send Data message to the HP-IL talker. However, if the accessory ID option has been enabled, then the interface sends a Send Accessory ID message instead. Similarly, if the device ID option has been enabled, the interface sends a Send Device ID message. (These options are selected by the "E3" and "E4" instructions—refer to page 34.)

An HP-IL accessory ID usually consists of one data byte; a device ID is usually a sequence of eight ASCII-coded bytes followed by carriage return, line feed. Each is followed by an End Of Transmission message. (The interface's accessory ID is 67; its device ID is "HP82169A".)

Service Requests

The interface enables HP-IL devices to request service from the HP-IB controller and enables the controller to determine the status of HP-IL devices. In addition, the interface itself requests service and provides status information to the controller.

Setting Service Requests

The interface will initiate HP-IB service requests whenever an interface error condition occurs or whenever an HP-IL device is requesting service. To request service on HP-IB, the interface sets the HP-IB SRQ line true. The interface responds to an HP-IB parallel poll if it has been enabled to do so. The interface looks for service requests on HP-IL Data Byte and End Byte messages, and it periodically sends Identify messages around the loop for HP-IL devices to indicate whether they need service.

Serial Poll Response

HP-IB devices can send only one byte of status during a serial poll, whereas HP-IL devices can send several bytes of status. When the HP-IB controller conducts a serial poll of HP-IL devices, the interface obtains the status bytes from the HP-IL device being polled (using the Send Status message) and stores them in its eight "excess status byte" registers. The interface transfers to HP-IB the first status byte it received. (If the HP-IL device sends less than eight bytes of status, the remaining excess status registers aren't changed—if you need these registers cleared, use the "I" instruction prior to polling the device.) If the controller wishes the obtain all of the status bytes sourced by an HP-IL device, it must make the interface a listener, send the "SS" instruction, make the interface the talker, and set the ATN line false. (The "I" and "SS" instructions are described on pages 34 and 35.)

If the HP-IL device does not respond to the serial poll, then the interface sets its "no response" status bit and sets the HP-IB SRQ line true.

If the HP-IB controller serial polls the interface, the interface sends one byte of its internal status, then clears it status byte and stops requesting service (if no HP-IL devices are requesting service).

Parallel Poll Response

If the interface has been enabled to respond to an HP-IB parallel poll (using the PPC and PPE commands), then it responds to a parallel poll according to HP-IB protocol. The interface responds to an HP-IB parallel poll when the interface has set the SRQ line true. The interface's response doesn't indicate to the HP-IB controller whether an HP-IL device or the interface itself is requesting service—it merely indicates whether service is or isn't required.

The interface does not enable the HP-IB controller to parallel poll HP-IL devices using the HP-IB parallel poll. (The HP-IB controller can conduct an HP-IL parallel poll using the "C" instruction to send the needed HP-IL messages—refer to page 34).

Interface Status

The interface's HP-IB status byte indicates four error conditions. The interface sets one bit in its status byte for each error condition and also sets bit 6 to indicate that service has been requested.

HP-IB Status Byte—Translator Mode

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Service Request	No HP-IL Response	HP-IL Transmit Error	0	Address Table Overflow	Unrecognized ASCII Instruction	0
Value = 128	Value = 64	Value = 32	Value = 16	Value = 8	Value = 4	Value = 2	Value = 1

Bit 1 is set when an unrecognized ASCII instruction is received or when an inappropriate ASCII sequence is received while selecting interface options. Once an unrecognized ASCII instruction is received, no other instructions will be recognized until a "terminator" is received (either an ASCII semicolon or line feed).

Bit 2 is set when more than 15 HP-IB device addresses are entered into the interface's address table. This table is cleared only at startup, at keyboard reset, or when an "I" instruction (refer to page 34) is received.

Bit 4 is set whenever there is a transmit error on HP-IL. A transmit error occurs when a message sourced by the interface on HP-IL returns to the interface not as sent, or when an HP-IL talker sends an End Of Transmission—Error message.

Bit 5 is set whenever the interface sends an HP-IL Send Data, Send Accessory ID, Send Device ID, or Send Status message to an HP-IL talker and it comes back to the interface—that is, the talker didn't respond.

Bit 6 is set whenever bit 1, 2, 4, or 5 is set. It indicates that the interface is requesting service.

The interface clears its status byte and stops requesting service after the status byte has been read by a serial poll or after a keyboard reset.

Passing Control

If the first command received by the interface after startup or keyboard reset is from the HP-IB side, the interface assumes that the system controller is on the HP-IB side. When the system controller is on the HP-IB side, the interface will accept IFC (Interface Clear) and REN (Remote Enable) commands from the HP-IB side only.

Active control is passed from the HP-IB side to the HP-IL side by sending a suitable HP-IL device (a device that can accept active control) its talk address followed by the TCT (Take Control) command. When the HP-IB controller lets the ATN line go false (therby releasing control), the interface sources an HP-IL Take Control message. After the interface sources the Take Control message, command messages are accepted from the HP-IL side. If the Take Control message returns to the interface (the HP-IL device didn't accept active control), the interface resumes accepting commands from the HP-IB side.

Control can be passed back to HP-IB either by the HP-IL controller executing a take control sequence or by the HP-IB system controller setting the Interface Clear line true.

HP-IB Options and Instruction Set

The interface responds to a set of ASCII-coded instructions. The "D" and "E" instructions disable and enable several options that determine how the interface operates. Following startup, keyboard reset, or receipt of the "I" instruction, these options are disabled.

Interface options are selected by sending the interface's listen address followed by ASCII-coded bytes that are interpreted as interface instructions. All instruction strings must be followed by a terminator, which is either an ASCII semicolon or line feed.

Certain instructions direct the interface to send status information. These instructions are two-letter ASCII instructions starting with the letter "S". Once these instructions have been accepted by the interface, you should make the interface the talker and start the interface sourcing the information.

If the interface has not received an instruction directing it to send status, then the interface sends all its status information: the 15 address table registers (empty registers are represented with the value 31) and the enable status byte.

The following table lists the ASCII instructions that the interface recognizes.

ASCII Instruction Set

Instruction	Meaning
A1	Add HP-IB address 1 to address table.
⋮	⋮
A30	Add HP-IB address 30 to address table.
C0,0	Send HP-IL message 000 00000000 (Data Byte 0).
⋮	⋮
C7,255	Send HP-IL message 111 11111111 (Identify—Service Request 255).
D1	Disable LF→EOT option.*
D2	Disable DDL/DDT ↔ SAD option.
D3	Disable SAI on ATN false option.
D4	Disable SDI on ATN false option.
D5	Disable configured option.*
D6	Disable general addressing.*
D7	Disable HP-IB parallel poll option.*
E1	Enable LF→EOT option.*
E2	Enable DDL/DDT ↔ SAD option.
E3	Enable SAI on ATN false option.
E4	Enable SDI on ATN false option.
E5	Enable configured option.*
E6	Enable general addressing.*
E7	Enable HP-IB parallel poll option.*
I	Disable all options and clear address table, enable status register, and excess status registers.
SA	Send addresses from HP-IB address table.
SC	Send message returned.
SE	Send enable status byte.
SS	Send excess status bytes.

* Can be enabled from HP-IB, but has effect only when control is on HP-IL. Refer to section 2 for detailed information.

Several "A", "D", or "E" instructions may be combined by separating the appropriate numbers by commas and omitting all letters but the first. For example, the instruction string

A2,3,7,17,25,5;E4;C4,154;SC (CR)(LF)

does the following:

1. Puts 2, 3, 5, 7, 17, and 25 into HP-IB address table registers.
2. Enables HP-IL Send Accessory ID on ATN false option.
3. Sends an HP-IL Auto Address Unconfigure message (100 10011010) on the loop.
4. Directs the interface to send the message that returned from the loop to the HP-IB controller.

The "A" instruction enables you to load the interface's HP-IB address table registers, which are used during general addressing operation (HP-IL active control). A maximum of 15 HP-IB addresses (from 0 to 30) can be stored. The address table is cleared only at startup, keyboard reset, or by the "I" instruction. Each new address entry is checked for duplication and entered if it is not already in the table. This means that as devices are added to the HP-IB side, only the new addresses must be entered into the table.

The "C" instruction enables the HP-IB controller to source any message on HP-IL. The three HP-IL control bits are specified by the first parameter (for example, command group = 4, ready group = 5, Data Byte message = 0, Identify message = 6). The eight HP-IL data bits are specified by the second parameter (from 0 through 255). The message is sourced when the terminator following the instruction is received by the interface. The message that comes back to the interface on HP-IL is stored and available to the controller using the "SC" instruction.

The "D" instruction is used to reset (disable) specific interface options, which are described under the "E" instruction.

The "E" instruction is used to select (enable) specific interface options, which are described next.

The "E2" option causes the interface to convert HP-IB secondary addresses to HP-IL Device Dependent Listener and Device Dependent Talker messages, and vice versa. When this option is enabled, an HP-IB secondary address is converted to the corresponding HP-IL Device Dependent Talker message if the last addressed HP-IB command created an HP-IL talker; otherwise, the secondary address is converted to the corresponding Device Dependent Listener message. If this option is not enabled, HP-IB secondary addresses are transferred unchanged.

The "E3" option causes the interface to source a Send Accessory ID message instead of a Send Data message when the HP-IB ATN line goes false after an HP-IL device has received its talk address. This function allows an HP-IB controller to obtain the accessory ID of HP-IL devices. Options "E3" and "E4" are mutually exclusive.

The "E4" option causes the interface to source a Send Device ID message instead of a Send Data message when the HP-IB ATN line goes false after an HP-IL device has received its talk address. This function allows an HP-IB controller to obtain the device ID of HP-IL devices. Options "E3" and "E4" are mutually exclusive.

The "I" instruction directs the interface to initialize its enable status register, the 15 HP-IB address table registers, and the 8 excess status byte registers (refer to the "SS" instruction below). All options are disabled.

The "SA" instruction directs the interface to source the contents of the HP-IB address table registers. After the interface receives its talk address and the ATN line goes false, it sends the defined addresses encoded as ASCII numerals. For example, it might send

2 , 3 , 5 , 7 , 1 7 , 2 5 (CR)(LF)

The "SC" instruction directs the interface to source on HP-IB the message that returned to the interface after it performed the "C" instruction. After the interface receives its talk address and the ATN line goes false, it sends as series of ASCII-coded numerals that represent the decimal values of the control bits and the data bits. For example, if the interface receives a Talk Address 7 message (100 01000111), it would send

4 , 7 1 (CR)(LF)

The "SE" instruction informs the interface to source the contents of the enable status byte. The enable status byte describes the active interface options.

Enable Status Byte

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	E7	E6	E5	E4	E3	E2	E1
Value = 128	Value = 64	Value = 32	Value = 16	Value = 8	Value = 4	Value = 2	Value = 1

After the interface receives its talk address and the ATN line goes false, it sources ASCII numerals that represent the decimal value of the enable status byte. For example, if interface options E6, E5, and E1 are active, then the enable status byte has a decimal value of 49, and the interface returns the ASCII characters

4 9 (CR)(LF)

The "SS" instruction directs the interface to source the contents of the eight excess HP-IL status byte registers. After the interface receives its talk address and the ATN line goes false, it sources ASCII numerals that represent the decimal value of these bytes. For example, the interface might return

2 1 3 , 4 4 , 0 , 0 , 0 , 0 , 0 , 0 (CR)(LF)

Response to HP-IB Messages

The table below describes the interface's response to each HP-IB message. Following each command name is the eight-bit pattern that defines the command. (An X indicates that the bit may be "0" or "1".)

Almost every HP-IB command is transferred to HP-IL as the HP-IL command message with the same bit pattern. The exceptions are the SPD and SPE commands and the SAD command (if the DDL/DDT ↔ SAD option has been enabled by the "E2" instruction). (The SPE command conflicts with the HP-IL Enable Asynchronous Requests message.)

HP-IB Message	Interface Response
Command Group	
Device Clear (DCL) 00010100	No interface response. Transferred to HP-IL.
Group Execute Trigger (GET) 00001000	No interface response. Transferred to HP-IL.
Go To Local (GTL) 00000001	No interface response. Transferred to HP-IL.
Interface Clear (IFC) IFC line true	Interface talker or listener status removed. The interface sources HP-IL Interface Clear messages at regular intervals until one comes back intact. (This ensures loop integrity). The interface then sources one Ready For Command message to prepare the loop and then assigns auto addresses. After an HP-IB IFC command has been received, the interface delays its response to any other HP-IB messages until the loop is ready.
Listen Address 0–30 (LAD) 001XXXXX	Transferred to HP-IL. If the address is the interface's address, then the interface is removed from talker status and becomes a listener. (If the interface is a listener, it transfers no data to HP-IL.)
Local Lockout (LLO) 00010001	No interface response. Transferred to HP-IL.
Not Remote Enable (NRE) REN line false	No interface status change. The HP-IB REN line is checked at startup and at keyboard reset if the first command is from HP-IB. If the line is false, then an HP- IL Not Remote Enable message is sourced during the HP-IL startup sequence (before the first HP-IB command is transferred). If the HP-IB REN line goes false during interface operation, an HP-IL Not Remote Enable message is sourced before the next HP-IB command is transferred (if system control is on HP-IB).

HP-IB Message	Interface Response
Command Group (Continued)	
Null (NUL) 00000000	No interface response. Transferred to HP-IL.
Parallel Poll Configure (PPC) 00000101	If listener, enables interface to interpret next command (if it is a secondary command) as parallel poll enable or disable. If the next command is not a secondary command, the interface is automatically parallel poll disabled. This command is transferred to HP-IL.
Parallel Poll Disable (PPD) 0111XXXX (secondary command)	If parallel poll configured, disables interface response to HP-IB parallel poll. This command is transferred to HP-IL unless option is selected by "E2" instruction.
Parallel Poll Enable 0–15 (PPE) 0110XXXX (secondary command)	If parallel poll configured, enables interface response to HP-IB parallel poll according to parallel poll conventions. The interface always responds in the positive sense. This command is transferred to HP-IL unless option is selected by "E2" instruction.
Parallel Poll Unconfigure (PPU) 00010101	Disables interface response to HP-IB parallel poll. Transferred to HP-IL.
Remote Enable (REN) REN line true	No interface status change. The HP-IB REN line is checked at startup and at keyboard reset if the first command is from HP-IB. If the line is true, an HP-IL Remote Enable message is sourced in the HP-IL startup sequence (before the first HP-IB command is transferred). Thereafter, before any HP-IB listen address command is transferred, the REN line is checked; if it is true and system control is on the HP-IB side, an HP-IL Remote Enable message is sourced before the listen address command.
Secondary Address 0–31 (SAD) 011XXXXX	No interface status change. Transferred to HP-IL unless option is selected by "E2" instruction.
Selected Device Clear (SDC) 00000100	No interface response. Transferred to HP-IL.
Take Control (TCT) 00001001	If an HP-IL device is talker, then the interface converts the HP-IB TCT command to an HP-IL Take Control ready message when the HP-IB ATN line goes false. After the HP-IL Take Control message has been sourced, the interface stops accepting commands from the HP-IB side (except for the IFC command, if system control is on HP-IB).
Talk Address 0–30 (TAD) 010XXXXX	Transferred to HP-IL. If the address is the interface's address, then the interface is removed from listener status and becomes a talker. (If the interface is talker, it sends all data to HP-IB, not to HP-IL.) If the address doesn't match the interface's address, the interface is removed from talker status.
Unlisten (UNL) 00111111	The interface is removed from listener status and the UNL command is transferred to HP-IL.
Untalk (UNT) 01011111	The interface is removed from talker status and the UNT command is transferred to HP-IL.
Data Group	
Data Byte (DAB) ATN line false EOI line false	If the interface is listener, then the interface accepts data as ASCII instructions; data is not transferred to HP-IL. If the interface is not listener, if there is no HP-IL talker or listeners, and if system control is on HP-IB, then no data is transferred to HP-IL, increasing HP-IB transfer speed. If there are listeners on HP-IL, then data from HP-IB is circulated around the loop. The HP-IB handshake is completed after the data byte returns to the interface on HP-IL. If the talker is on HP-IL, then the data is sent to HP-IB (and the HP-IB handshake completed) before the interface retransmits it on HP-IL.
End Byte (END) ATN line false EOI line true	If the interface is listener, then it accepts the end byte as part of an ASCII instruction. If the interface is transferring data bytes to HP-IL, an end byte is ransferred as an HP-IL End Byte message. When the talker is on HP-IL, an HP-IL End Byte message causes the HP-IB EOI line to be set true for the duration of the handshake.

Section 4

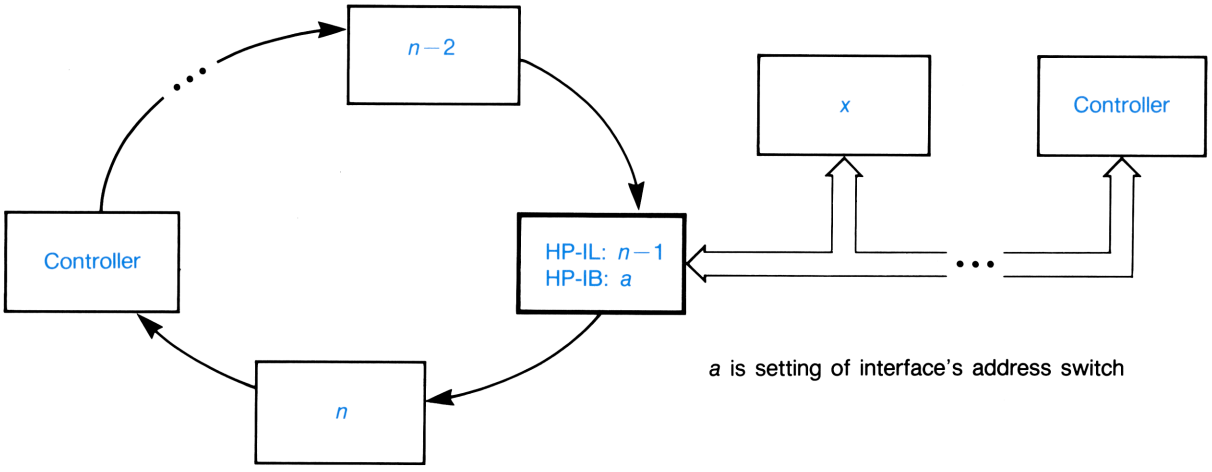
Mailbox Mode Operation

This section describes the operation of the HP-IL/HP-IB interface in Mailbox mode. In this mode the interface isolates the HP-IL and HP-IB systems. Mailbox mode enables the transfer of data between the HP-IL and HP-IB systems, with each system controlled by an active controller. The interface uses two 110-byte buffers, providing bidirectional, full-duplex transfer between the two systems. The "first-in, first-out" buffers are used by making the interface a listener and transferring data to one buffer (retrieved by the other system), and by making the interface a talker and retrieving data from the other buffer (which is loaded by the other system).

System Startup and Addressing

If bit *m* of the mode/address switch is set to "1" at startup or keyboard reset, the interface is set to Mailbox mode.

When the interface is in Mailbox mode, it responds like an ordinary device on each system. The interface takes (and responds to) one HP-IL auto address and one HP-IB device address. The HP-IB address is set by the mode/address switch. The HP-IL address is 15 until the HP-IL controller assigns an auto address. There is no restriction against having the same address in both systems.



HP-IL Operation

After the HP-IL controller assigns the interface an auto address, the controller can direct the flow of data to and from the interface, enabling it to exchange data with the HP-IB system.

Sending Data to the Interface

To fill the HP-IL → HP-IB buffer, the controller must make the interface a listener and send data. Upon receipt of the first byte of HP-IL data, the interface sets the HP-IB SRQ line true and sets its HP-IB status byte to the data available condition.

When the HP-IL → HP-IB buffer becomes full, the interface will not retransmit the data byte that filled

the buffer, suspending HP-IL operation. When the HP-IB side reads some data (making room in the HP-IL → HP-IB buffer), the interface will retransmit the data byte, thereby allowing the HP-IL talker to source another message.

If the HP-IL → HP-IB buffer is full and operation is suspended, the controller can clear the loop by sourcing an Interface Clear message. If it then attempts to put another byte into the buffer, it replaces the byte in the last buffer location and suspends loop operation once again.

To prevent the interface from suspending operation, you can enable it to source a Not Ready For Data message when its buffer is one byte from full. This allows the controller to stop the flow of data. If another byte is sent to the interface after the Not Ready For Data message is sent, then the interface will store it in the last buffer location and suspend loop operation.

To enable the interface to source Not Ready For Data messages, the HP-IL controller must make the interface listener and send the Enable Device NRD message. Any other HP-IL command message sent after this message disables this condition.

The HP-IL → HP-IB buffer is cleared at startup, keyboard reset, or receipt of an HP-IL Device Clear (or Selected Device Clear) message.

Retrieving Data From the Interface

The HP-IL controller retrieves data from the interface's HP-IL ← HP-IB buffer by making the interface the talker and sending it an HP-IL Send Data message. The interface will send data until the HP-IL ← HP-IB buffer is empty, then it sources an End Of Transmission—OK message. If the interface is directed to send data and the buffer is empty, the interface sends an End Of Transmission—OK message.

When the interface's HP-IL ← HP-IB buffer is empty and it receives data from HP-IB, the interface requests service on HP-IL and sets its HP-IL status byte to the data available condition.

HP-IL Status Byte—Mailbox Mode

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Service Request	0	0	0	0	0	Data Available for HP-IL
Value = 128	Value = 64	Value = 32	Value = 16	Value = 8	Value = 4	Value = 2	Value = 1

The interface can also send to the HP-IL controller the interface's accessory ID and device ID.

Response to HP-IL Messages

The table below describes the interfaces's response to each HP-IL message. The interface does not repond to any messages not listed.

HP-IL Message	Interface Response
Command Group	
Auto Address Unconfigure 100 10011010	Interface address is set to 15. The interface is now ready to receive an auto address.
Device Clear 100 00010100	HP-IL → HP-IB buffer is cleared.
Interface Clear 100 10010000	Interface talker or listener status removed.
Listen Address 0–31 100 001XXXXX	If the message address is the interface's address, then the interface is removed from talker status and becomes a listener. If the message address is 31, interface is removed from listener status.

HP-IB Message	Interface Response
Command Group (Continued)	
Parallel Poll Disable 100 00000101	If listener, disables interface response to HP-IL parallel poll.
Parallel Poll Enable 0–15 100 1000XXXX	If listener, enables interface response to HP-IL parallel poll according to parallel poll conventions. (Refer to page 21.)
Parallel Poll Unconfigure 100 00010101	Disables interface response to HP-IL parallel poll.
Selected Device Clear 100 00000100	If listener, HP-IL → HP-IB buffer is cleared.
Talk Address 0–31 100 010XXXXX	If the message address is the interface's address, then the interface is removed from listener status and becomes a talker. If the message address doesn't match interface's address, the interface is removed from talker status.
Unlisten 100 00111111	The interface is removed from listener status.
Untalk 100 01011111	The interface is removed from talker status.
Ready Group	
Auto Address 0–31 101 100XXXXX	If the message address is less than 31 and the interface doesn't have an earlier assigned address, then the interface's HP-IL address is set to the message address, and the message address is incremented by one and transmitted. If the interface has a previously assigned address, no response. If the message address is 31, no response.
Not Ready For Data 101 01000010	If the interface is talker, then the previous data byte sourced by the interface becomes the last byte. After the last byte returns to the interface, it sources an End Of Transmission message.
Ready For Command 101 00000000	Retransmitted by the interface after it has accepted the last command sent.
Send Accessory ID 101 01100011	If the interface is talker, then it sends one byte with the value of 67 decimal and an End Of Transmission message.
Send Data 101 01100000	If the interface is talker, then it starts sending the contents of the HP-IL ← HP-IB buffer. If the buffer is empty, the interface sends an End Of Transmission—OK message.
Send Device ID 101 01100010	If the interface is talker, then it sends the eight ASCII-coded bytes "HP82169A" followed by carriage return, line feed, and an End Of Transmission message.
Send Status 101 01100001	If the interface is talker, then it sends one byte of status information followed by an End Of Transmission message and clears its HP-IL status byte.
Identify Group	
Identify 110 XXXXXXXX Identify—Service Request 111 XXXXXXXX	If the interface is set to respond by a Parallel Poll Enable message and the interface is requesting service, then the interface will modify the message according to the parallel poll setup. The service request control bit is always set by the interface if service is requested. (Refer to page 21.)
Data/End Group	
Data Byte 000 XXXXXXXX Data Byte—Service Request 001 XXXXXXXX	If the interface is listener, then it loads the data into its HP-IL → HP-IB buffer. If the buffer is one byte from full and the interface is enabled to do so, the interface will source a Not Ready For Data message. If the buffer is full, the interface waits until there is room for the byte. If service is required by the interface, the message is modified to Data Byte—Service Request message. (The service request bit has no effect on the interface.)
End Byte 010 XXXXXXXX End Byte—Service Request 011 XXXXXXXX	If the interface is listener, then it loads the data into its HP-IL → HP-IB buffer. If the buffer is one byte from full and the interface is enabled to do so, the interface will source a Not Ready For Data message. If the buffer is full, the interface waits until there is room for the byte. If service is required by the interface, the message is modified to End Byte—Service Request message. (The service request bit has no effect on the interface.)

HP-IB Operation

The HP-IB controller can direct the flow of data to and from the interface, enabling it to exchange data with the HP-IL system.

Sending Data to the Interface

To fill the HP-IL ← HP-IB buffer, the controller must make the interface a listener and send data. Upon receipt of the first byte of HP-IB data, the interface indicates a service request on HP-IL and sets its HP-IL status byte to the data available condition.

When the HP-IL ← HP-IB buffer becomes full, the interface will not finish the HP-IB handshake on the data byte that filled the buffer, suspending HP-IB operation. When the HP-IL side reads data (making room in the HP-IL ← HP-IB buffer), the interface will finish the current handshake and resume receiving HP-IB data.

If the HP-IL ← HP-IB buffer is full and HP-IB operation suspended, the controller can clear the bus by setting the IFC line true. If it then attempts to put another byte into the buffer, the interface suspends HP-IB operation again.

The HP-IL ← HP-IB buffer is cleared at startup, keyboard reset, or receipt of an HP-IB Device Clear (or Selected Device Clear) message.

Retrieving Data From the Interface

The HP-IB controller retrieves data from the interface's HP-IL → HP-IB buffer by making the interface a talker and setting the HP-IB ATN line false. The interface will send data until the HP-IL → HP-IB buffer is empty, then it stops sourcing data (leaves the DAV line false). On the last byte of data in the buffer the interface sets the HP-IB EOI line true.

If the interface is directed to send data and the buffer is empty, the interface suspends HP-IB operation until it receives some HP-IL data to send or until the IFC line goes true.

When the interface's HP-IL → HP-IB buffer is empty and it receives data from HP-IL, the interface sets the SRQ line true and sets its HP-IB status byte to the data available condition.

HP-IB Status Byte—Mailbox Mode

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Service Request	0	0	0	0	0	Data Available for HP-IB
Value = 128	Value = 64	Value = 32	Value = 16	Value = 8	Value = 4	Value = 2	Value = 1

Response to HP-IB Messages

The table below describes the interface's response to each HP-IB message. The interface does not repond to any messages not listed.

HP-IB Message	Interface Response
Command Group	
Device Clear (DCL) 00010100	HP-IL ← HP-IB buffer is cleared.
Interface Clear IFC) IFC line true	Interface talker or listener status removed.
Listen Address 0–30 (LAD) 001XXXXX	If the message address is the interface's address, then the interface is removed from talker status and becomes a listener.
Parallel Poll Configure (PPC) 00000101	If listener, enables interface to interpret next command (if it is a secondary command) as parallel poll enable or disable. If the next command is not a secondary command, the interface is automatically parallel poll disabled.
Parallel Poll Disable (PPD) 0111XXXX(secondary command)	If parallel poll configured, disables interface response to HP-IB parallel poll.
Parallel Poll Enable 0–15 (PPE) 0110XXXX(secondary command)	If parallel poll configured, enables interface response to HP-IB parallel poll according to parallel poll conventions (the interface always uses the "positive" sense).
Parallel Poll Unconfigure (PPU) 00010101	Disables interface response to HP-IB parallel poll.
Selected Device Clear (SDC) 00000100	If listener, HP-IL ← HP-IB buffer is cleared.
Talk Address 0–30 (TAD) 010XXXXX	If the message address is the interface's address, then the interface is removed from listener status and becomes a talker. If the address doesn't match, the interface is removed from talker status.
Unlisten (UNL) 00111111	The interface is removed from listener status.
Untalk (UNT) 01011111	The interface is removed from talker status.
Data Group	
Data Byte (DAB) ATN line false EOI line false	If the interface is listener, then it loads the data into its HP-IL ← HP-IB buffer. If the buffer is full, the interface will suspend HP-IB operation. (The SRQ line has no effect.)
End Byte (END) ATN line false EOI line true	If the interface is listener, then it loads the data into its HP-IL ← HP-IB buffer. If the buffer is full, the interface will suspend HP-IB operation. (The SRQ line has no effect.)

Appendix A

Care, Warranty, and Service Information

Care of the Interface

The HP 82169A HP-IL/HP-IB Interface contains sensitive electronic components that may be damaged by improper handling and use. Observe the following precautions to minimize the possibility of damage:

- Take precautions against damage to the interface's circuitry from electrostatic discharge.
- Observe these temperature limits:

Operating: 0° to 55°C (32° to 131°F)

Storage: −40° to 75°C (−40° to 167°F)

- Use only cables designed for use on HP-IB and HP-IL.

Verifying Proper Operation

If at any time you suspect that your interface is not operating properly, you can verify its operation using the following test. This test checks continuity of the interface loop and the operation of most of the interface's circuitry.

1. Connect only the interface and the HP-IL controller in the interface loop and nothing to HP-IB.
2. Press the RESET key on the interface, then use the controller to assign an auto address to the interface.
3. Using the controller, make the interface a listener and send it configuration data such as A1,2,3,4;SA (CR)(LF), or A1,2,3,4 (CR)(LF) and SA (CR)(LF). This loads the interface's internal HP-IB address table registers with 1, 2, 3, and 4 and instructs the interface to send the contents of these registers.

    - If the HP-IL messages (including Data Bytes) are passed around the loop and back to the controller, the interface and HP-IL cables have proper continuity.
    - If HP-IL messages do not return to the controller, try different cables or a different HP-IL peripheral. If HP-IL continuity is a problem only for the interface, then the interface requires service.

4. Using the controller, make the interface a talker and instruct it to send data (the HP-IB address table registers).

    - If the retrieved data bytes match the original addresses (1, 2, 3, 4), then the HP-IL and microprocessor circuitry in the interface is good.
    - If the retrieved data bytes don't match the original addresses, the interface requires service.

5. Repeat steps 1 through 4 with the controller on HP-IB and using HP-IB instead of HP-IL. This tests the HP-IB portion of the interface.

If a logic analyzer is available, you can check the interface's operation using the built-in diagnostic test. If the mode/address switch is set to "011111" at startup or keyboard reset, the interface changes to a test condition. You can check for these conditions:

- The T/R light turns on at half intensity.
- The HP-IB SRQ line is set to "0".
- All other HP-IB lines toggle between "0" and "1" at about 5 kHz.
- Data Byte 85 messages are sourced on HP-IL continuously.

Limited One-Year Warranty

What We Will Do

The HP 82169A HP-IL/HP-IB Interface is warranted by Hewlett-Packard against defects in materials and workmanship for one year from the date of original purchase. If you sell your unit or give it as a gift, the warranty is automatically transferred to the new owner and remains in effect for the original one-year period. During the warranty period, we will repair or, at our option, replace at no charge a unit that proves to be defective, provided you return the unit, shipping prepaid, to a Hewlett-Packard service center.

What Is Not Covered

This warranty does not apply if the product has been damaged by accident or misuse or as the result of service or modification by other that an authorized Hewlett-Packard service center.

No other express warranty is given. The repair or replacement of a product is your exclusive remedy. **ANY OTHER IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS IS LIMITED TO THE SPECIFIED DURATION OF THIS WRITTEN WARRANTY.** Some states, provinces, or countries do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you. **IN NO EVENT SHALL HEWLETT-PACKARD COMPANY BE LIABLE FOR CONSEQUENTIAL DAMAGES.** Some states, provinces, or countries do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state, province to province, or country to country.

Warranty for Consumer Transactions in the United Kingdom

This warranty shall not apply to consumer transactions and shall not affect the statutory rights of a consumer. In relation to such transactions, the rights and obligations of Seller and Buyer shall be determined by statute.

Obligation to Make Changes

Products are sold on the basis of specifications applicable at the time of manufacture. Hewlett-Packard shall have no obligation to modify or update products once sold.

Warranty Information

If you have any questions concerning this warranty, please contact an authorized Hewlett-Packard dealer or a Hewlett-Packard sales and service office. Should you be unable to contact them, please contact:

- In the United States:

Hewlett-Packard
1000 N.E. Circle Blvd.
Corvallis, OR 97330
Telephone: (503) 758-1010
Toll-Free Number: (800) 547-3400 (except in Oregon, Hawaii, and Alaska)

- In Europe:

Hewlett-Packard S.A.
7, rue du Bois-du-Lan
P.O. Box
CH-1217 Meyrin 2
Geneva
Switzerland
Telephone: (022) 83 81 11

Note: Do *not* send units to this address for repair.

- In other countries:

Hewlett-Packard Intercontinental
3495 Deer Creek Rd.
Palo Alto, California 94304
U.S.A.
Telephone: (415) 857-1501

Note: Do *not* send units to this address for repair.

Service

Hewlett-Packard maintains service centers in most major countries throughout the world. You may have your unit repaired at a Hewlett-Packard service center any time it needs service, whether the unit is under warranty or not. There is a charge for repairs after the one-year warranty period.

Hewlett-Packard products are normally repaired and reshipped within five (5) working days of receipt at any service center. This is an average time and could possibly vary depending upon the time of year and work load at the service center. The total time you are without your unit will depend largely on the shipping time.

Obtaining Repair Service in the United States

The Hewlett-Packard United States Service Center for the HP 82169A HP-IL/HP-IB Interface is located in Corvallis, Oregon:

Hewlett-Packard Company
Corvallis Division Service Department
P.O. Box 999
Corvallis, Oregon 97339, U.S.A.
or
1030 N.E. Circle Blvd.
Corvallis, Oregon 97330, U.S.A.
Telephone: (503) 757-2000

Obtaining Repair Service in Europe

Service centers are maintained at the following locations. For countries not listed, contact the dealer where you purchased your unit.

AUSTRIA
HEWLETT-PACKARD Ges.m.b.H.
Kleinrechner-Service
Wagramerstrasse-Lieblgasse 1
A-1220 Wien (Vienna)
Telephone: (0222) 23 65 11

BELGIUM
HEWLETT-PACKARD BELGIUM SA/NV
Woluwedal 100
B-1200 Brussels
Telephone: (02) 762 32 00

DENMARK
HEWLETT-PACKARD A/S
Datavej 52
DK-3460 Birkerod (Copenhagen)
Telephone: (02) 81 66 40

EASTERN EUROPE
Refer to the address listed under Austria

FINLAND
HEWLETT-PACKARD OY
Revontulentie 7
SF-02100 Espoo 10 (Helsinki)
Telephone: (90) 455 02 11

FRANCE
HEWLETT-PACKARD FRANCE
Division Informatique Personnelle
S.A.V. Calculateurs de Poche
F-91947 Les Ulis Cedex
Telephone: (6) 907 78 25

GERMANY
HEWLETT-PACKARD GmbH
Kleinrechner-Service
Vertriebszentrale
Berner Strasse 117
Postfach 560 140
D-6000 Frankfurt 56
Telephone: (611) 50041

ITALY
HEWLETT-PACKARD ITALIANA S.P.A.
Casella postale 3645 (Milano)
Via G. Di Vittorio, 9
I-20063 Cernusco Sul Naviglio (Milan)
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International Service Information

Not all Hewlett-Packard service centers offer service for all models of HP products. However, if you bought your product from an authorized Hewlett-Packard dealer, you can be sure that service is available in the country where you bought it.

If you happen to be outside of the country where you bought your unit, you can contact the local Hewlett-Packard service center to see if service is available for it. If service is unavailable, please ship the unit to the address listed above under "Obtaining Repair Service in the United States." A list of service centers for other countries can be obtained by writing to that address.

All shipping, reimportation arrangements, and customs costs are your responsibility.

Service Repair Charge

There is a standard repair charge for out-of-warranty repairs. The repair charges include all labor and materials. In the United States, the full charge is subject to the customer's local sales tax. In European countries, the full charge is subject to Value Added Tax (VAT) and similar taxes wherever applicable. All such taxes will appear as separate items on invoiced amounts.

Products damaged by accident or misuse are not covered by the fixed repair charges. In these situations, repair charges will be individually determined based on time and material.

Service Warranty

Any out-of-warranty repairs are warranted against defects in materials and workmanship for a period of 90 days from date of service.

Shipping Instructions

Should your unit require service, return it with the following items:

- A completed Service Card, including a description of the problem and system setup when the problem occurred.
- A sales receipt or other documentary proof of purchase date if the one-year warranty has not expired.

The product, the Service Card, a brief description of the problem and system configuration, and (if required) the proof of purchase date should be packaged in the original shipping case or other adequate protective packaging to prevent in-transit damage. Such damage is not covered by the original warranty; Hewlett-Packard suggests that you insure the shipment to the service center. The packaged unit should be shipped to the nearest Hewlett-Packard designated collection point or service center. Contact your dealer directly for assistance. (If you are not in the country where you originally purchased the unit, refer to "International Service Information" above.)

Whether the unit is under warranty or not, it is your responsibility to pay shipping charges for delivery to the Hewlett-Packard service center.

After warranty repairs are completed, the service center returns the unit with postage prepaid. On out-of-warranty repairs in the United States and some other countries, the unit is returned C.O.D. (covering shipping costs and the service charge).

Further Information

Service contracts are not available. Circuitry and designs are proprietary to Hewlett-Packard, and service manuals are not available to customers.

Should other problems or questions arise regarding repairs, please call your nearest Hewlett-Packard service center.

Potential for Radio/Television Interference (for U.S.A. Only)

The HP 82169A HP-IL/HP-IB Interface generates and uses radio frequency energy and, if not installed and used properly (that is, in strict accordance with the instructions in this manual), may cause interference to radio and television reception. It has been tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If the interface does cause interference to radio or television reception, which can be determined by unplugging the interface, you are encouraged to try to correct the interference by one or more of the following measures:

- Reorient the receiving antenna.
- Relocate the interface with respect to the receiver.
- Move the interface away from the receiver.
- Plug the interface's power supply into a different outlet so that the power supply and the receiver are on different branch circuits.

If necessary, you should consult your sales representative or an experienced radio/television technician for additional suggestions. You may find the following booklet, prepared by the Federal Communications Commission, helpful: *How to Identify and Resolve Radio-TV Interference Problems*. This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock Number 004-000-00345-4.

Dealer and Product Information

For dealer locations, product information, and prices, please call (800) 547-3400. In Oregon, Alaska, and Hawaii, call (503) 758-1010.

Appendix B

ASCII Character Set

ASCII Char.	Character Code			
	Binary	Oct	Hex	Dec
NUL	00000000	000	00	0
SOH	00000001	001	01	1
STX	00000010	002	02	2
ETX	00000011	003	03	3
EOT	00000100	004	04	4
ENQ	00000101	005	05	5
ACK	00000110	006	06	6
BEL	00000111	007	07	7
BS	00001000	010	08	8
HT	00001001	011	09	9
LF	00001010	012	0A	10
VT	00001011	013	0B	11
FF	00001100	014	0C	12
CR	00001101	015	0D	13
SO	00001110	016	0E	14
SI	00001111	017	0F	15
DLE	00010000	020	10	16
DC1	00010001	021	11	17
DC2	00010010	022	12	18
DC3	00010011	023	13	19
DC4	00010100	024	14	20
NAK	00010101	025	15	21
SYN	00010110	026	16	22
ETB	00010111	027	17	23
CAN	00011000	030	18	24
EM	00011001	031	19	25
SUB	00011010	032	1A	26
ESC	00011011	033	1B	27
FS	00011100	034	1C	28
GS	00011101	035	1D	29
RS	00011110	036	1E	30
US	00011111	037	1F	31

ASCII Char.	Character Code			
	Binary	Oct	Hex	Dec
space	00100000	040	20	32
!	00100001	041	21	33
"	00100010	042	22	34
#	00100011	043	23	35
$	00100100	044	24	36
%	00100101	045	25	37
&	00100110	046	26	38
'	00100111	047	27	39
(	00101000	050	28	40
)	00101001	051	29	41
*	00101010	052	2A	42
+	00101011	053	2B	43
,	00101100	054	2C	44
–	00101101	055	2D	45
.	00101110	056	2E	46
/	00101111	057	2F	47
0	00110000	060	30	48
1	00110001	061	31	49
2	00110010	062	32	50
3	00110011	063	33	51
4	00110100	064	34	52
5	00110101	065	35	53
6	00110110	066	36	54
7	00110111	067	37	55
8	00111000	070	38	56
9	00111001	071	39	57
:	00111010	072	3A	58
;	00111011	073	3B	59
<	00111100	074	3C	60
=	00111101	075	3D	61
>	00111110	076	3E	62
?	00111111	077	3F	63

ASCII Char.	Character Code			
	Binary	Oct	Hex	Dec
@	01000000	100	40	64
A	01000001	101	41	65
B	01000010	102	42	66
C	01000011	103	43	67
D	01000100	104	44	68
E	01000101	105	45	69
F	01000110	106	46	70
G	01000111	107	47	71
H	01001000	110	48	72
I	01001001	111	49	73
J	01001010	112	4A	74
K	01001011	113	4B	75
L	01001100	114	4C	76
M	01001101	115	4D	77
N	01001110	116	4E	78
O	01001111	117	4F	79
P	01010000	120	50	80
Q	01010001	121	51	81
R	01010010	122	52	82
S	01010011	123	53	83
T	01010100	124	54	84
U	01010101	125	55	85
V	01010110	126	56	86
W	01010111	127	57	87
X	01011000	130	58	88
Y	01011001	131	59	89
Z	01011010	132	5A	90
[	01011011	133	5B	91
\	01011100	134	3C	92
]	01011101	135	5D	93
^	01011110	136	5E	94
_	01011111	137	5F	95

ASCII Char.	Character Code			
	Binary	Oct	Hex	Dec
`	01100000	140	60	96
a	01100001	141	61	97
b	01100010	142	62	98
c	01100011	143	63	99
d	01100100	144	64	100
e	01100101	145	65	101
f	01100110	146	66	102
g	01100111	147	67	103
h	01101000	150	68	104
i	01101001	151	69	105
j	01101010	152	6A	106
k	01101011	153	6B	107
l	01101100	154	6C	108
m	01101101	155	6D	109
n	01101110	156	6E	110
o	01101111	157	6F	111
p	01110000	160	70	112
q	01110001	161	71	113
r	01110010	162	72	114
s	01110011	163	73	115
t	01110100	164	74	116
u	01110101	165	75	117
v	01110110	166	76	118
w	01110111	167	77	119
x	01111000	170	78	120
y	01111001	171	79	121
z	01111010	172	7A	122
{	01111011	173	7B	123
|	01111100	174	7C	124
}	01111101	175	7D	125
~	01111110	176	7E	126
DEL	01111111	177	7F	127

Appendix C

Using the HP-41 As a Controller

The HP-41 Handheld Computer, when used with an HP 82160A HP-IL Module, can control the HP 82169A HP-IL/HP-IB Interface and attached HP-IB devices. This system can access most of the commonly used capabilities of the interface and of HP-IB devices. This appendix describes how the HP-41 can work with the HP-IL/HP-IB system using this configuration. (The HP 82183A Extended I/O Module provides functions that give full capability for controlling the interface and HP-IB devices. However, this extended configuration is not covered in this appendix.)

The HP-41 is *always* the controller in the HP-IL system. This means that in Translator mode, the interface can't have an active HP-IB controller connected. In Mailbox mode, the HP-41 is the controller on the HP-IL side; the HP-IB side must have a controller, also.

For operation in Translator mode, the interface must use default addressing and be the last device in the loop—the HP-41 uses only sequential HP-IL addresses such as those provided by default addressing. HP-IB devices must have their address switches set to addresses higher than the interface's HP-IL address—these devices are accessed by the HP-41 using their HP-IB addresses. The HP-41 can select the interface as the primary device when ASCII instructions are to be sent to it or when interface information is to be retrieved. The HP-41 should select an HP-IB device as the primary device when data or commands are to be sent to it or data retrieved from it.

For operation in Mailbox mode, the interface has only one HP-IL address. The HP-41 must select the interface as the primary device whenever it sends data to the HP-IB side or retrieves data from that side. The HP-41 has no control over what happens to the data it sends to the HP-IB side, nor can the HP-41 control what data it receives from the HP-IB side. (HP-IL command messages aren't sent to the HP-IB side, so the HP-41 can't specify HP-IB listeners or talkers.)

The following table lists functions provided by the HP 82160A HP-IL Module that may be used to operate the HP-IL/HP-IB interface and HP-IB devices. For operation in Translator mode, "primary device" refers to either the interface or an HP-IB device, according to the address specified for the most recent [SELECT] operation. For operation in Mailbox mode, "primary device" refers to the interface. Refer to the owner's manual for the HP-IL module for additional information about HP-IL functions.

Function	Response
HP-41 → Primary Device	
[ACA]*	Sends the ASCII codes of the characters in the ALPHA register to the primary device. No end-of-line indicator is sent.
[ACCHR]*	Sends the ASCII code specified in the X-register to the primary device. This enables the HP-41 to send characters that aren't among its standard character set, such as semicolon (code 59). No end-of-line indicator is sent. (Characters 10, 13, and 126 can't be sent with this function.)
[ACX]*	Sends the ASCII codes of the digits in the X-register (using the current display format) to the primary device. No end-of-line indicator is sent.
[ADV]*	Sends (CR)(LF) to the primary device.
[OUTA]	Sends the ASCII codes of the characters in the ALPHA register to the primary device, followed by (CR)(LF) (unless suppressed by flag 17 set).†

Function	Response
HP-41 → Primary Device (Continued)	
PRA *	Sends the ASCII codes of the characters in the ALPHA register to the primary device, followed by (CR)(LF) (unless suppressed by flag 17 set).
PRBUF *	Sends (CR)(LF) to the primary device.
PRP *	Sends ASCII characters of program listing to the primary device.
PRX *	Sends the ASCII codes of the digits in the X-register (using current display format) and the PRX format characters to the primary device, followed by (CR)(LF).
REMOTE	Enables the primary device to operate in Remote mode when it next is made a listener. (Refer to page 53.)
TRIGGER	Triggers primary device.†
HP-41 ← Primary Device	
INA	Retrieves the ASCII codes of up to 24 characters from the primary device. Transfer terminates after the 24th character, when (CR)(LF) is received (unless suppressed by flag 17 set), or when an End Of Transmission message is received. The characters are stored in the ALPHA register.
IND	Retrieves the ASCII codes of a sequence of digits from the primary device. Transfer terminates when (CR)(LF) is received or when an End Of Transmission message is received. The characters are interpreted as a number, which is placed in the X-register.
INSTAT	Retrieves one number (byte) representing the primary device's current status. Places the number (modulo 64) in the X-register and sets flags 00 through 07 accordingly.
FINDID	Places in the X-register the address of the device whose device ID is specified in the ALPHA register.

* The HP-41 must be in Manual I/O mode (using MANIO).

† Under certain conditions, the intended devices may include all listeners (using LISTEN). (Refer to "Making a Device a Listener" in the owner's manual for the HP-IL module.)

The end-of-line indicator for the HP-41 is carriage return (CR) line feed (LF)—character codes 13 and 10. Flag 17 controls how the HP-41 uses end-of-line indicators. If flag 17 is clear, the HP-41 includes (CR)(LF) at the end of each sequence of Data Bytes it sends (as from OUTA) and interprets (CR)(LF) as an end-of-line indicator in data it receives (Data Byte messages with decimal values of 10 or 13 aren't interpreted as data). If flag 17 is set, the HP-41 doesn't send (CR)(LF) at the end of Data Byte sequences and interprets (CR) and (LF) as data in sequences it receives. However, note that several functions *always* include (CR)(LF) as an end-of-line indicator, regardless of the status of flag 17.

Any of the general printer functions in the HP-IL module may be used to send information to the interface or HP-IB devices. Each line of information as formatted by a printer function is always followed by an end-of-line indicator.

Example: This example illustrates how you might use the interface to control an HP-IB printer whose HP-IB address is 17. Be sure that *m* is set to "0" on the mode/address switch so that the interface operates in Translator mode. Assume that a program labeled TEST is stored in the HP-41.

Keystrokes	Display	
MANIO		Sets the HP-41 to Manual mode.
17	17_	HP-IB device address of HP-IB printer.
SELECT	17.0000	Selects HP-IB printer as primary device.
PRP	PRP _	
ALPHA TEST ALPHA	17.0000	Lists program TEST on HP-IB printer.

Example: The following program utilizes an HP-IB multimeter at HP-IB address 22, an HP 82162A Thermal Printer, and an HP 82161A Digital Cassette Drive. It creates a file on the cassette drive in which to store voltage data, then it stores the voltage readings and also prints them on the printer. Be sure that *m* is set to "0" on the mode/address switch so that the interface operates in Translator mode.

```
01♦LBL "VCREATE"      Program to create file VSTORE.
02 AUTOIO
03 1500               Defines file size for 1500 readings.
04 "VSTORE"           Places filename in ALPHA register.
05 CREATE             Creates file VSTORE.
06 RTN

07♦LBL "VOLT"         Program to store readings in file VSTORE.
08 AUTOIO             Sets Auto mode for mass storage and printing.
09 22                 Specifies address of multimeter.
10 SELECT             Selects multimeter as primary device.
11 REMOTE             Puts multimeter in Remote mode.
12 "T4"               Puts multimeter in "single trigger" mode.
13 OUTA               Sends instruction to multimeter.
14 "VSTORE"           Specifies name of data storage file.
15 0                  Specifies register 0.
16 SEEKR              Initializes cassette to first register.
17 1.100
18 STO 00             Initializes counter for 100 sets of readings.
19 2.016
20♦LBL 01
21 STO 01             Initializes counter for 15 readings per set.
22♦LBL 02
23 TRIGGER            Triggers mulimeter to take a reading.
24 IND                Gets voltage reading.
25 STO IND 01         Stores reading in next register.
26 PRX                Prints reading.
27 ISG 01
28 GTO 02             Branches for next reading.
29 2.016
30 WRTRX              Writes 15 readings on cassette drive.
31 ISG 00
32 GTO 01             Branches for next set of readings.
33 END
```

The HP 82160A HP-IL Module provides two functions that may be useful for operating HP-IB devices in their remote and local states when using Translator mode. These functions are [REMOTE] and [LOCAL]. However, these functions affect all HP-IL and HP-IB devices that have a remote capability.

The [REMOTE] function causes the interface to send the HP-IB Remote Enable command, makes the primary device a listener, and then removes it from listener status. If the primary device has remote mode capability, then it will be in remote mode. In addition, all HP-IL and HP-IB devices that have a remote capability will be enabled to switch to remote mode when they next become a listener.

The [LOCAL] function causes the interface to send the HP-IB Go To Local command. If the primary device is an HP-IB device, that device will switch to local mode. (However, devices remain remote enabled if they were previously enabled.) The next time the device is made a listener, it will again go into remote mode.

The HP-IL module sends a sequence of messages on the loop before it actually performs an I/O operation. In the process of sending these preliminary messages, the HP-IL module makes the primary device a listener, then cancels the listener status. If you select a device and execute [LOCAL], the device will be in local mode. However, the next time you perform any function with that device as the primary device, the HP-IL module's preliminary messages will put the device back into remote mode. The only time you may be able to use the [LOCAL] function to put the device into local mode is in certain programming situations where there is no printer on the loop or the printer is not tracing the program operation.*

* The HP 82183A Extended I/O Module provides functions that enhance your I/O capabilities. Two functions ([NOTREM] and [ADROFF]) are useful for enabling and disabling remote operation and controlling preliminary messages.

Appendix D

Using the HP-75 As a Controller

The HP-75 Portable Computer can control the interface and its HP-IB devices when the HP-75 contains the LEX file HPILCMDS.* This LEX file is provided with the *HP-75 I/O Utilities Solutions Book* (part number 00075-90122). The HPILCMDS file gives the HP-75 the capability to use almost all of the HP-IL messages listed under "Response to HP-IL Messages" for both Translator mode and Mailbox mode (sections 2 and 4).

When using default addressing in Translator mode, you must set the addresses of the HP-IB devices so that they're compatible with the HP-75's addressing scheme. The HP-75's `ASSIGNIO` statement expects all addresses to be in sequential order. When the `ASSIGNIO` instruction is executed, the HP-75 will display `30 Device(s) on loop` and `Device #1= ':  '`. You must assign all HP-IL devices (including the interface) and then assign all the HP-IB devices. If an HP-IB device address switch is inconvenient to access, you can make "nonexistent" assignments for the address space between the interface's address and the HP-IB device's address. (You won't use these "nonexistent" assignments.) Once all of the HP-IB devices have been assigned, press [RTN] without making an assignment to end the assignment process.

Example: Assume that three devices are on the loop: an HP 82163A Video Interface, an HP 82161A Digital Cassette Drive, and the HP-IL/HP-IB interface. There are two devices on the HP-IB side: a printer at address 22 and a voltmeter at address 7. Assume that the address of the printer is changed to 4; the address switches on the voltmeter are inside the device, so its address is left at 7. Be sure that *m* is set to "0" on the interface's mode/address switch so that the interface operates in Tranlator mode. Assign the devices as follows:

```
Device #1 = ':tv'          Assigns the video interface.
Device #2 = ':ca'          Assigns the cassette drive.
Device #3 = ':in'          Assigns the HP-IL/HP-IB interface.
Device #4 = ':pr'          Assigns the printer.
Device #5 = ':na'          Nonexistent assignment to fill assignment space.
Device #6 = ':nb'          Nonexistent assignment to fill assignment space.
Device #7 = ':vm'          Assigns the voltmeter.
Device #8 = ':  '          (Press [RTN].)
```

The HP-IL and HP-IB devices can now be accessed using their corresponding device codes. The following program uses the device assignments to list a program on the HP-IB printer.

```
10 RESTORE IO                    Makes sure the loop is properly assigned.
20 PWIDTH 80                     Sets 80 characters as the length of a line.
30 PRINTER IS ':PR'              Assigns the HP-IB printer as the loop printer.
40 INPUT 'FILE NAME? ';A$        Prompts for the name of the file to be printed.
50 PLIST A$                      Prints the file.
60 PRINTER IS *                  Removes the HP-IB printer as the loop printer.
70 END
```

* You may be able to use the HP-75 by itself to work with the interface for output operations only (using the `PRINT` or `DISP` statements).

The following list gives the HP-75 BASIC statements that enable you to send HP-IL messages. These statements are provided by the HPILCMDS file mentioned earlier. Refer to "Response to HP-IL Messages" (in sections 2 and 4) for the interface's exact response to a particular message.

`ASSIGN IO`
: Assigns the devices on HP-IL and HP-IB and allows you to give each device a unique specifier.

`CLEAR LOOP`
: Sends a series of Interface Clear messages.

`ENTIO$(' device code ' , ' message list ')`
: Retrieves up to 256 data bytes from an HP-IL or HP-IB device.

  The device code is the two letter name assigned to the device on an `ASSIGN IO` statement. They are entered as `':xy'`. If no specifier is used, enter the null string `''`.

  The message list is one or more of the HP-IL message specifiers listed in the table below. If more than one specifier is used, they are separated by commas.

`OFF IO`
: Disables normal loop operations, device specifiers not usable, `SENDIO` and `ENTIO$` are still usable if you address the loop and use address numbers in your messages.

`RESTORE IO`
: Restores normal loop operations, device specifiers are usable.

`SENDIO ' device code ' , ' message list ' , ' data list '`
: Sends any HP-IL messages and data on the loop.

  The device code is the name assigned to the device on an `ASSIGN IO` statement. They are entered as `':xy'`. If no specifier is used, enter the null string `''`.

  The message list is one or more of the HP-IL message specifiers listed in the table below. If more than one specifier is used, they are separated by commas.

  The data list contains the data characters you wish to send. If no characters are to be sent, then you must enter the null string `''`. If you wish to enter character codes, you can use the `CHR$` function concatenated by the ampersand (`&`).

Message Specifiers

Specifier	HP-IL Message
`AAD`*n*	Auto Address 0–31. *n* is a number from 0 to 31 and is the starting address of the loop.
`AAU`	Auto Address Unconfigure.
`AEP`*n*	Auto Extended Primary 0–31. *n* is a number from 0 to 31 and is the extended address number.
`AES`*n*	Auto Extended Secondary 0–31. *n* is a number from 0 to 31 and is the starting address of the loop.
`CL+`	Inserts carriage return and line feed characters onto the end of a group of incoming data bytes.
`DCL`	Device Clear.
`DDL`*x*	Device Dependent Listener 0–31. *x* is a number from 0 to 31 and is the number of the Device Dependent Listener message to be sent.
`DDT`*x*	Device Dependent Talker 0–31. *x* is a number from 0 to 31 and is the number of the Device Dependent Listener message to be sent.
`EAR`	Enable Asychronous Requests.
`EDN`	Enable Listener NRD.
`GTL`	Go To Local.
`IFC`	Interface Clear.
`LAD`*n*	Listen Address 0–31. *n* is a number from 0 to 31 and specifies the address of the device that should be a listener.

Message Specifiers (Continued)

Specifier	HP-IL Message
LAD#	Makes the device with the device code a listener.
LPD	Loop Power Down.
NOP	No Operation.
NRD	Not Ready For Data.
NRE	Not Remote Enable.
PPD	Parallel Poll Disable.
PPE*n*	Parallel Poll Enable 0–31. *n* is a number from 0 to 31 and is the number of the Parallel Poll Enable message.
PPU	Parallel Poll Unconfigure.
REN	Remote Enable.
SAD*n*	Secondary Address 0–30. *n* is a number from 0 to 30 and is the number of the Secondary Address message to be sent.
SAI	Send Accessory ID.
SDA	Send Data.
SDC	Selected Device Clear.
SDI	Send Device ID.
SST	Send Status.
TAD*n*	Talk Address 0–31. *n* is a number from 0 to 31 and is the address of the device that should be the talker.
TAD#	Makes the device in the device code the talker.
TL+	Does not allow the HP-75 to send out an Untalk and Unlisten message after the current message string is completed.
UNL	Unlisten.
UNT	Untalk.

The HP-75 does not automatically send an end-of-line (CR)(LF) sequence when the SENDIO statement is used. If you need an end-of-line sequence, you need to send those characters with your string.

The ENTIO$ statement does not automatically send a Send Data message. The HP-75 does not look for the end-of-line characters (CR) and (LF) when this statement is used.

Example: The following program creates a data file in the HP 75 for storing voltage readings. It prints each reading on an HP-IB printer and stores the entire data file on the cassette drive when the file is full. Be sure that *m* is set to "0" on the mode/address switch so that the interface operates in Translator mode.

```
10 RESTORE IO                          Makes sure loop is properly assigned.
20 PRINTER IS ':PR'                    Assigns HP-IB printer as the loop printer.
30 ASSIGN #1 TO 'DATA'                 Create an HP-75 data file called DATA.
40 SENDIO ':VM','REN,LAD#','T4'        Puts the voltmeter in remote mode and enables
                                       "single trigger" option. (Remote instruction is
                                       "T4").
50 FOR I=1 TO 2000                     Sets up loop for obtaining 2000 voltage readings.
60 SENDIO ':VM','LAD#,GET',''          Triggers the voltmeter to take a reading.
70 A$=ENTIO(':VM','TAD#,SDA')          Gets reading from voltmeter as an ASCII string.
80 A=VAL(A$)                           Converts ASCII string to a number.
90 PRINT #1;A                          Stores the voltage in the data file DATA.
100 PRINT A                            Prints the voltage reading on the HP-IB printer.
110 NEXT I
120 ASSIGN #1 TO *                     Removes data file assignment.
130 COPY 'DATA' TO ':CA'               Writes data file to cassette.
140 PRINTER IS *                       Removes the HP-IB printer as the loop printer.
```

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Page numbers in **bold** type indicate primary references; page references in regular type indicate secondary references.

HP 82169A HP-IL/HP-IB Interface
Owner's Manual

HEWLETT
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