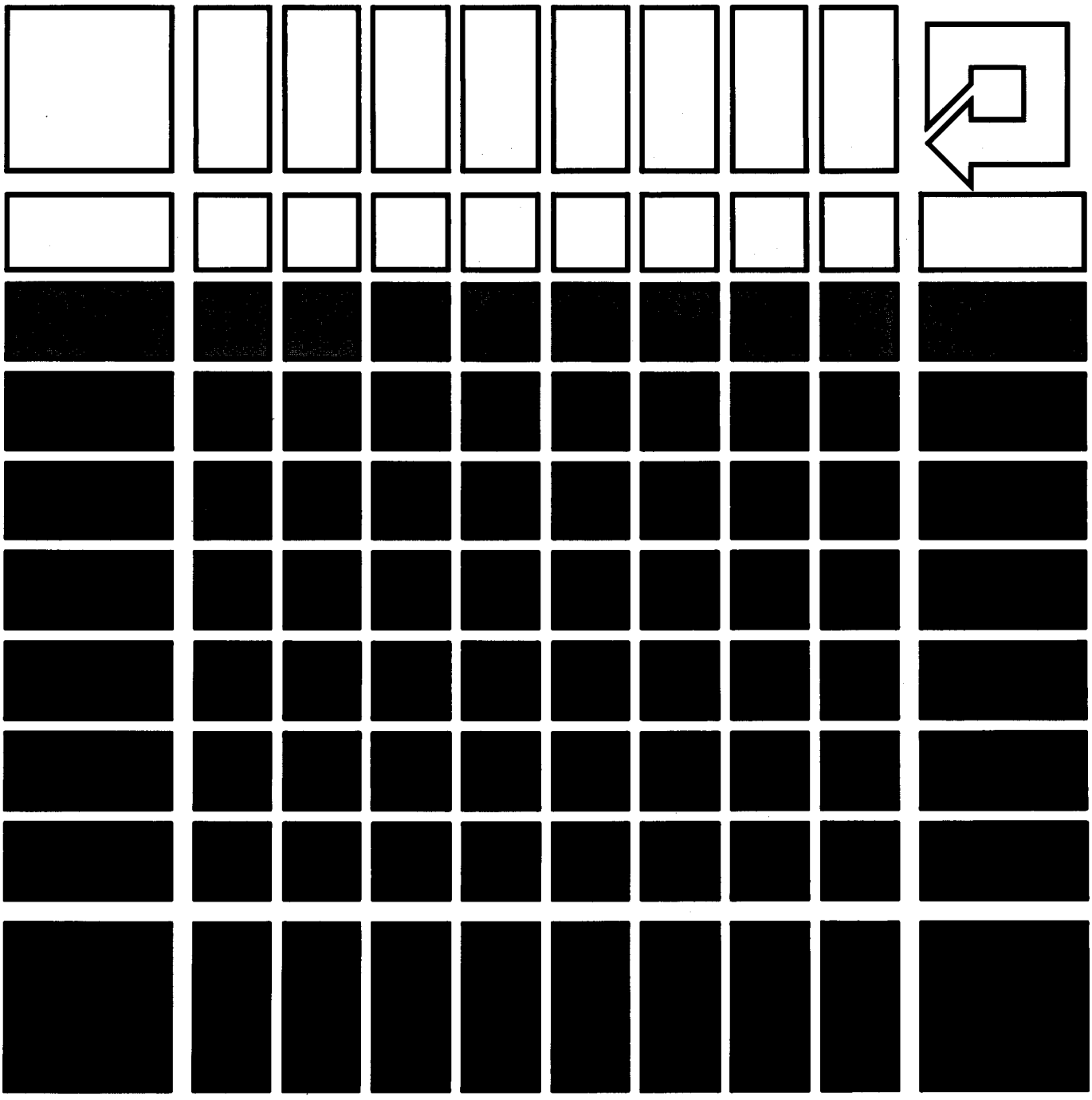
HEWLETT-PACKARD

HP 82165A

HP-IL/GPIO Interface

OWNER'S MANUAL



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Owner's Manual

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Introduction

The HP 82165A HP-IL/GPIO Interface provides the capability to interface an external device having general-purpose input/output (GPIO) capabilities with the Hewlett-Packard Interface Loop (HP-IL).

The HP 82165A HP-IL/GPIO Interface is packaged with the following accessories:

- One HP-IL cable.
- A mating 25-pin D-subminiature GPIO connector.
- An ac adapter.

Additional HP-IL cables are available in packages of one:

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

This manual gives information about the interface's design, its interaction with HP-IL, and its operation using the GPIO capabilities of the external device. Operating specifications are included to assist in interfacing the interface and the external device. (Typical installations are described in appendix C.)

Installation

The following paragraphs describe how to set up the HP 82165A HP-IL/GPIO Interface in an HP-IL system.

GPIO Connection

Before plugging the 25-pin D-subminiature GPIO connector into the interface, wire the GPIO connector to the external device and disconnect the power to the interface.

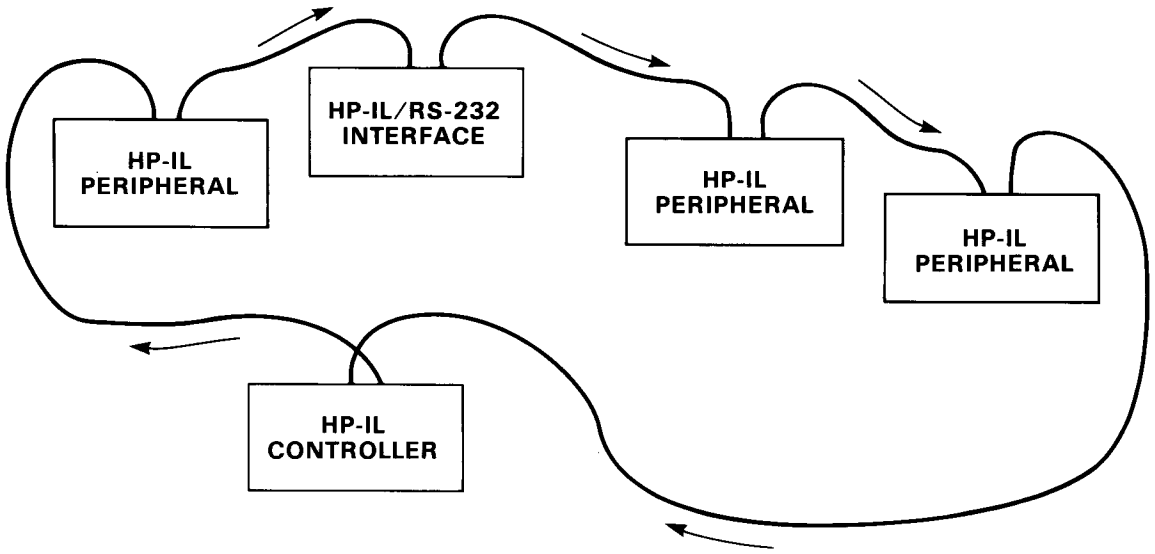
Power

The HP-IL/GPIO 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, first make sure that the interface is disconnected from HP-IL. Next, insert the ac adapter plug into the proper ac outlet. Finally, insert the power connector into the power receptacle in the rear of the interface.

HP-IL Connection

The Hewlett-Packard Interface Loop (HP-IL) consists of one or more peripheral devices and a controller (a calculator or computer). The devices may be connected in any order—but all of the interface cables must form a continuous loop. All connections are designed to ensure proper orientation.

To connect the HP 82165A HP-IL/GPIO Interface onto the loop, first turn off the controller. Then disconnect the loop in one place and connect the interface onto the loop at that place. (In some instances, the interface may be the only peripheral in the loop.)



Operation

The HP 82165A HP-IL/GPIO Interface becomes operational when the ac adapter is connected, when it is coupled to a controller via the HP-IL, and when it is properly coupled to an external device through the GPIO bus. You should refer to the owner's manual for your calculator, computer, or HP-IL extension to find the primary information about controlling the interface.

Appendix A contains information about verifying proper operation of the interface.

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

RESET Key. The RESET key is a momentary switch that returns the interface to its initial startup conditions (page 10).

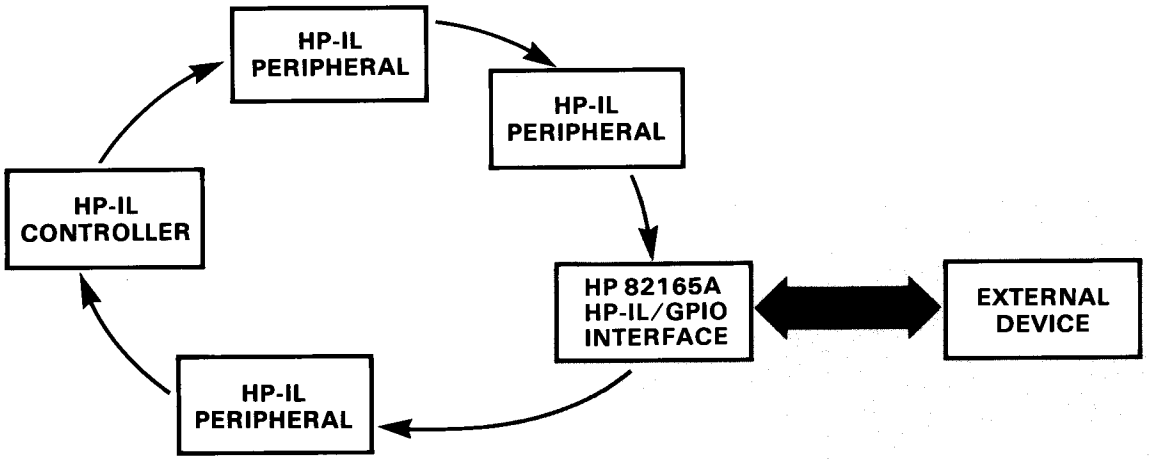
PWR Light. The power (PWR) light is on whenever the ac adapter supplies power to the interface.

T/R Light. The transmit/receive (T/R) light goes on each time data is transferred across the GPIO bus. More technically, the light is on each time the DAVI or DAVO signal is true. The light is lit only for the duration of the transfer, so it will often appear to flash or blink.

MSRQ Key. Pressing the manual service request key (MSRQ) sets a Manual Service Request condition in the status register. (Refer to page 14 for more details.)

An Overview of the HP-IL/GPIO Interface

Consider the HP-IL system shown below. The interface loop contains an HP-IL *controller* (such as a calculator), perhaps one or more additional HP-IL devices, and the HP-IL/GPIO interface. The interface connects to an *external device* (such as a GPIO printer), allowing the controller to interact indirectly with the external device. In this way, the external device becomes an HP-IL controlled peripheral.



If the controller needs to send data to the external device, the controller first makes the interface a listener, which means that the interface is set to accept data from HP-IL and pass it to the external device. The controller then initiates the transfer of data around the interface loop, one character (or byte) at a time. As characters are received by the interface, it stores them internally. Meanwhile, the interface sends the data to the external device, one character at a time. The interface uses its three GPIO output "handshake" lines (RDYI, DAVO, and DACI) to control the flow of data on the data lines. When the external device sets RDYI (*ready*) true, the interface places one byte (character) on the data lines and sets DAVO (*data valid*) true. The external device sets DACI (*data accepted*) true after it has accepted the data byte, and then sets RDYI true when it is ready for the next byte. In this way, each character received by the interface is transferred to the external device. This is called an HP-IL➔GPIO ("HP-IL to GPIO") operation.

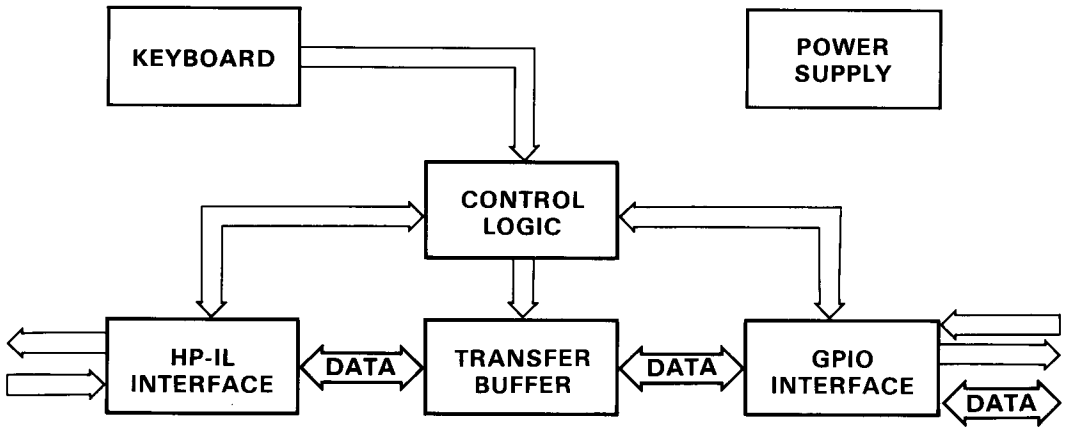
If the controller needs the external device to send data to listeners on HP-IL, the controller first makes the interface a talker, which means that the interface is set to accept data from the external device and send it on HP-IL. The controller then directs the interface to start sending data. The interface uses its three GPIO input "handshake" lines (RDYO, DAVI, and DACO) to control the flow of data on the data lines. The interface sets the RDYO line true. When the external device places one byte on the data lines, it sets DAVI true. The interface sets the DACO line true when it has accepted the data byte and has stored it internally. The interface accepts and stores additional bytes in the same manner. Meanwhile, the interface sends each byte on HP-IL, where it is received by all HP-IL listeners. This is called an HP-IL ➔GPIO ("HP-IL from GPIO") operation.

This example illustrates one way that the interface can be used. However, the interface is a general-purpose interfacing device. It can be set up to operate in several different ways. Using the interface with HP-IL and an external device requires an understanding of these options. Read through this manual in its entirety before attempting to connect and use the HP 82165A HP-IL/GPIO Interface with a particular external device.

> **Note:** Not all controllers can use all of the interface's features. Some controllers may require an I/O (input/output) module (or "ROM") in order to control certain aspects of the interface's operation. (Refer to the appendicies for additional information.)

Internal Design

The HP-IL/GPIO interface has six primary features that are important for understanding the interface's operation: the HP-IL interface, the GPIO interface, the transfer buffer, the control logic, the keyboard, and the power supply.



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.

GPIO Interface

The GPIO interface portion of the interface provides the connection to the external device. The physical connection consists of a 25-pin D-subminiature GPIO connector. By making the appropriate connections, the external device and the interface use signal lines to send and receive information. The signal lines include two 8-line GPIO data buses, six GPIO handshake lines, two HP-IL interfacing lines, and a ground line. (Signal descriptions are described on page 9.)

Transfer Buffer

The transfer buffer consists of 32 registers, each capable of holding one byte of information. (Each byte consists of eight bits.) This buffer stores information being transferred from HP-IL to GPIO or from GPIO to HP-IL. It gives the interface the capability of holding up to 32 bytes waiting to be sent. The buffer passes data in the order it was received—first in, first out.

Control Logic

The control logic stores operating information, implements various operating modes that can be selected, and controls the flow and interpretation of data within the interface. It includes registers that store operating information: the control registers and the status register. This operating information can come from either the HP-IL controller or the interface's keyboard.

Control Registers. The operation of the interface is defined by information stored in 19 control registers—R00 through R18. Each register stores one byte (eight bits) of control information. The tables in appendix B list the effects of the control registers. When power is applied to the interface, the default values listed in the appendix are stored in the control registers. The contents of the registers may be changed by subsequent operations on HP-IL. (Refer to the Device Dependent Listener 0 message on page 13.)

Note: In this manual, individual bits in a control register are indicated by appending them to the register name. For example, bits 7 and 6 of control register R02 are indicated by R02–7,6.

Status Register. Information about the current state of the interface is stored in the status register. This register stores one byte of status information, as described on page 13.

Keyboard

The keyboard contains the RESET key, the MSRQ (manual service request) key, the PWR (power) indicator light, and the T/R (transmit/receive) indicator light. The RESET key and the MSRQ key allow you to interact with the interface and set certain states. (The operation of these two keys were explained on page 6.) When the PWR indicator light is lit, there is power to the interface. The T/R light is lit during the transfer of data across the GPIO bus.

Power Supply

The HP-IL/GPIO interface contains no internal power source; therefore, the interface must be connected to the ac adapter. The power supply provides a regulated voltage to the interface.

Signal Descriptions

The HP-IL/GPIO interface provides two interfaces: a pair of standard HP-IL receptacles in the front panel and a 25-pin D-subminiature GPIO connector at the rear of the unit. (Electrical and timing specifications are listed on pages 19 and 20.)

HP-IL Signals

The interface provides full electrical and mechanical compatibility with HP-IL. The interface's two HP-IL receptacles connect to the interface loop using standard HP-IL cables. Because information travels around the loop in one direction, the receptacles are labeled IN and OUT, indicating the direction of communication and the sequence of normal HP-IL addressing.

GPIO Signals

The interface provides two 8-line bidirectional GPIO data buses, six GPIO handshake lines, two HP-IL interfacing lines, and a ground line. These lines are available to the external device at the 25-pin GPIO connector. Each input and output line is TTL-compatible.

Data Bus A (DA0-DA7). These GPIO lines can be configured as an input/output bus or as an input-only bus. Data Bus A transfers information between transfer buffer and the external device.

Data Bus B (DB0-DB7). These GPIO lines can be configured as an input/output bus or as an output-only bus. Data Bus B transfers information between the transfer buffer and the external device.

GPIO Output Handshake Lines (RDYI, DAVO, DACI). These three lines, used in four different combinations, provide four methods of data output to GPIO (HP-IL → GPIO). A true RDYI input indicates that the external device is ready to receive data. A true DAVO output indicates that the data on the data buses is valid; when DAVO is false, the data bus lines are high. A true DACI input indicates that the external device has received the data.

GPIO Input Handshake Lines (RDYO, DAVI, DACO). These three lines control the input of data from GPIO (HP-IL ← GPIO). A true RDYO output indicates that the interface is ready to receive data. A true DAVI input indicates that the data on the data buses is valid. A true DACO output is the only indication that the interface has received the data. (The external device is not required to use the RDYO and DACO output signals.)

HP-IL Interfacing Input Line ($\overline{\text{MSRQ}}$). This input line allows the interface to signal the HP-IL controller. An active low $\overline{\text{MSRQ}}$ signal causes the interface to request service from the HP-IL controller by setting the service request bit in Identify, Data Byte, or End Byte HP-IL messages. It also affects the internal status byte. Manual service requests—those initiated by this signal—can be disabled by setting R00-6 equal to 0.

HP-IL Interfacing Output Line ($\overline{\text{GETO}}$). This output line informs the external device that a Group Execute Trigger message has been received on HP-IL. An active low signal on the $\overline{\text{GETO}}$ line sets a Group Execute Trigger message.

GPIO Signal Descriptions

Name	Description	Direction
DACI	Data Accepted Input	Interface ← Device
DACO	Data Accepted Output	Interface → Device
DAVI	Data Valid Input	Interface ← Device
DAVO	Data Valid Output	Interface → Device
DA0 - DA7	Data Bus A	Interface ↔ Device
DB0 - DB7	Data Bus B	Interface ↔ Device
$\overline{\text{GETO}}$	Group Execute Trigger Output	Interface → Device
GND	Ground	Interface ↔ Device
$\overline{\text{MSRQ}}$	Manual Service Request	Interface ← Device
RDYI	Ready Input	Interface ← Device
RDYO	Ready Output	Interface → Device

Operation

The HP-IL/GPIO interface's basic function is to transfer data between HP-IL and the external GPIO device. For data transfer from HP-IL to the external device (HP-IL→GPIO), the interface must be an HP-IL listener—receiving data on HP-IL and sending it on GPIO. For data transfer from the external device to HP-IL (HP-IL←GPIO), the interface must be an HP-IL talker—receiving data on GPIO and sending it on HP-IL. The listener and talker status is determined by the controller.

The interface interacts with devices connected to the interface loop and with the external device. The HP-IL interaction is defined in terms of standard HP-IL messages sent and received by the interface. The GPIO interaction with the external device consists of signals transmitted on the GPIO control and data lines.

Startup Conditions

When the ac adapter applies power to the interface, the interface is initialized according to the default parameters in the control registers. (Refer to appendix B.) The interface's HP-IL address is undefined, preventing the interface from performing any HP-IL operation until it is assigned a valid address by the HP-IL controller.

HP-IL Interaction

The interface provides complete compatibility with HP-IL. It interacts with other HP-IL devices by sending and receiving HP-IL messages on the interface loop. (Refer to the owner's manual for the HP-IL controller for information about controlling peripherals such as the HP-IL/GPIO interface.) The interface responds to HP-IL messages as described in the table below. Except as noted in the table, each HP-IL message the interface receives is automatically sent to the next device in the loop. In general, the interface checks each message it initiates for transmission errors when the message comes back to the interface.

Responses to HP-IL Messages

HP-IL Message	Interface Response
COMMAND GROUP	
Interface Clear	Talker or listener status removed and pending addressable message cleared.
Device Clear	No response.
Selected Device Clear	No response.
Go To Local	No response.
Local Lockout	No response.
Remote Enable	No response.
Not Remote Enable	No response.
Parallel Poll Enable 0–15	If listener and not already parallel poll enabled, set to modify subsequent Identify messages according to parallel poll conventions. (Refer to pages 14 and 15.)
Parallel Poll Disable	If listener, set to not modify subsequent Identify messages.
Parallel Poll Unconfigure	Set to not modify subsequent Identify messages.
Group Execute Trigger	Pulses GETO line low.
Loop Power Down	No response.
Enable Asynchronous Requests	No response.
Auto Address Unconfigure	Address set to 8.
Listen Address 0–31	If address matches,* data for HP-IL cleared from transfer buffer, device removed from talker status, and device becomes a listener. If address is 31, device removed from listener status. (End-of-line sequence sent to GPIO, if enabled to do so.)
Unlisten	Device removed from listener status. (End-of-line sequence sent to GPIO, if enabled to do so.)
Device Dependent Listener 0–31	If listener, responds as described in table on page 13.
Talk Address 0-31	If address matches,* device removed from listener status and becomes a talker. If address doesn't match, device removed from talker status.
Untalk	Device removed from talker status.
Device Dependent Talker 0–31	If talker, responds as described in table on page 13.
Secondary Address 0–30	Following addressed message, if primary and secondary addresses match device's addresses, responds to message.
Null	No response.
READY GROUP	
Take Control	If talker, the response is not defined. (Operation as a controller is not supported.)
Ready For Command	Executes a pending Loop Power Down message.
Send Data	If talker, begins sending contents of transfer buffer or GPIO registers, as selected.†
Send Device ID	If talker, sends eight ASCII-coded bytes: HP 82165A.+
Send Accessory ID	If talker, sends one byte with the value 64.+
Not Ready For Data	If talker, makes previous data byte the last byte sent.
Send Status	If talker, sends one byte of status. (Refer to pages 13 and 14.)†

Responses to HP-IL Messages (Continued)

HP-IL Message	Interface Response
End Of Transmission—OK	If talker, responds as described under End of Data, page 18.
	If listener, end-of-line sequence sent to GPIO if enabled to do so.
End Of Transmission—Error	If talker, sent immediately for bad HP-IL error check.
	If listener, end-of-line sequence sent to GPIO if enabled to do so.
Auto Address 0–31	If device has earlier assigned address, no response.
	If message address is 31, no response.
	If message address less than 31 and device doesn't have earlier assigned address, device address set to message address, increments message address by one, and passes revised message.
Auto Extended Primary 0–31	If device has earlier assigned address, no response.
	If address is 31, no response.
	If not preceded by Auto Extended Secondary message, no response.
	If preceded by Auto Extended Secondary 31, no response.
	If preceded by Auto Extended Secondary less than 31, if message address less than 31, and if device doesn't have earlier assigned address, then device address is set to primary and secondary addresses just received.
Auto Extended Secondary 0–31	If device has earlier assigned address, no response.
	If address is 31, no response.
	If message address less than 31 and device doesn't have earlier assigned address, device secondary address set to message address, increments message address by one, and passes revised message. (Must be followed by Auto Extended Primary message to establish valid device address.)
Auto Multiple Primary 0–31	No response.
IDENTIFY GROUP	
Identify (no service request) Identify (service request)	If device set to respond by Parallel Poll Enable message, modifies message according to parallel poll setup and service request status. (Refer to pages 14 and 15.)
DATA GROUP	
Data Byte (no service request)	If talker, sends next data byte.†
Data Byte (service request)	If listener, accepts data byte and passes to next device. Data is normally sent to transfer buffer.
	If service is required by interface, message is modified to Data Byte (service request).
End Byte (no service request)	If talker, sends next data byte.†
End Byte (service request)	If listener, accepts data byte and passes to next device. Data is normally sent to transfer buffer. (End-of-line sequence sent to GPIO, if enabled to do so.)
	If service is required by interface, message is modified to End Byte (service request).

* For extended addressing, the message address must match the primary address. The response occurs only if the correct Secondary Address message follows.

† Indicates that the received message is not passed to the next device in the loop.

Device Dependent Messages. Device Dependent Listener messages and Device Dependent Talker messages (listed in the command group above) are special HP-IL messages whose meanings depend upon the device receiving them—the listener or the talker. When these messages are sent to the interface, they are referred to by names that correspond to the specific actions they cause. Device dependent message numbers, names, and responses are listed below.

Responses to Device Dependent Messages

HP-IL Message	Name	Interface Response
Device Dependent Listener:		
0	Set Control Registers	Transfer buffer cleared. Up to 19 subsequent Data Bytes from HP-IL are stored in R00 through R18.
1	Interface/HP-IL Test	Interrupts GPIO output and clears transfer buffer. Subsequent Data Bytes are held in transfer buffer waiting to be sent to HP-IL (not sent to GPIO). Subsequent HP-IL output operation allows comparison with original Data Bytes. (Refer to Verifying Proper Operation in appendix A.)
2	Clear Transfer Buffer	Transfer buffer cleared.
3-31		No response.
Device Dependent Talker:		
0	Send Control Registers	Subsequent Send Data message causes the contents of R00 through R18 to be sent on HP-IL (19 Data Bytes). Transfer buffer cleared.
1	Send Data Bus B	Subsequent Send Data message causes one Data Byte representing the data on Data Bus B to be sent to the transfer buffer. (No input handshake is used.)
2	Enable End-Of-Line	Sets interface for detecting and deleting end-of-line sequence in GPIO input and inserting different end-of-line sequence into HP-IL output (ending with an End Byte). Operates on next string of Data Bytes only. The GPIO end-of-line sequence must be the last Data Bytes in the buffer. Requires that R04-7 and R04-3 equal 1. Sequences specified by R04 through R14.
3-31		No response.

Status. The interface maintains a one-byte record of its current condition in the status register. The definition of the status byte is shown in the table below. Normally, the status condition in the status register is updated whenever the interface's status changes. However, for the Buffer Busy condition, the status register is not changed until an HP-IL Send Status message causes the status to be sent on HP-IL.

Status Byte Definition

Status Byte		Condition	Definition
Decimal	Binary*		
1 or 65	0X000001	Ready For HP-IL Data	Ready to receive data on HP-IL (HP-IL ➔ GPIO).
2 or 66	0X000010	Data Ready For HP-IL	Data available in transfer buffer for HP-IL (HP-IL ← GPIO).
4 or 68	0X000100	Buffer Full (for GPIO)	Transfer buffer is full (HP-IL ➔ GPIO).
6 or 70	0X000110	Buffer Full (for HP-IL)	Transfer buffer is full (HP-IL ← GPIO).
8 or 72	0X001000	No GPIO Handshake	During HP-IL ➔ GPIO operation, DACI not received within DAVO timeout period or RDYI not received.
16 or 80	0X010000	Buffer Busy	Transfer buffer not empty and data sent from external device during HP-IL ➔ GPIO operation. (Data not accepted by interface.)
32 or 96	0X100000	Manual Service Request	$\overline{\text{MSRQ}}$ line set low by the external device or by pressing the MSRQ key on the interface.

* The eight bits are shown in order—bit 7 (most-significant) through bit 0 (least-significant). An X indicates that bit 6 may be either a "0" or a "1". If bit 6 is a "1" (corresponding to the higher decimal value), the interface has originated a service request on HP-IL. Bit 6 is reset to a "0" when the status condition changes.

Service Requests. Two types of conditions can cause the interface to initiate a service request (indicated by a control bit in an HP-IL Data Byte, End Byte, or Identify message): a *manual* service request and a *status* service request. A manual service request is initiated by an active low signal from the external device on the $\overline{\text{MSRQ}}$ input line or by pressing the MSRQ key. A status service request is initiated by the occurrence of a particular condition as indicated by the status register. The conditions that cause a service request are specified by control register R00. (If a condition is enabled in register R00, the occurrence of that condition will initiate a service request on HP-IL.)

R00-7 controls whether certain status conditions initiate HP-IL service requests. R00-6 controls whether a manual service request condition initiates an HP-IL service request. If R00-7 is set, either R00-5 can make *all* status conditions initiate service requests, or else R00-4 through R00-0 select *particular* status conditions to initiate service requests.

Parallel Poll. The interface can be enabled to respond to a parallel poll. A parallel poll allows the HP-IL controller to determine which devices require attention. When it receives an HP-IL Parallel Poll Enable message, the interface is set to respond in a particular way to subsequent parallel polls. The parallel poll consists of an HP-IL Identify message sent by the active HP-IL controller. If the interface has been parallel poll enabled, it modifies all Identify messages according to the table below. Basically, for the first eight enable messages listed below, a "no service request" condition makes the designated bit a "1"; otherwise, the bit is not affected. For the last eight enable messages, a "service request" condition makes the designated bit a "1"; otherwise, the bit is not affected. In all cases, a "service request" condition is indicated by placing a "1" in the Service Request bit in the Identify message. No other bits are affected by the interface.

If the interface receives a Parallel Poll Unconfigure message, or if the interface is a listener and receives a Parallel Poll Disable message, the interface won't respond to subsequent parallel polls—that is, it doesn't modify Identify messages.

Parallel Poll Response to Identify Message

Enable Message	Designated Bit	Effect on Designated Bit	
		If Service Requested	If No Service Requested
Parallel Poll Enable 0	Bit 1		
Parallel Poll Enable 1	Bit 2		
Parallel Poll Enable 2	Bit 3		
Parallel Poll Enable 3	Bit 4	"0" → "0"*	"0" → "1"
Parallel Poll Enable 4	Bit 5	"1" → "1"*	"1" → "1"
Parallel Poll Enable 5	Bit 6		
Parallel Poll Enable 6	Bit 7		
Parallel Poll Enable 7	Bit 8		
Parallel Poll Enable 8	Bit 1		
Parallel Poll Enable 9	Bit 2		
Parallel Poll Enable 10	Bit 3		
Parallel Poll Enable 11	Bit 4	"0" → "1"*	"0" → "0"
Parallel Poll Enable 12	Bit 5	"1" → "1"*	"1" → "1"
Parallel Poll Enable 13	Bit 6		
Parallel Poll Enable 14	Bit 7		
Parallel Poll Enable 15	Bit 8		

* Also, Service Request bit is set to "1".

GPIO Interaction

The interface's interaction with the external device (using the GPIO data and control lines) is directly related to the way that the interface is set up to operate. The HP-IL controller determines the contents of the control registers, which define the converter's operation—including its GPIO interaction. The controller uses the Device Dependent Listener 0 message (page 13) to change the control registers, defined in appendix B.

Data Transfer. Normally, the flow of data in the interface is determined by the interface's role in the interface loop. When the interface is an HP-IL listener, data moves from HP-IL to the transfer buffer and then to the external device on the GPIO bus. When the interface is not a listener and the transfer buffer has no data from HP-IL, the external device can send data to the interface. When the interface is an HP-IL talker, data moves from the external device via the GPIO bus to the transfer buffer and then to HP-IL. The GPIO data bus is half-duplex: it can transfer information in only one direction at a time.

Data Bus Configuration. The interface has two eight-line data buses (DA0–DA7 and DB0–DB7) that can be organized in three ways: 8-bit bidirectional, 8-bit input and 8-bit output (unidirectional), and 16-bit bidirectional. These options are specified by control register R02-2,1. For 16-bit bidirectional operation, Data Bus A carries the most-significant bits and Data Bus B carries the least-significant bits. The table below summarizes the data bus options.

Data Bus Options

Configuration		Selected by*	Options
8-Bit Bidirectional: Data Bus A Data Bus B	 external device (not used)	R02-2,1 = 00	Positive Logic (R02-5 = 0) Negative Logic (R02-5 = 1)
8-Bit Unidirectional: Data Bus A Data Bus B	 external device external device	R02-2,1 = X1	
16-Bit Bidirectional: Data Bus A Data Bus B	 external device external device	R02-2,1 = 10	

* An X indicates that the bit is ignored, so the bit may be either a "0" or a "1".

Handshake. For HP-IL→GPIO operations, the interface provides four GPIO handshake options: full handshake, valid/accepted handshake, ready/valid handshake, and strobed output. For each option, when DAVO is true, the data on the data bus is valid; when DAVO is false, the data lines are high. The handshake options are specified by control register R02-7,6. The following tables summarize the handshake options.

Output (HP-IL→GPIO) Handshake Options

Handshake	Selected by	Options
Full Handshake: RDYI, DAVO, DACI	R02-7,6 = 11	Positive Logic (R02-4 = 0) Negative Logic (R02-4 =1)
Valid/Accepted: DAVO, DACI	R02-7,6 = 10	100-μs DAVO Time Unit (R02-3 = 0)* 5-μs DAVO Time Unit (R02-3 = 1)*
Ready/Valid: RDYI, DAVO	R02-7,6 = 01	No DAVO Timeout (R02-0 = 0)* DAVO Timeout (R02-0 = 1)*
Strobed: DAVO	R02-7,6 = 00	DAVO Pulse Width Number (R03)

* For ready/valid and strobed output, these options aren't used: the DAVO signal time unit is automatically 5 μs, and the DAVO signal always remains true for the number of units specified by R03.

Input (HP-IL←GPIO) Handshake Options

Handshake	Selected by	Options
Full Handshake: RDYO, DAVI, DACO	(always used)	Positive Logic (R02-4 = 0) Negative Logic (R02-4 = 1)

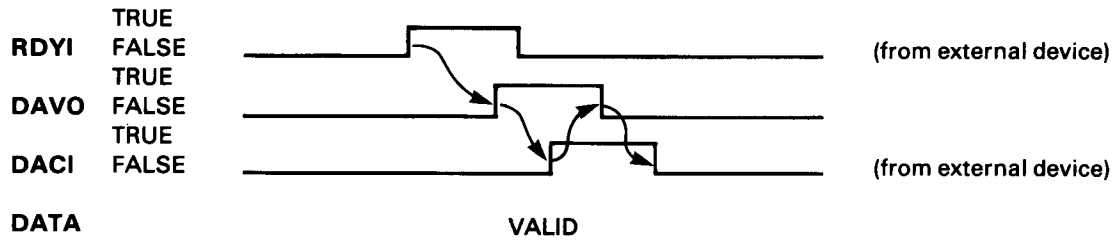
The diagrams below indicate how the three output handshake lines control the transfer of data. (The arrows show how changes in signal levels trigger subsequent changes.) For full and valid/accepted handshake, the DAVO signal may be limited to a time interval specified by control registers R02-3,0 and R03—the data will be removed from the data bus if DACI is not received within that interval. For ready/valid handshake and strobed output, the DAVO signal is true for the interval specified by R03 (and the 5-μs time unit).

For HP-IL ← GPIO operations, the interface uses full handshake on GPIO. The external device should use the RDYO or DACO signal from the interface to determine that the interface is ready for the data or has accepted the data—otherwise, the external device doesn't know whether the interface is set to receive data. However, the external device is not required to use both of the signals.

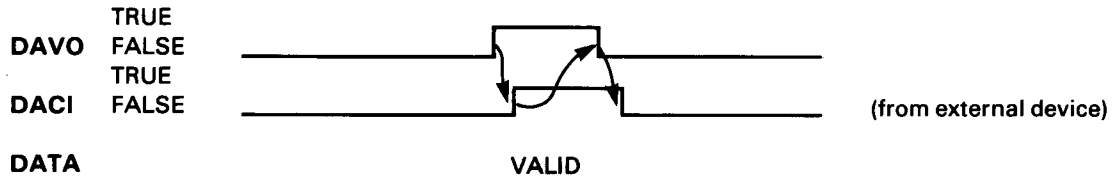
Another handshake feature for HP-IL → GPIO and HP-IL ← GPIO operations is provided by control register R01. R01-2 and R01-0 indicate the status of the DACI and RDYI input lines. If R01-7 equals 1, the HP-IL controller can set the DACO and RDYO output lines using R01-5 and R01-3.

HP-IL → GPIO Operation

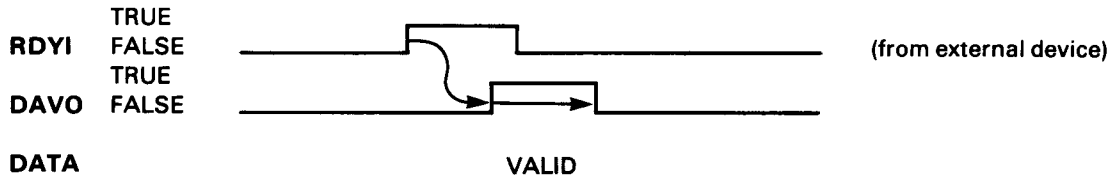
Full Handshake



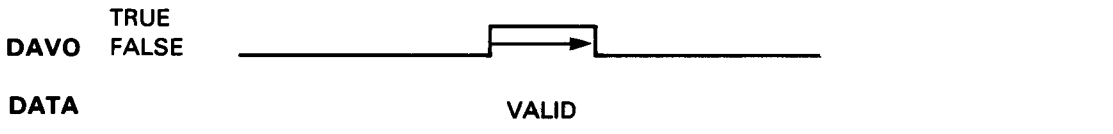
Valid/Accepted Handshake



Ready/Valid Handshake

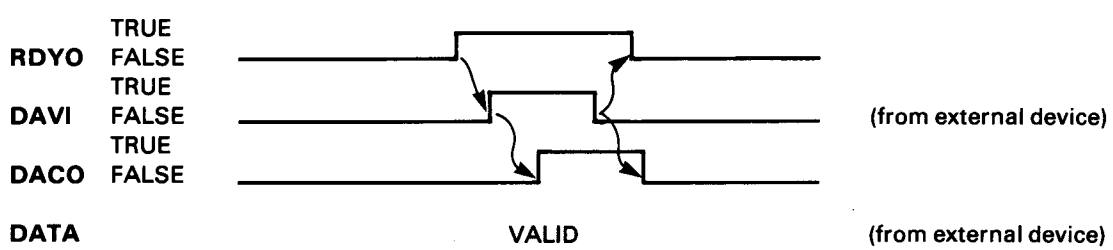


Strobed Output



HP-IL ← GPIO Operation

Full Handshake



Logic System. The interface uses positive logic or negative logic for the data buses and for the handshake lines—each specified independently by control register R02-5,4.

End-Of-Line Indicators. In its default condition, the interface is not set to detect characters or messages that indicate the end of a line of data (end-of-line indicators). Sequences of Data Bytes (and End Bytes) received from HP-IL are normally sent to the transfer buffer and then to the GPIO data bus without being altered. Similarly, sequences received from the GPIO bus are sent to HP-IL without being altered. Of course, the external device or an HP-IL device may respond to a certain character or sequence as an end-of-line indicator, even though the interface isn't set to recognize it. This condition is set up by R04-3 and R04-7 equal to 0.

The table below lists other options for indicating the end of a line of data. Using these options, the interface can detect an end-of-line indicator, delete the end-of-line characters, and insert a different end-of-line indicator at the end of the data. This feature allows you to operate an external device with HP-IL, even if the end-of-line indicators are different. These options are specified by R04-3 and R04-7. The end-of-line characters are specified by R04-6,2,1,0 and R05 through R14.

End-Of-Line Indicators

Indicator Detected/Deleted	Indicator Added	Selected by
Output (HP-IL → GPIO)		
None	None	R04-3 = 0
End Byte, End Of Transmission, or Unlisten HP-IL message	R04-2,1,0 and R05 thru R12 on GPIO	R04-3 = 1
Input (HP-IL ← GPIO)		
None	None	R04-7 =0
Specified GPIO Sequence: R04-6, R13, R14	End Byte on HP-IL	R04-7 = 1
Specified GPIO Sequence: R04-6, R13, R14	R04-2,1,0 and R05 thru R12 with End Byte on HP-IL	R04-7 = 1 R04-3 = 1 Device Dependent Talker 2 message*

* Selected for next line of data only.

End of Data. For HP-IL ← GPIO operation (the interface is a talker), the interface receives data from the external device and sends it to HP-IL until it receives a Not Ready For Data message on HP-IL. It then terminates data transfer with an End Of Transmission message. This method of data termination is under the control of the HP-IL controller device—the external device doesn't terminate the transfer.

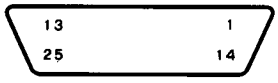
The transfer of data to HP-IL can also be terminated whenever the transfer buffer is empty. With this capability enabled, if the external device stops sending data to the buffer (or fails to keep up with the HP-IL data rate), the interface will send an End Of Transmission message. This additional method of terminating data transfer is enabled by setting control register R01-4 equal to 1. It allows the external device to terminate HP-IL ← GPIO data transfer.

For HP-IL ← GPIO operation, if the transfer buffer contains data for GPIO when the interface receives a Send Data message, the interface immediately sends an End Of Transmission message. This indicates that no data is available for HP-IL.

Specifications

The tables that follow describe the GPIO D-subminiature connector pin assignments, the temperature limits, electrical characteristics, and timing characteristics of the HP 82165A HP-IL/GPIO Interface. The electrical and timing characteristics describe conditions for the interface's GPIO interface.

GPIO Connector Pin Assignments



1	RDYI	14	DAVO
2	DACI	15	RDYO
3	DAVI	16	DACO
4	$\overline{\text{GETO}}$	17	DB0
5	DA0	18	DB1
6	DA1	19	DB2
7	DA2	20	DB3
8	DA3	21	GND
9	DB4	22	DA4
10	DB5	23	DA5
11	DB6	24	DA6
12	DB7	25	DA7
13	$\overline{\text{MSRQ}}$		

Temperature Limits

Operating	0° to 65°C (32° to 149°F)
Storage	−40° to 75°C (−40° to 167°F)

Electrical Characteristics

Characteristic	Symbol	Minimum	Maximum	Unit	Condition
Voltage to Any Pin			5.5	V	
Input Voltage, High Level	V_{IH}	2.0		V	
Input Voltage, Low Level	V_{IL}	−0.3	0.8	V	
Output Voltage, High Level	V_{OH}	2.0		V	$I_{OH} = 15$ mA
Output Voltage, Low Level	V_{OL}		0.5	V	$I_{OL} = 24$ mA
Input Current, High Level	I_{IH}		0.1	mA	$V_{IN} = 5.5V$
			20	μA	$V_{IN} = 2.7V$
Input Current, Low Level	I_{IL}		−0.2	mA	$V_{IL} = 0.4V$
Output Current, High Level	I_{OH}		15	mA	
Output Current, Low Level	I_{OL}	−40	−225	mA	$V_{OL} = 0.0V$
Output Rise Time	t_r		40	ns	$R_L = 667\Omega$
Output Fall Time	t_f		40	ns	$C_L = 45$ pF

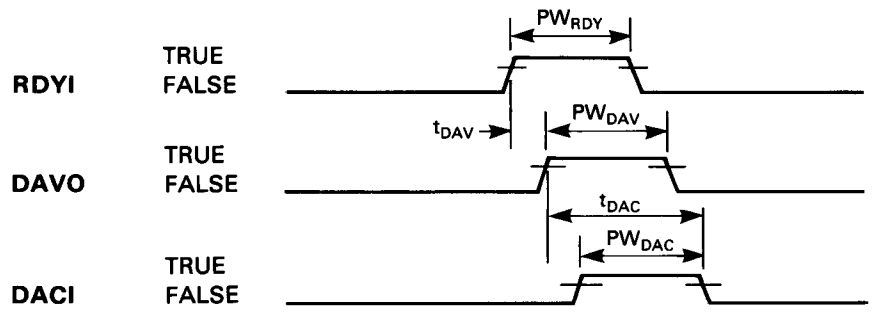
Timing Characteristics

Characteristic	Symbol	Minimum	Maximum	Unit
Output (HP-IL ➔ GPIO) Timing				
RDYI Pulse Width	PW_{RDY}	90		μs
DAVO Delay	t_{DAV}		350	μs
DAVO Pulse Width	PW_{DAV}		selectable (R02, R03)	
DAVO Pulse Width Tolerance	Δ_{DAV}		±10	μs
DACI Interval	t_{DAC}	170		μs
DACI Pulse Width	PW_{DAC}	74		μs
Input (HP-IL ➔ GPIO) Timing				
RDYO Pulse Width	PW_{RDY}	105*		μs
DAVI Delay	t_{DAV}		60†	μs
DAVI Pulse Width	PW_{DAV}	75/740†		μs
DACO Delay	t_{DAC}		280	μs
DACO Turnoff Delay	t_{OFF}		64*	μs
HP-IL Interfacing				
HP-IL Data Rate			1250	bytes/s
$\overline{\text{MSRQ}}$ Input Pulse Width		800		μs
$\overline{\text{GETO}}$ Output Pulse Width		750	850	μs

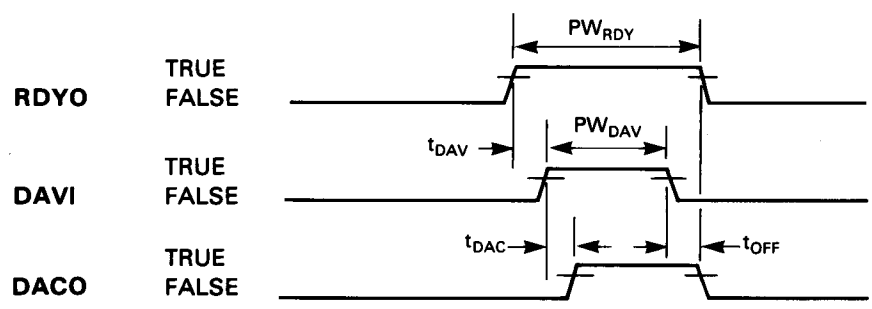
* Unless R01-7 equals 1.

† Use larger PW_{DAV} if DAVI isn't true within t_{DAV}.

Output (HP-IL ➔ GPIO) Timing:



Input (HP-IL ➔ GPIO) Timing:



Appendix A

Care, Warranty, and Service Information

Care of the Interface

The HP 82165A HP-IL/GPIO Interface contains sensitive, electronic components that may be damaged by improper handling and use. Observe the following precautions to minimize the possibility of damage:

- When connecting wires or circuitry to the interface's GPIO interface, be sure the GPIO connector is disconnected from the interface. Plug in the connector *after* all of its external connections have been made.
- Take precautions against damage to the interface's circuitry from electrostatic discharge.
- Observe the electrical specifications listed on page 19.
- Observe the temperature limits listed on page 19.

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. (Some HP-IL controllers may be unable to send the device dependent messages needed for this test.) This test checks the continuity of the interface loop and the operation of most of the interface's circuitry.

1. Connect only the interface and HP-IL controller in the interface loop.

2. Using the controller, make the interface a listener and send it a Device Dependent Listener 1 message. This sets the interface to its Interface/HP-IL test condition.

3. Using the controller, send one or more Data Bytes to the interface.
   - 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 this test again with the external device disconnected from the interface. This will tell whether the external device is interfering with HP-IL communication, possibly due to improper GPIO connections. If the external device isn't causing the problem, then the HP-IL continuity is bad. To determine the cause, try different cables or a different HP-IL peripheral. If HP-IL continuity is a problem for only the interface, then the interface requires service.

4. Using the controller, make the interface a talker and retrieve the previous Data Bytes from the interface. This ends the test.
   - If the retrieved Data Bytes match the original Data Bytes, the tested part of the interface is good. (Only the GPIO interface part of the interface is not tested by this test.)
   - If the retrieved Data Bytes don't match the original Data Bytes, the interface requires service.

Limited One-Year Warranty

What We Will Do

The HP 82165A HP-IL/GPIO 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 than 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
Corvallis Division
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 82165A HP-IL/GPIO Interface is located in Corvallis, Oregon:

Hewlett-Packard Company
Corvallis Division Service Department
P.O. Box 999/1000 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 GmbH
Kleinrechner-Service
Wagramerstr.-Lieblgasse
A-1220 VIENNA
Telephone: (222) 23 65 11

BELGIUM
HEWLETT-PACKARD BELGIUM SA/NV
Boulevard de la Woluwe 100
Woluwelaan
B-1200 BRUSSELS
Telephone: (2) 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)
Telephone: (2) 90 36 91

NETHERLANDS
HEWLETT-PACKARD NEDERLAND B.V.
Van Heuven Goedhartlaan 121
N-1181 KK AMSTELVEEN (Amsterdam)
P.O. Box 667
Telephone: (020) 472021

NORWAY
HEWLETT-PACKARD NORGE A/S
P.O. Box 34
Oesterndalen 18
N-1345 OESTERAAS (Oslo)
Telephone: (2) 17 11 80

SPAIN
HEWLETT-PACKARD ESPANOLA S.A.
Calle Jerez 3
E-MADRID 16
Telephone: (1) 458 2600

SWEDEN
HEWLETT-PACKARD SVERIGE AB
Enighetsvagen 3
Box 205 02
S 161 BROMMA 20 (Stockholm)
Telephone: (8) 730 05 50

SWITZERLAND
HEWLETT-PACKARD (SCHWEIZ) AG
Kleinrechner-Service
Allmend 2
CH-8967 WIDEN
Telephone: (057) 50111

UNITED KINGDOM
HEWLETT-PACKARD Ltd
King Street Lane
GB-WINNERSH, WOKINGHAM
Telephone: (734) 784774

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 one year 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 82165A HP-IL/GPIO 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 turning the interface off and on, 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

Control Register Descriptions

The HP 82165A HP-IL/GPIO Interface contains 19 control registers. These registers control the way that the interface operates, as discussed throughout this manual. The tables shown below summarize the effects of the control registers.

When power is first supplied to the interface or when the RESET key is pressed, the control registers are initialized to the default values shown below. (The value for a register is determined by adding the indicated values of all bits that are "1".) The HP-IL controller can change the contents of the registers using the HP-IL Device Dependent Listener 0 message. (Refer to page 13.)

R00—Service Request Conditions (Default 01000000, Value=64)

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Status Service Request 0=Disable 1=Enable	Manual Service Request 0=Disable 1=Enable	All Status Service Requests 0=Disable 1=Enable	Buffer Busy 0=Disable 1=Enable	Buffer Full 0=Disable 1=Enable	No GPIO Handshake 0=Disable 1=Enable	Data Ready For HP-IL 0=Disable 1=Enable	Ready For HP-IL Data 0=Disable 1=Enable
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

R01—Control and Status of Handshake (Default 00000000, Value=0)

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
DACO and RDYO Control 0=Disable 1=Enable	Not Used	Set DACO 0=False 1=True	Buffer Empty End-of-Data 0=Disable 1=Enable	Set RDYO 0=False 1=True	DACI Status 0=False 1=True	Not Used	RDYI Status 0=False 1=True
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

R02—Handshake and Data Formats (Default 11011000, Value=216)

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Handshake Options 00=Strobed 01=Ready/Valid 10=Valid/Accepted 11=Full		Data Logic 0=Positive 1=Negative	Handshake Logic 0=Positive 1=Negative	DAVO Time Unit 0=100 μs 1=5 μs	Data Format 0=8-bit 1=16-bit	Data Bus Setup 0=Bidirectional 1=Unidirectional	DAVO Timeout 0=Disable 1=Enable
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

R03—DAVO Pulse Width (Default 00000101, Value=5)

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Total value specifies number of DAVO time units added to basic 25-μs DAVO pulse width, except that a value of zero specifies 256 units. (DAVO pulse width is limited to 25 μs plus specified number of time units—40 μs minimum.)							
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

R04—Character Sequences (Default 00000000, Value=0)

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Detect/Delete End-Of-Line Characters 0=Disable 1=Enable	End-Of-Line Detect/Delete Number 0=2 Characters 1=1 Characters	Not Used	Not Used	Insert End-Of-Line Characters 0=Disable 1=Enable	End-Of-Line Insert Number 000=1 Character 001=2 Characters ⋮ ⋮ 111=8 Characters		
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

R05—Eighth From Last End-Of-Line Insert Character (No Default)
R06—Seventh From Last End-Of-Line Insert Character (No Default)
R07—Sixth From Last End-Of-Line Insert Character (No Default)
R08—Fifth From Last End-Of-Line Insert Character (No Default)
R09—Fourth From Last End-Of-Line Insert Character (No Default)
R10—Third From Last End-Of-Line Insert Character (No Default)
R11—Second From Last End-Of-Line Insert Character (No Default)
R12—Last End-Of-Line Insert Character (No Default)
R13—First End-Of-Line Detect/Delete Character (No Default)
R14—Second End-Of-Line Detect/Delete Character (No Default)

BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
Total value specifies 8-bit code of character.							
Value=128	Value=64	Value=32	Value=16	Value=8	Value=4	Value=2	Value=1

R15, R16, R17, R18—Reserved for Future Use

Appendix C

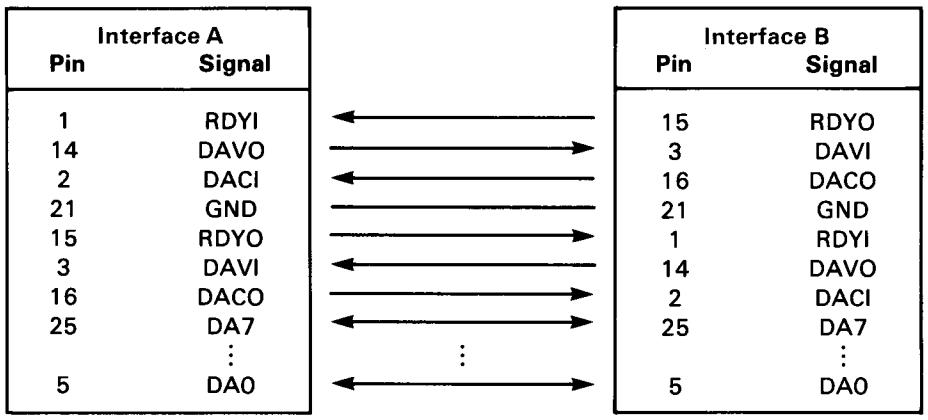
Typical Installations

This appendix illustrates several electrical installations using the HP 82165A HP-IL/GPIO Interface. These examples illustrate the types of GPIO interfacing that may be used.

> Note: The interface's data lines do not have consecutive pin numbers. The diagrams below don't give the pin number for each data line—refer to page 19 or to the interface's label for pin numbers.

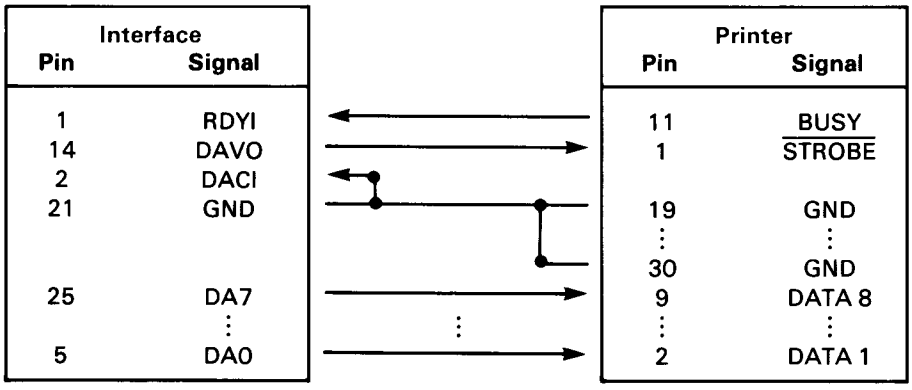
Interface to Interface

Two interfaces may be connected together at their GPIO interfaces. This provides the capability for one HP-IL system to communicate with another HP-IL system. Each HP-IL controller must set up its interface—one for HP-IL→GPIO operation and one for HP-IL←GPIO operation. The control registers are set to their default conditions.



Interface to Parallel Printer

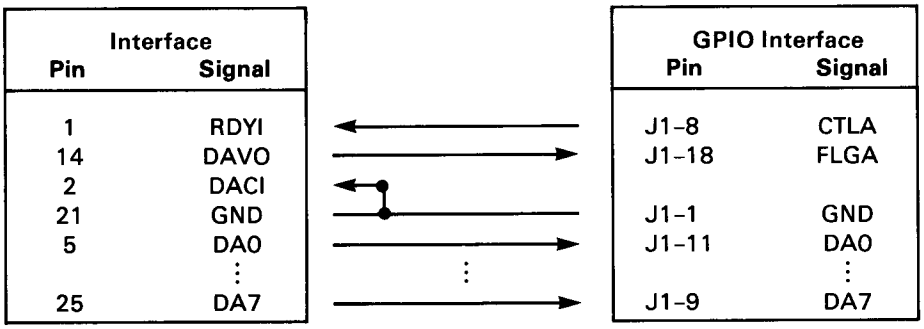
The interface may be connected to a printer that uses a standard printer interface, often called the "parallel printer" or "Centronics-type" interface. Using this installation, the HP-IL controller can print information on a standard printer. The control registers are set to their default conditions. Note that DACI is connected to ground, making this signal always true.



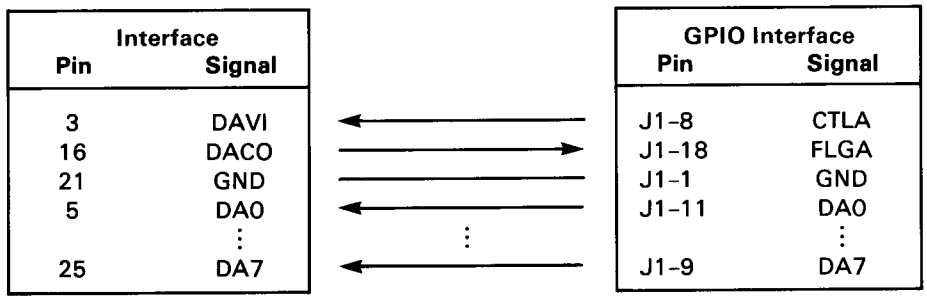
Interface to HP 82940A GPIO Interface

The interface may be connected to a Series 80 GPIO interface using any of the five installations described below. These installations allow a Series 80 computer to interact with HP-IL. For each installation, the computer must use the device address that corresponds to the port configuration.

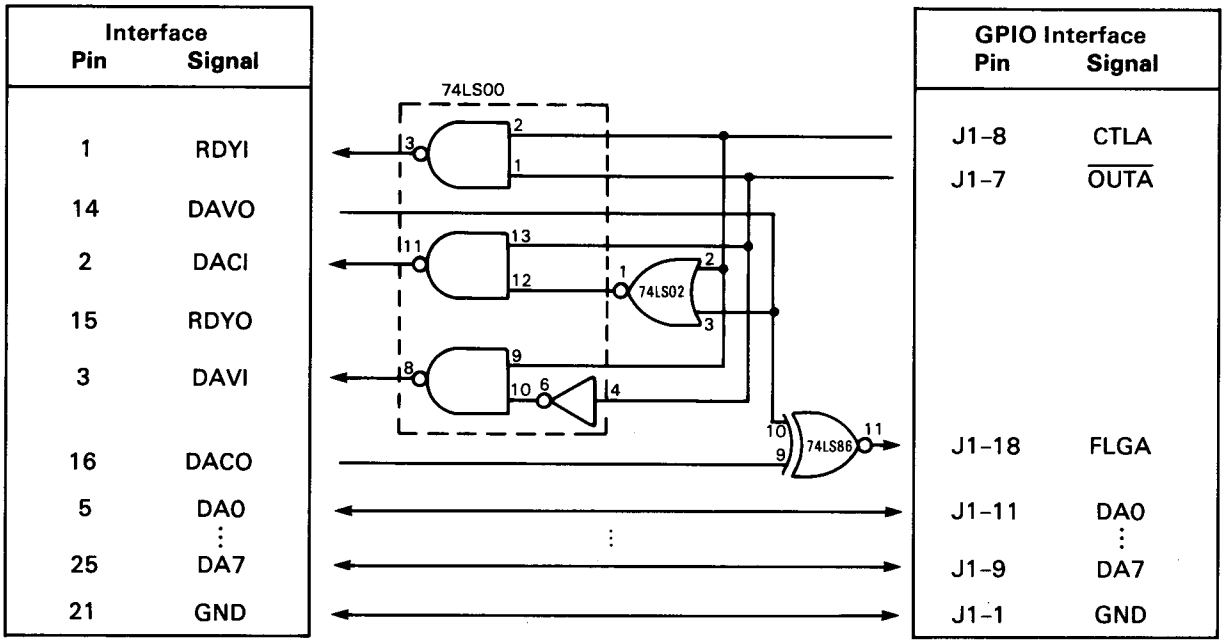
The first installation provides one-way communication from the interface to the GPIO interface. The interface's control registers use their default values. (The GPIO interface must have bit 5 of register 4 equal to 1—Busy to Ready; other registers use their default values.)



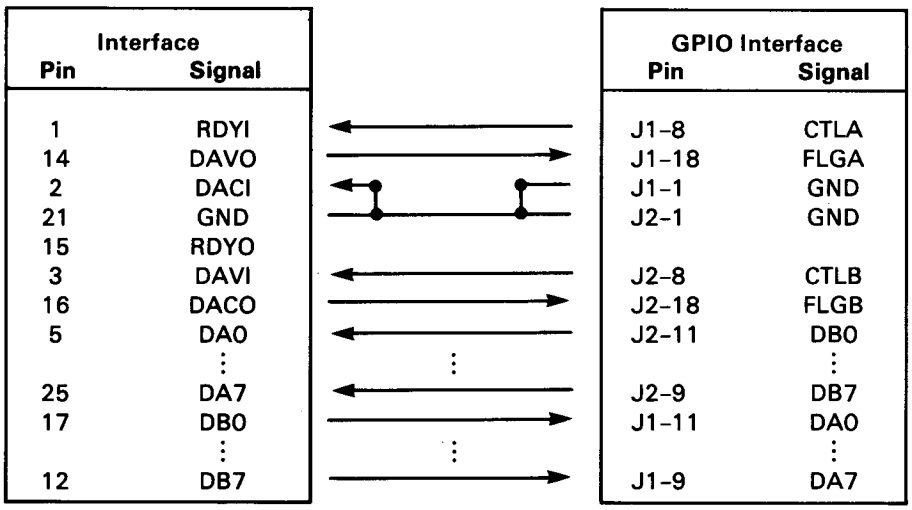
The second installation provides one-way communication from the GPIO interface to the interface. The interface uses the default values for its control registers. (The GPIO interface must have bits 4 and 0 of register 3 equal to 1—FLGA and CTLA negative-true—and bit 0 of register 8 equal to 1—Output Enable A; other registers use their default values.)



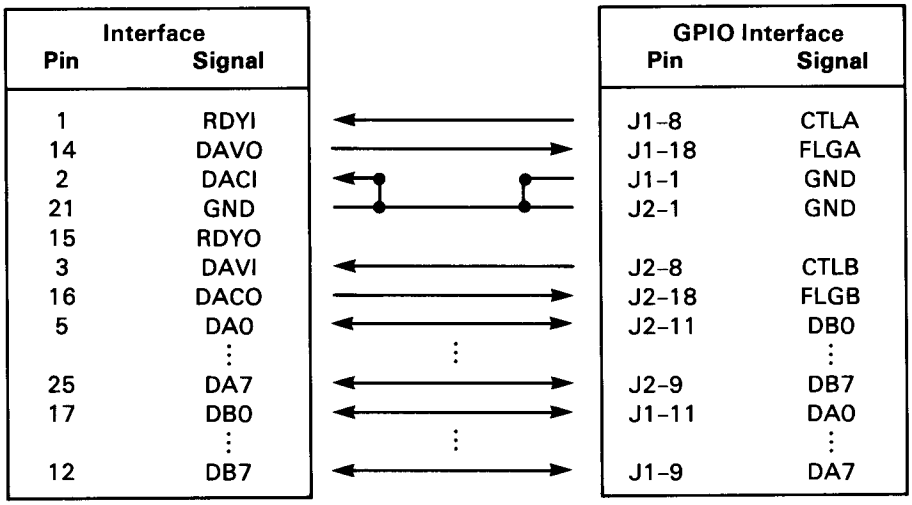
The next installation uses an 8-bit bidirectional data bus. The extra circuitry eliminates the need to modify the interface's control registers—the default values can be used. (The GPIO interface must have bit 0 of register 8 equal to 1—Output Enable A; other registers use their default values.)



This installation uses an 8-bit unidirectional data bus. It doesn't require any extra circuitry, although the interface's control registers must be modified. Control register R02 must be set to 11001010 (value 202)—full handshake, positive data and handshake logic, 5-μs time unit, 8-bit unidirectional data, disabled timeout; other control regesters may be set to their default values. (The GPIO interface must have bit 1 of register 8 equal to 1—Output Enable B; other registers use their default values.)



The last installation uses a 16-bit bidirectional data bus. Control register R02 must be set to 11001100 (value 204)—full handshake, positive data and handshake logic, 5-μs time unit, 16-bit bidirectional data, disabled timeout; other control registers may be set to their default values. (The GPIO interface must have bits 1 and 0 of regester 8 equal to 1—Output Enable B and Output Enable A; other registers use their default values.)



Appendix D

Using the HP-41 As a Controller

The HP-41 calculator, when used with an HP 82160A HP-IL Module, can control the interface and its external device. The following interface control functions are useful for sending instructions and sending and receiving information.

Function	Response
Calculator ➔ Interface	
[OUTA]*	Sends the character codes of the characters in the ALPHA register to the interface and external device, followed by an end-of-line indicator (unless suppressed by flag 17 set).
[ACA]†	Sends the character codes of the characters in the ALPHA register to the interface and external device. No end-of-line indicator is sent.
[PRA]†	Sends the character codes of the characters in the ALPHA register to the interface and external device, followed by an end-of-line indicator.
[ACX]†	Sends the character codes of the digits in the X-register (using the current display format) to the interface and external device. No end-of-line indicator is sent.
[PRX]†	Sends the character codes of the digits in the X-register (using the current display format) to the interface and external device, followed by an end-of-line indicator.
[ACCHR]†	Sends the character code specified in the X-register to the interface and external device. This enables you to send characters that aren't among the standard HP-41 character set, such as Escape (code 27) and Bell (code 7). No end-of-line indicator is sent. (Characters 10, 13, and 126 can't be sent with this function.)
[ADV]†	Sends an end-of-line indicator to the interface and external device.
[PRBUF]†	Sends an end-of-line indicator to the interface and external device.
[TRIGGER]*	Makes the interface signal the external device on the $\overline{\text{GETO}}$ line.
Calculator ⬅ Interface	
[INA]‡	Fetches the character codes of up to 24 characters from the interface's transfer buffer. The characters are stored in the ALPHA register.
[IND]‡	Fetches the character codes of a sequence of digits from the interface's transfer buffer. The characters are interpreted as a number, which is placed in the X-register.
[INSTAT]‡	Fetches one number (byte) representing the interface's current status and allows the status register to be updated. Flags 00 through 07 are set according to the eight status bit values, and the status number (modulo 64) is placed in the X-register.
[FINDID]	If the ALPHA register contains **HP82165**, the address of the interface is placed in the X-register.

* The interface must either be the primary device selected by the HP-41 or—under certain conditions—be a listener (using [LISTEN]).

† The interface must be the primary device selected by the HP-41 and the calculator must be in Manual mode (using [MANIO]).

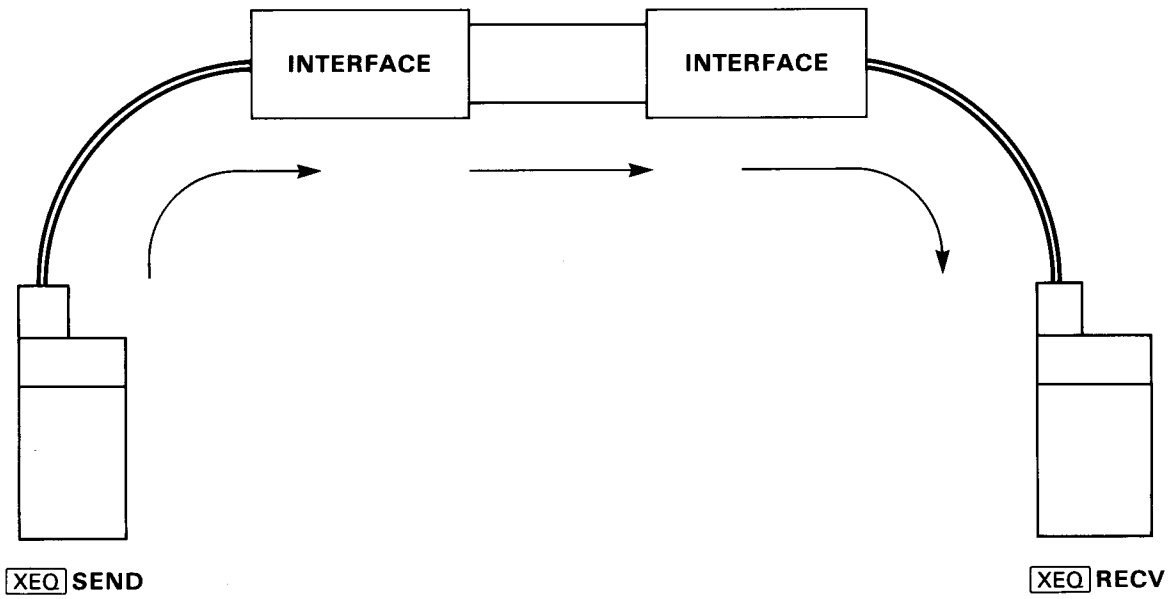
‡ The interface must be the primary device selected by the HP-41.

The end-of-line indicator for the HP-41 is Carriage Return (CR), Linefeed (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. If flag 17 is set, the HP-41 doesn't send CR LF at the end of Data Byte sequences and ignores CR LF in sequences it receives. However, note that several functions *always* include an end-of-line indicator, regardless of the status of flag 17.

In addition to the functions listed above, any of the general printer functions in the HP-IL module may be used to send information to the interface and external device. Each line of information as formatted by a printer function is always followed by an end-of-line indicator. To use these functions, ensure that the interface is the primary device selected by the HP-41 and that the calculator is in Manual mode.

Note that the HP 82160A HP-IL Module doesn't give the HP-41 the capability of sending device dependent messages. For this reason, *the calculator and HP-IL module can't store or read data in the interface's control registers*—you must use the interface with the default values in its control registers. (Also, the calculator and HP-IL module can't perform the Interface/HP-IL test described in appendix A.)

Application: Passing Information Between Systems. In this application, two HP-IL systems are connected by interfaces. Each loop is controlled by one HP-41. One loop is set up for the HP-41 to send data to an interface. The other loop is set up for the HP-41 to receive data from an interface. (Connect the interfaces as shown in appendix C.)



The following program is stored in each calculator. Execute "RECV" on the calculator that is to receive ALPHA data, and execute "SEND" on the calculator that is to send ALPHA data. Then enter a message at the sender followed by [R/S].

```
01◆LBL "RECV"        Program to receive ALPHA data.
02  XEQ "SELINT"     Selects interface as primary device.
03◆LBL 01
04  INSTAT           Fetches current interface status.
05  FC? 01           Tests bit 1 of status (Data Ready For HP-IL).
06  GTO 01           Branch for "0" in bit 1.
07  INA              Fetches ALPHA data.
08  AVIEW            Displays ALPHA register.
09  GTO 01           Branches to status loop.
10◆LBL "SEND"        Program to send ALPHA data.
11  XEQ "SELINT"     Selects interface as primary device.
12◆LBL 02
13  "MESSAGE?"       Enters prompt message.
14  AON              Activates ALPHA mode.
15  PROMPT           Prompts for ALPHA input.
16  AOFF
17  OUTA             Sends ALPHA data.
18  GTO 02
19◆LBL "SELINT"      Subroutine to select interface as primary device.
20  "HP82165"        Specifies interface's identity.
21  FINDID           Places interface's address in X-register.
22  X=0?
23  STOP             Stops execution if interface isn't in loop.
24  SELECT           Selects interface as primary device.
25  CF 17            Specifies use of end-of-line indicators.
26  RTN
```

Application: Controlling a Printer. In this application, an HP-41 controls a interface connected to a parallel printer—in this example, a Centronics 737-1 printer. (The printer is connected to the interface as described in the second example in appendix C.) This printer responds to special instructions encoded as "control codes"—sequences of character codes—listed below. (Other printers may have different coding or different capabilities.)

Character Code Sequence	Instruction
14	Terminates underlined printing.
15	Selects underlined printing.
27, 14	Selects elongated printing for one line only.
27, 17	Selects secondary (proportional) character set.
27, 19	Selects primary character set.

The following program for the HP-41 enables you to print using elongated secondary characters or normal primary characters, either underlined or not underlined. Set flag 01 for underlined printing, or clear flag 01 for printing without underlining. Place the desired characters in the ALPHA register, then execute "PNORM" for normal primary characters or "SLONG" for elongated secondary characters. (The program assumes that the interface is the primary device and that the calculator is in Manual mode.)

```
01◆LBL "PNORM"
02  27
03  ACCHR
04  CLX
05  19
06  ACCHR
07  GTO 05
08◆LBL "SLONG"
09  27
10  ACCHR
11  CLX
12  17
13  ACCHR
14  CLX
15  27
16  ACCHR
17  CLX
18  14
19  ACCHR
20◆LBL 05
21  CLX
22  15
23  FS? 01
24  ACCHR
25  ACA
26  CLX
27  14
28  ACCHR
31  PRBUF
32  CLX
33  +
34  RTN
```

Selects primary character set.

Selects secondary character set.

Selects elongated printing.

Selects underlined printing if flag 01 set.

Sends contents of ALPHA register.

Terminates underlined printing, if used.

Sends CR LF (and prints line).

Restores X-register.

HP 82165A HP-IL/GPIO Interface
Owner's Manual

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HP 82166A
HP-IL Converter

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Introduction

The information in this supplement applies to the HP 82165A HP-IL/GPIO Interface and to the HP 82166A HP-IL Converter. Additional technical information not contained in the owner's manuals is provided here to assist in the proper application of these two products. You should refer to the owner's manuals supplied with these products for other operating information. In addition, this supplement provides corrections to the manuals.

Because these two products are nearly identical functionally, the information in this supplement refers to both unless explicitly stated otherwise. The term "converter" refers to both products throughout this supplement. Page references to the *HP 82166A HP-IL Converter Technical Manual* (part number 82166-90002, dated November 1981) will be given when appropriate followed by the corresponding page references to the *HP 82165A HP-IL/GPIO Interface Owner's Manual* (part number 82165-90002, dated February 1982) contained in parentheses—for example, page 12 (14). If information contained herein conflicts with information in the owner's manuals, this supplement takes precedence.

Important Information for HP-41 Owners

The HP 82160A HP-IL Module for the HP-41 Handheld Computer does not by itself provide functions to access the converter control registers. This means that the converter can be used only in its power-on default operating mode: eight-bit bidirectional data bus, full three-line handshake, positive (high-true) data bus logic, negative (low-true) handshake line logic, and service request for manual service request only. Additional operations that cannot be performed with the HP-IL module alone are the converter/HP-IL test, the clear transfer buffer command, and operation using service requests. This default operation mode is sufficient for many applications.

The HP 82183A Extended I/O Module (available March 1983), when used with the HP-IL module, provides the additional functions needed to access the other converter operating modes for those applications that require them. While it was not designed with this purpose in mind, the HP-IL Development Module, part number 00041-15043 (available December 1982), also contains a set of functions which can provide this extra capability when used with the HP-IL module.

Additional information regarding the use of the HP-41 and the HP-IL module with the converter is contained in Appendix D, "Using the HP-41 As a Controller," page 33 (34), as well as in the HP-IL module owner's manual. Information on the extended I/O module and the HP-IL development module can be found in their respective owner's manuals.

The Transfer Buffer

All the data that passes through the converter is stored temporarily in the transfer buffer. There is only one transfer buffer. It can contain data bytes being sent from HP-IL to the GPIO device or bytes being sent from the GPIO device to HP-IL, but not both simultaneously. If the buffer contains data received from the GPIO device and HP-IL performs a write operation to the converter, the data from the GPIO device will be lost. If the buffer has data from HP-IL, the GPIO device cannot write into the converter buffer since the RDYO line will not go true. This will be a problem only in applications where data must pass in both directions. Loss of data from GPIO can be avoided by reading the converter status before writing data from HP-IL into the buffer.

Although the transfer buffer consists of 32 registers, it will never hold 32 bytes of data. If the GPIO device is not accepting data, HP-IL can put 30 bytes of data into the transfer buffer. The 31st byte will be held by the converter and not retransmitted on the loop. When the GPIO device accepts some data, thereby making room in the buffer, this byte will be retransmitted on the loop (and loaded into the buffer), and the transmission of data can continue. If the GPIO device does not respond, the converter will hold the 31st byte indefinitely or until the controller times out. In this situation, the controller normally aborts the data transmission and displays an error message.

If the GPIO device is sending data to HP-IL, the converter buffer can contain up to 31 bytes of data from the GPIO device. In this condition, the RDYO line will not go true, so the GPIO device cannot write any more data into the converter. When HP-IL reads one or more bytes from the buffer, the RDYO line will once again go true, and the GPIO device can continue sending its data.

Information on the transfer buffer is found on page 6 (8), 11–13 (13–15), 16 (18), and 27–28 (28–29).

The Status Byte and Service Requests

An application that only sends data to the GPIO device may not require status information. If the GPIO device is faster than the sourcing device, the buffer will never have more than one or two bytes in it. The data transmission will take place without interruption at the rate of the sourcing device. On the other hand, if the GPIO device is slower than the sourcing device, the buffer may fill up. When this occurs and another byte is sourced, the converter simply holds up the loop transfer until the GPIO device accepts a byte, thereby making room in the buffer. In this case, the data transmission takes place with brief interruptions at the rate of the GPIO device.

When the GPIO device must send data to HP-IL, when data must flow both ways, or when I/O operations need to be interleaved, it is important to know the converter status so the controller can determine what needs to be done next. Most of the status indications are related to the transfer buffer.

If the decimal value of the returned status byte is 1, the converter is ready to receive data from HP-IL. This could mean the buffer is empty, or it could mean that the buffer still contains some data from HP-IL which is flowing steadily out to the GPIO device and more data can be accepted from HP-IL immediately. If the status value is 8, the buffer has some data from HP-IL, but the data is not flowing out to the GPIO device. This usually means that the GPIO device did not set the RDYI handshake line true. If the DAVO timeout option is enabled in the converter control registers, it could mean that although the RDYI line was true, the GPIO device did not accept the data byte by driving the DACI line true before the timeout period expired.

However, in most situations the convertor returns a value of 1 even though the GPIO device is not taking the data. If the Interface Clear message is sent to the converter just prior to reading its status, it will update the status internally and return the correct value, either 8 or 1. For example, the HP-41 sends this message by executing the [STOPIO] function. Note that the Interface Clear message does not change the data in any way.

When data is being sent from HP-IL to GPIO, the status will always be either 1 or 8. Even though the buffer is full (30 bytes), the buffer full status value of 4 will *not* be indicated. Furthermore, data cannot be sent from the GPIO device while data from HP-IL is in the buffer since the RDYO line will not go true, so that the buffer busy status value of 16 will also never be generated.

A status value of 2 indicates that the buffer contains some data from the GPIO device and is ready to send it to HP-IL. When the status byte is 6, the transfer buffer has received 31 bytes of data from the GPIO device and will accept no more until some of the data is read out of the buffer by HP-IL.

On the HP 82165A HP-IL/GPIO Interface only, the front panel MSRQ (manual service request) key simply connects the $\overline{\text{MSRQ}}$ line (pin 13) to ground while it is pressed. On both products, the status value of 32 (Manual Service Request) is returned only if status is read while the $\overline{\text{MSRQ}}$ line is grounded. The Manual Servcie Request condition is not automatically retained until the status is read.

Each of the status conditions (as well as the Manual Service Request condition) can be used to generate a service request on the loop (sets bit C0 in Data and Identify messages). The power-on default condition is that Manual Service Request will generate a service request, while the status conditions do not. This default can be changed by setting or clearing the appropriate bits in control register R00. If bit 7 is set to enable status service requests, either bit 5 can be set to enable *any* change in status to cause a service request, or bit 5 can be left clear and combinations of bits 4 through 0 can be set to cause *particular* status conditions to send a service request.

Information on the converter status and service requests is found on pages 12–13 (14–15) and 27–28 (28–29).

The Handshake Lines

Before the operation of the handshake lines can be thoroughly understood, some familiarity with the microprocessor program structure is needed. All of the I/O operations of the converter are done by polling rather than by interrupts. The converter's internal program simply runs in a continuous loop checking to see if an HP-IL or GPIO operation needs to be done. The operation of this program loop is the same regardless of whether the converter is the talker or a listener on HP-IL. Only the transfer buffer and the handshake lines affect this program loop. (The program is illustrated on the following page.)

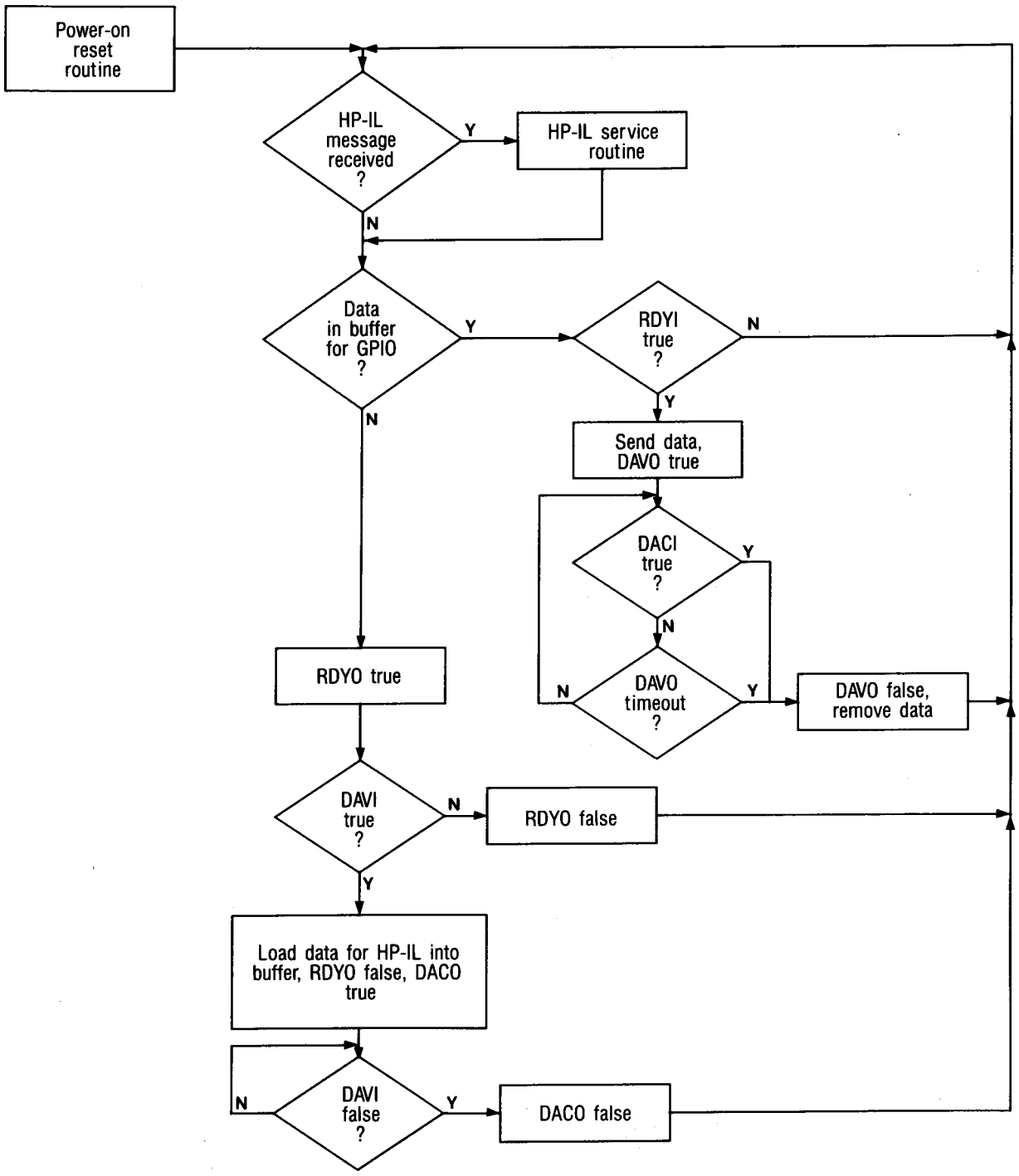
At the top of the loop, HP-IL is polled to see if a message has been received. If it has, the appropriate action is taken, which might include retransmitting the received message on the loop, or perhaps sending a data byte from the transfer buffer to the loop.

Next, the microprocessor checks to see if there is data in the buffer waiting to be sent to the GPIO device. If there is, the state of the RDYI line is checked. If the GPIO device is not ready (RDYI false), the internal program simply goes back to the top of the loop. If the GPIO device is ready (RDYI true), the converter sends the byte on the data bus lines and sets the DAVO line true. Then the converter waits until the GPIO device accepts the data by driving the DACI line true. When this occurs, the microprocessor goes back to the top of the loop and continues.

If the GPIO device does not respond by driving the DACI line true, the converter will wait indefinitely. This means that HP-IL will not function during this time, since the converter cannot respond to a received message until it gets back to the top of the loop. If necessary, the DAVO timeout option can be enabled to handle this situation. By appropriate settings for control register R02-3,0 and control register R03, the converter can be made to wait only the specified amount of time in this state and then remove the data from the data bus lines and drive the DAVO line false if the GPIO device has not responded. The data byte is retained in the converter buffer and the converter program will attempt to output the byte again the next time through the loop.

Use the following information instead of the output (HP-IL → GPIO) timing numbers in the table on page 19 (20). The following paragraphs provide the appropriate information for interfacing in any one of the four output handshake modes. Refer to the diagrams on page 15 (17).

In the full handshake mode (default), the GPIO device may set the RDYI line true at any time to indicate that it is ready to receive data. The GPIO device must hold the RDYI line true until the converter responds by driving the data bus lines and the DAVO line true. If there is no data in the buffer, the GPIO device should simply wait until there is. If there is data in the buffer, the delay from RDYI true to DAVO true may range from about 250 microseconds to 1 millisecond. As soon as the DAVO line is true, the GPIO device may accept the data and



drive the DACI line true to indicate this. If the GPIO device does not drive the DACI line true immediately, the converter will simply wait until it does (unless the DAVO timeout option is enabled, as described previously). The GPIO device now holds the DACI line true until the converter removes the data and sets the DAVO line back to its false state (about 80 microseconds). Then the GPIO device can return the RDYI and DACI lines to the false state, thus completing the cycle. This should be done within about 50 microseconds after the DAVO line goes false so that the converter will not try to send a second byte on the same cycle.

In the valid/accepted handshake mode, the RDYI line is not used. When there is data in the buffer, the converter simply drives the data bus lines and the DAVO line true. The converter now waits until the GPIO device

signals acceptance of the byte by setting the DACI line true. (The DAVO timeout option may be used here, also.) The GPIO device holds the DACI line true until the converter removes the data and drives the DAVO line false again (about 80 microseconds). The GPIO device must return the DACI line to its false state within about 50 microseconds after the DAVO line goes false so that a second byte will not be sent on the same cycle. Note that if the GPIO device simply holds the RDYI line always true in the full handshake mode, the result is the same as the valid/accepted mode just described.

The DACI line is not used in the ready/valid handshake mode. The GPIO device simply sets the RDYI line true when it is ready to accept data. If there is data in the buffer there will be a delay (250 microseconds to 1 millisecond) and then the converter will drive the data bus lines and the DAVO line true. The DAVO line will remain true for a period of time determined by control registers R02-3 and R03. (There is no DAVO timeout option in this mode.) The GPIO device should return the RDYI line to its false state within about 50 microseconds after the DAVO line goes false to prevent a double byte transfer. If the GPIO device holds the DACI line always true in the full handshake mode, the result is the same as the ready/valid mode except for the length of the DAVO pulse.

Neither the RDYI line nor the DACI line are used in the strobed output mode. When there is data in the buffer the converter simply drives the data bus lines and the DAVO line true for a length of time determined by control registers R02-3 and R03. (There is no DAVO timeout option here, either.) If the GPIO device holds the RDYI line and the DACI line always true in the full handshake mode, the result is the same as the strobed output mode except for the length of the DAVO pulse.

Note: On the HP 82165A HP-IL/GPIO Interface only, the GPIO device should not use the leading edge of the DAVO line to latch data from the converter. The data is not valid until approximately 50 nanoseconds after the leading edge of the DAVO pulse. This does not apply to the HP 82166A HP-IL Converter.

If there is no data to be sent to the GPIO device, the microprocessor checks to see if the GPIO device wants to send data to HP-IL. It does this by driving the RDYO line true and then waiting a short time to see if the GPIO device drives the DAVI line true to indicate that the data on the data bus is valid. If the GPIO device does not respond, the converter returns the RDYO line to its normal false state and goes back to the top of the loop. Consequently, when no data is being transferred, a series of pulses will be transmitted on the RDYO line, one pulse each time the microprocessor passes through the polling loop. If there is data in the buffer to be sent to the GPIO device, there will be no RDYO pulses and the converter will not be able to receive data from the GPIO device.

After the GPIO device puts data on the bus and sets the DAVI line true in response to the RDYO pulse, the converter will load the data into the buffer and set the DACO line true and the RDYO line false. The GPIO device now returns the DAVI line to its false state and removes the data from the bus. At this point, the converter resets the DACO line to its false state and goes back to the top of the loop.

In order for the converter to recognize that the GPIO device wants to send data, the DAVI line must be true sometime during a time window starting at the leading edge of the RDYO pulse (about 60 microseconds). If the device does not set the DAVI line quickly enough, it will simply need to wait for the next RDYO pulse, holding the data and the DAVI line true until the converter drives the DACO line true.

The external device must use the RDYO line in order to know whether or not the converter can receive data. If the external device responds quickly enough to the RDYO pulse and carefully controls the length of time that it drives the data and the DAVI lines true, then it need not use the DACO line. However, it will generally be easier for the device to simply drive the data and the DAVI lines true when the RDYO line goes true and remove the data and set the DAVI line false when the DACO line goes true. This information should clarify the paragraphs near the bottom of page 7 (9), "GPIO Input Handshake Lines (RDYO, DAVI, DACO)" and on page 14 (17), "For HP-IL ← GPIO operations, ..." Refer to the input (HP-IL ← GPIO) timing characteristics in the table on page 19 (20).

Note that the microprocessor waits until the GPIO device removes its data and drives the DAVI line false before it returns the DACO line to its normal false state. If the GPIO device holds the DAVI line true and does not return it to the false state, the converter will wait indefinitely for this to happen. As before, HP-IL will not be functional while the GPIO device holds the converter in this state. There is no timeout option for this situation.

In the diagram at the bottom of page 15 (17), "HP-IL ← GPIO Operation," the blue arrow from the trailing edge of the DAVI pulse to the trailing edge of the RDYO pulse should be drawn from the leading edge of the DAVI pulse to the trailing edge of the RDYO pulse. Also, all the diagrams on page 15 (17) indicate the logical state of the handshake lines—not the voltage level. If negative handshake logic is active (the default condition), the true state (shown as high in the diagrams) corresponds to zero voltage, and the false state (low in the diagrams) corresponds to a positive voltage. If positive handshake logic is active, the logic levels shown in the diagram correspond to the actual voltage levels.

A lock-up condition can occur if a GPIO device using positive handshake logic is connected to the converter and is powered on before or at the same time as the converter. The GPIO device will power on with the DAVI line driven false (its normal condition), which is low. The converter powers on reading the low DAVI line as a true condition, however, and stops in the loop waiting for the DAVI line to go high (false). The control registers cannot be modified to remove the lock-up, since the program cannot return to the HP-IL service routine.

In order to use positive handshake logic, it is necessary to first set the control registers in the converter and then connect the GPIO device. An alternative is for the GPIO device to hold the DAVI line high until the converter control registers are properly set from HP-IL. Because of this, use of positive handshake logic may cause one invalid data byte to be accepted from the GPIO device at power-on only.

One other situation which can arise is best illustrated by considering two converters connected back-to-back on GPIO. If HP-IL writes, say, 40 bytes of data into the first converter, GPIO will transfer 31 bytes into the second converter's buffer, and 9 bytes will remain in the first converter's buffer to be sent later. Now if HP-IL writes some data into the second converter, the 31 bytes will be destroyed, and both converters will be locked up, waiting to send data to the other on GPIO. Neither can accept the other's data since the HP-IL data in the buffer prevents either converter from driving its RDYO line true. A clear buffer command or power-on reset is needed to recover from this situation. Unusual circumstances might also cause a similar condition to occur with a GPIO device and a converter. HP-IL continues to function in this case.

Additional Information

The following information applies to the HP 82165A HP-IL/GPIO Interface manual only:

On page (6) the box in the diagram should be labeled "HP-IL/GPIO Interface" rather than "HP-IL/RS-232 Interface".

On page (9) under "Power Supply," add the sentence "The interface is isolated from earth ground by the AC adapter."

On page (9) under "GPIO Output Handshake Lines (RDYI, DAVO, DACI)," the phrase "when DAVO is false, the data bus lines are high" should read "when DAVO is false, the data bus lines are undefined."

On page (10) under "HP-IL Interfacing Output Line (GETO)," the sentence "An active low signal on the GETO line sets a Group Execute Trigger message" should read "The GETO line is normally driven high by the interface. When an HP-IL Group Execute Trigger message is received, the interface pulses this line low briefly."

On page (11) the entry in the table next to "Ready for Command" should be "No response" rather than "Executes a pending Loop Power Down message."

On page (16) add the following note to the table at the top of the page, "In the eight-bit unidirectional configuration, data bus A receives data from the external device and data bus B sends data to the external device."

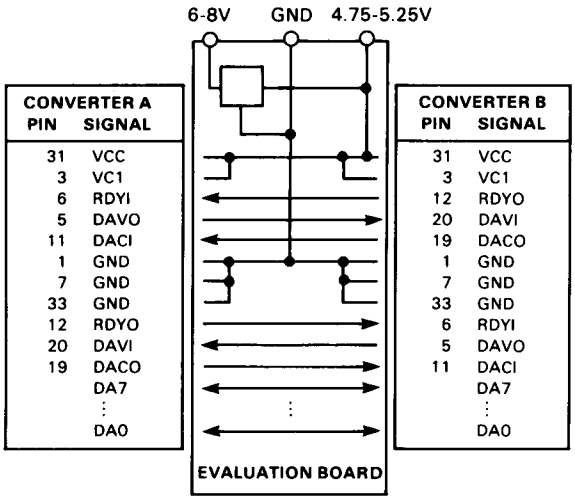
On page (19) under "Electrical Characteristics," the entry for "Voltage to Any Pin" should include a minimum of −0.3V. Also, delete the last four lines of the table, beginning with "Output Current, High Level."

The following information applies to the HP 82166A HP-IL Converter manual only:

On page 11 in the bottom table, the response for the Device Dependent Talker 0 message (Send Control Registers) should include the sentence "The transfer buffer is cleared." The response for the Device Dependent Talker 2 message (Enable End-Of-Line) should include the sentence "The GPIO end-of-line sequence must be the last data bytes in the buffer."

On page 18, under "Electrical Characteristics," the specification for "Supply Ripple Voltage" should be deleted.

On page 29 under "Converter to Converter," the evaluation board has been changed to provide more convenient operation. Change the supply voltages in the second paragraph to 4.75 to 5.25 Vdc and 6 to 8 Vdc. Delete the caution—the evaluation board won't be damaged by operating it with less than two units connected. Revise the diagram of the board as shown below.



The following information applies to both manuals:

On page 13 (15) in the table, the designations "Bit 1", "Bit 2", etc. should be changed to "D0", "D1", etc.

On page 19 (20) in the lower timing diagram, the vertical line extending through the trailing edges of both RDYO and DACO should be two separate lines. The end of the RDYO pulse is not related to the end of the DACO pulse.

On page 36 (37) the last four lines in the program example should be numbered consecutively with the previous line.