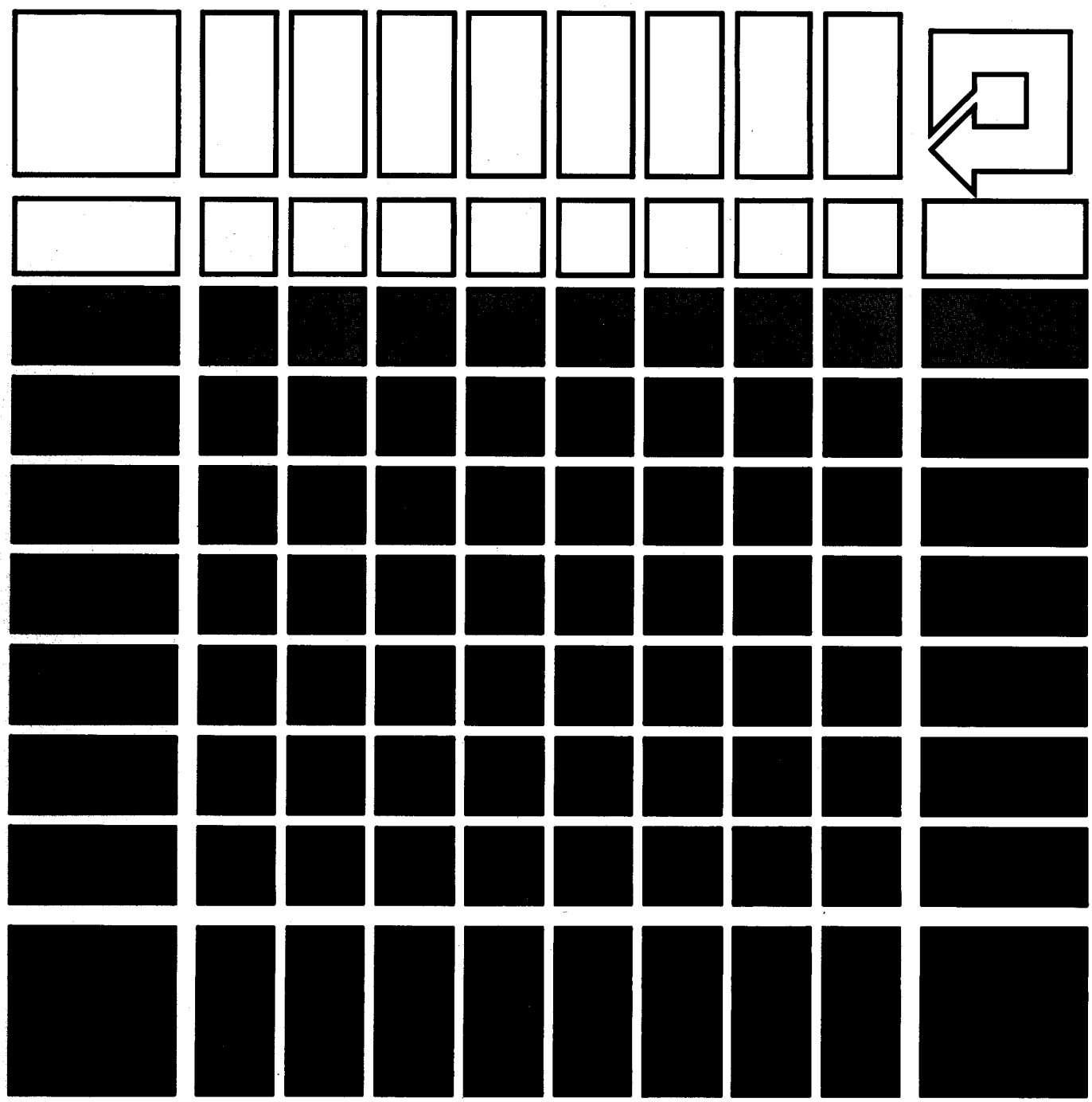
HEWLETT-PACKARD

HP 82166A

HP-IL Converter

TECHNICAL MANUAL



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Technical Manual

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Contents

Introduction

The HP 82166A HP-IL Converter provides the capability to convert an external device with general-purpose input/output (GPIO) capabilities into a device compatible with the Hewlett-Packard Interface Loop (HP-IL).

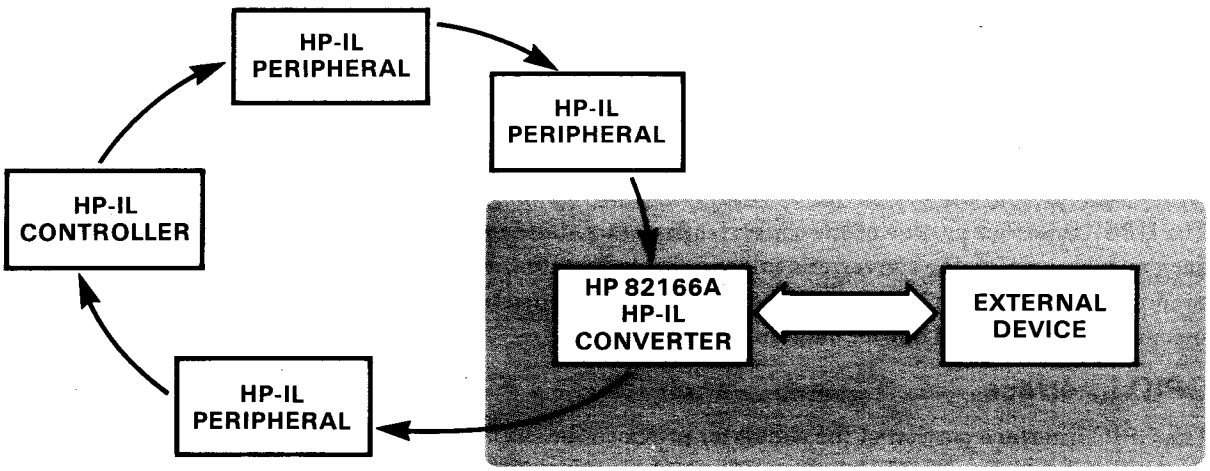
The converter package includes the following:

- Two HP 82166A HP-IL Converters
- Two HP-IL cables.
- Two GPIO connectors.
- An evaluation board.

This manual gives information about the converter'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 integrating the converter and the external device. (Typical installations and a description of the evaluation board are included in appendix C.)

An Overview of the HP-IL Converter

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 converter. The converter 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 peripheral.



If the controller needs to send data to the external device, the controller first makes the converter a *listener*, which means that the converter is set to accept data from HP-IL and send 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 converter, it stores them internally. Meanwhile, the converter sends the data to the external device one character at a time. The converter uses its three GPIO output "handshake" lines (RDYI, DAVO, and DACI) to control the flow of data on the GPIO data lines. When the external device sets RDYI (*ready*) true, the converter 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 converter is transferred to the external device. This is called HP-IL ➔ GPIO ("HP-IL to GPIO") operation.

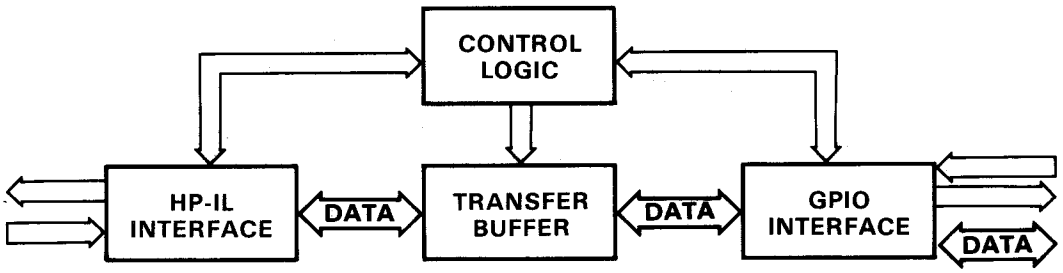
If the controller needs the external device to send data to listeners on HP-IL, the controller first makes the converter a *talker*, which means that the converter is set to accept data from the external device and send it on HP-IL. The controller then directs the converter to start sending data. The converter uses its three

GPIO input "handshake" lines (RDYO, DAVI, and DACO) to control the flow of data on the data lines. It sets the RDYO line true. When the external device places one byte on the data lines, it sets DAVI true. The converter sets the DACO line true when it has accepted the data byte and has stored it internally. The converter accepts and stores additional bytes in the same manner. Meanwhile, the converter sends each byte on HP-IL, where it is received by all HP-IL listeners. This is called HP-IL ← GPIO ("HP-IL from GPIO") operation.

This example illustrates one way that the converter can be used. However, the converter is a general-purpose interfacing device. It can be set up to operate in several different ways. Using the converter 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 82166A HP-IL Converter with a particular external device.

Internal Design

The HP-IL converter has four primary features that are important for understanding the converter's operation: the HP-IL interface, the GPIO interface, the transfer buffer, and the control logic.



HP-IL Interface

The HP-IL interface portion of the converter performs standard operations required by the interface loop, such as maintaining the converter'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 converter provides the connection to the external device. The physical connection consists of a 34-pin connector on the printed-circuit assembly. By making the appropriate connections, the external device provides power to the converter and uses signal lines to send and receive information from the converter. The signal lines include two GPIO data buses, GPIO handshake lines, HP-IL interfacing lines, and indicator lines. (Signal descriptions are discussed on page 7.)

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 converter 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 converter. It includes registers that store operating information: the control registers and the status register.

Control Registers. The operation of the converter 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 converter, 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 11.)

> 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 converter is stored in the status register. This register stores one byte of status information, described on page 12.

Signal Descriptions

The HP-IL converter provides two interfaces: a pair of standard HP-IL receptacles in the front panel and a 34-pin GPIO connector at th rear of the unit. (Electrical and timing specifications are listed on pages 18 and 19.)

HP-IL Signals

The converter provides full electrical and mechanical compatibility with HP-IL. The converter'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 converter provides two bidirectional GPIO data buses, six GPIO handshake lines, five HP-IL interfacing lines, and two indicator lines. These lines are available to the external device at the 34-pin GPIO connector.

Each input and output line is TTL-compatible. Each line (except for WKUP) has an internal 6K (typical) pullup resistor.

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 directly to and from the transfer buffer.

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 to and from the transfer buffer, and it also is used for internal communication.

> Note: If the external device uses Data Bus B, it must not interfere with these lines while the $\overline{CS}$ output line is low. This bus is used for internal communication while $\overline{CS}$ is low.

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 converter 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 converter has received the data. (The external device is not required to use the RDYO and DACO output signals.)

HP-IL Interfacing Input Line ($\overline{MSRQ}$). This input line controls the converter's interaction with HP-IL. An active low $\overline{MSRQ}$ signal causes the converter 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 Lines ($\overline{\text{DCLO}}$, $\overline{\text{GETO}}$, $\overline{\text{PWDN}}$, WKUP). Three of these output lines inform the external device of certain messages received on HP-IL. An active low signal occurs on $\overline{\text{DCLO}}$ for a Device Clear or Selected Device Clear message, on $\overline{\text{GETO}}$ for a Group Execute Trigger message, or on $\overline{\text{PWDN}}$ for a Loop Power Down message.

The WKUP output line transmits a series of pulses to the external device each time an HP-IL message is received—even if no power is supplied to the converter. This permits the external device to provide power to the converter in response to any incoming HP-IL message—particularly if the external device responds to a Loop Power Down message.

Indicator Lines ($\overline{\text{CS}}$, HLLO). These output lines inform the external device of conditions in the converter. An active low $\overline{\text{CS}}$ signal indicates that Data Bus B is being used for internal communication and should not be used by the external device. A high (or low) HLLO signal indicates that the six GPIO handshake lines are using negative logic (or positive logic). The HLLO signal is determined by R02-4.

Power Connections

The external device uses five lines at the GPIO connector to provide power to the converter.

Power Lines (VCC, VC1). These two lines should be connected to a +5V (+4.75V to +5.25V) power supply.

Ground Lines (GND). The converter has *two* grounds: a signal ground (pins 7 and 33) and an HP-IL reference ground (pin 1). The two grounds are *not* connected internally—*they must be connected together externally*. That is, pin 1 must be connected to pin 7 or pin 33 or both.

The two grounds may be connected together near the GPIO connector; however, high levels of electrostatic discharge (ESD) may reset the converter. If the two grounds are connected together as close as possible to the power supply, the converter's ESD immunity is improved.

CAUTION

Be sure the HP-IL reference ground is connected to the signal ground. If this is not done, the circuitry may be damaged.

GPIO Signal Descriptions

Name	Description	Direction
DA0 – DA7	Data Bus A	Converter ◄► Device
DB0 – DB7	Data Bus B	Converter ◄► Device
RDYI	Ready Input	Converter ◄— Device
DAVO	Data Valid Output	Converter —► Device
DACI	Data Accepted Input	Converter ◄— Device
RDYO	Ready Output	Converter —► Device
DAVI	Data Valid Input	Converter ◄— Device
DACO	Data Accepted Output	Converter —► Device
$\overline{\text{MSRQ}}$	Manual Service Request	Converter ◄— Device
$\overline{\text{DCLO}}$	Device Clear Output	Converter —► Device
$\overline{\text{GETO}}$	Group Execute Trigger Output	Converter —► Device
$\overline{\text{PWDN}}$	Power Down	Converter —► Device
WKUP	Wake Up	Converter —► Device
$\overline{\text{CS}}$	Internal Chip Select	Converter —► Device
HLLO	Handshake Line Logic Output	Converter —► Device
VCC	Supply Voltage	Converter ◄— Device
VC1	Supply Voltage	Converter ◄— Device
GND	Ground	Converter ◄► Device

Operation

The HP-IL converter'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 converter 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 converter must be an HP-IL talker—receiving data on GPIO and sending it on HP-IL.

The converter 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 converter. The GPIO interaction with the external device consists of signals transmitted on the GPIO control and data lines.

Startup Conditions

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

HP-IL Interaction

The converter 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 converter.) The converter responds to HP-IL messages as described in the table below. Except as noted in the table, each HP-IL message the converter receives is automatically sent to the next device in the loop. In general, the converter checks each message it initiates for transmission errors when the message comes back to the converter.

Responses to HP-IL Messages

HP-IL Message	Converter Response
COMMAND GROUP	
Interface Clear	Talker or listener status removed and pending addressable message cleared.
Device Clear	Pulses $\overline{\text{DCLO}}$ line low.
Selected Device Clear	If listener, pulses $\overline{\text{DCLO}}$ line low.
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 page 12.)
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 $\overline{\text{GETO}}$ line low.
Loop Power Down	Pulses $\overline{\text{PWDN}}$ line low.
Enable Asynchronous Requests	No response.
Auto Address Unconfigure	Address set to 4.

Responses to HP-IL Messages (Continued)

HP-IL Message	Converter Response
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 below.
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 below.
Secondary Address 0-30	Following addressed message, if primary and secondary addresses match device's extended address 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 control registers, as selected.†
Send Status	If talker, sends one byte of status.† (Refer to page 12.)
Send Device ID	If talker, sends eight ASCII-coded bytes: HP82166A.†
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.
End Of Transmission—OK	If talker, responds as described under End of Data, page 16.
	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 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 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.

Responses to HP-IL Messages (Continued)

HP-IL Message	Converter 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 page 12.)
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 normally sent to transfer buffer. If service required by converter, modifies message 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 normally sent to transfer buffer. (End-of-line sequence sent to GPIO, if enabled to do so.) If service required by converter, modifies message 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 converter, 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	Converter 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	Converter/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		Reserved for factory testing.
4-31		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).
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 converter 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. Requires that R04-7 and R04-3 equal 1. Sequences specified by R04 through R14.
3-31		No response.

Status. The converter 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 converter's status changes. However, for the Buffer Busy condition, the status condition 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
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 converter.)
32 or 96	0X100000	Manual Service Request	$\overline{\text{MSRQ}}$ line set low by external device.

*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 converter has originated a service request. Bit 6 is reset to a "0" when the status condition changes or a Send Status message is received.

Service Requests. Two types of conditions cause the converter 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. 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.)

Parallel Poll. The converter 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 converter 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 converter 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 converter.

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

Parallel Poll Response to Identify Message

Enable Message	Designated Bit	Effect on Designated Bit: If Service Requested	Effect on Designated Bit: 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 converter's interaction with the external device (using the GPIO data and control lines) is directly related to the way that the converter 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 11) to change the control registers, defined in appendix B.

Data Transfer. Normally, the flow of data in the converter is determined by the converter's role in the interface loop. When the converter 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 converter isn't a listener and the transfer buffer has no data from HP-IL, the external device can send data to the converter. When the converter 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 converter 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.

Note: If the external device uses Data Bus B, it must not interfere with these lines while the $\overline{CS}$ output line is low. This bus is used for internal communication while $\overline{CS}$ is low.

Data Bus Options

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

Handshake. For HP-IL ➔ GPIO operations, the converter 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 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)

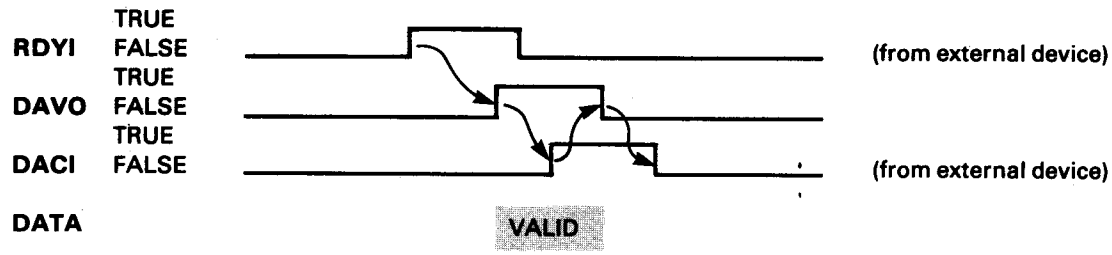
The diagrams following indicate how the three output handshake lines control the transfer of data. (The arrows show how changes in signal levels trigger subsequent changes.) For full and valid/accepted handshake, the DAVO signal may be limited to a time interval specified by control registers R02-3,0 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 a 5-μs time unit).

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

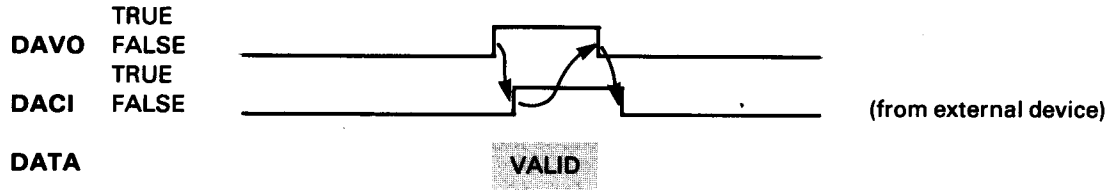
Another handshake feature for HP-IL ➔ GPIO and HP-IL ➔ GPIO operations is provided by control register R01. R01-2 and R01-0 indicate the status of the DACI and RDYI input lines. If R01-7 equals 1, the HP-IL controller can set the DACO and RDYO output lines using R01-5 and R01-3.

HP-IL → GPIO Operation

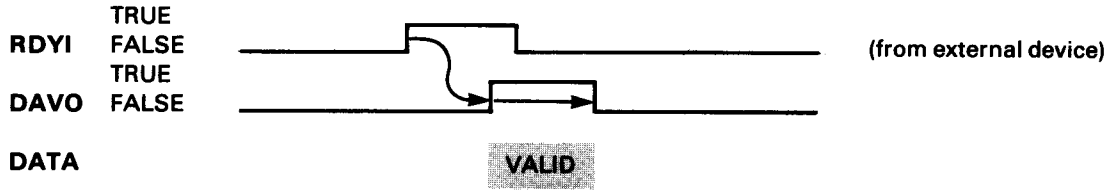
Full Handshake



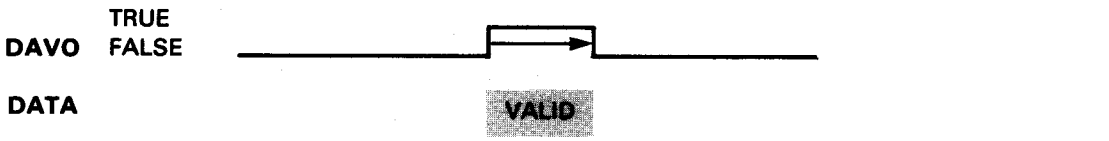
Valid/Accepted Handshake



Ready/Valid Handshake

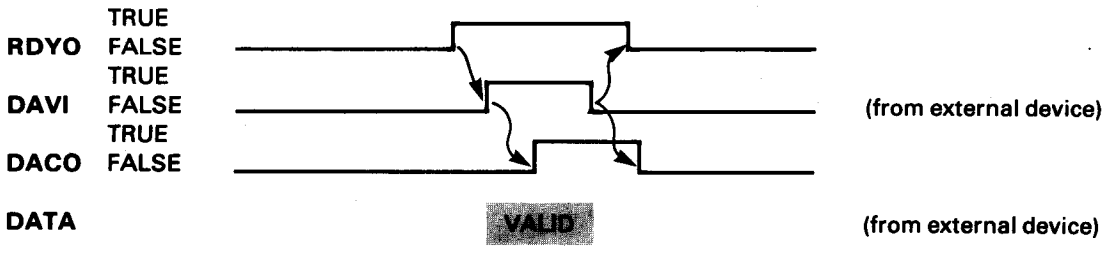


Strobed Output



HP-IL ← GPIO Operation

Full Handshake



Logic System. The converter 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 power-on condition, the converter 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 certain characters or sequences as an end-of-line indicator, even though the converter isn't set to recognize it. These conditions are 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 converter 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 converter is a talker), the converter 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 converter will send an End Of Transmission message. This additional method of terminating data transfer is enabled by control register R01-4 equal to 1. It allows the external device to terminate HP-IL ← GPIO data transfer.

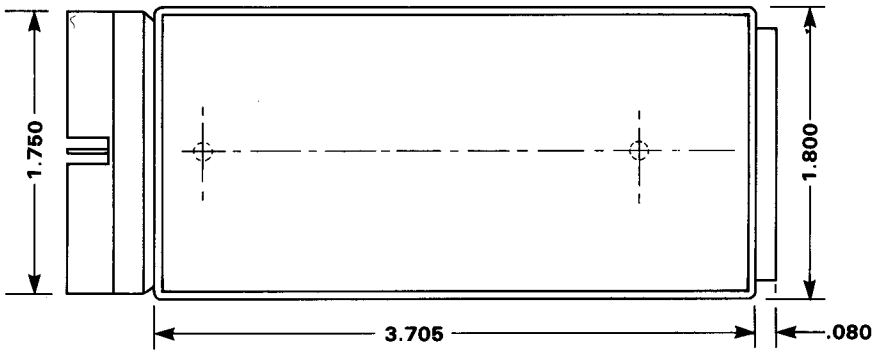
For HP-IL ← GPIO operation, if the transfer buffer contains data for GPIO when the converter receives a Send Data message, the converter immediately sends an End Of Transmission message. This indicates that no data is available for HP-IL.

Installation

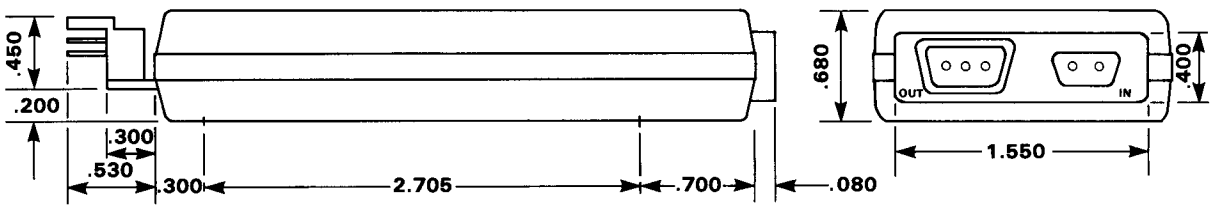
The diagram below shows the dimensions of the HP-IL converter. The front panel contains the HP-IL receptacles. The 34-pin GPIO connector at the rear of the unit provides electrical connections for the external device. Pin assignments are also shown below.

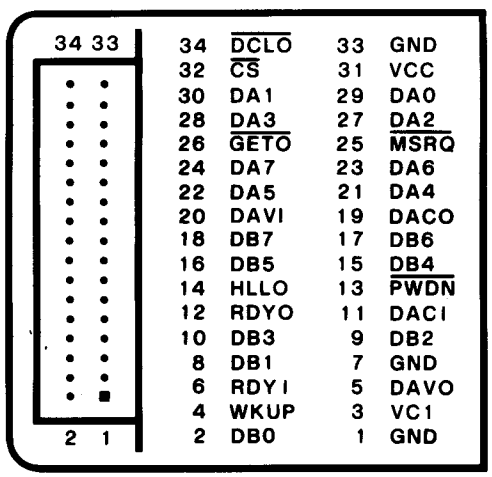
The converter can be physically mounted to any flat surface using one or both screw holes in the bottom case. First, cut out the bottom label around the screw. Remove the screw, then install a longer screw through the surface and into the case. Use a screw with 2-28 Plastite (or equivalent) self-tapping threads. Be sure the new screws are the proper length to secure the top case without protruding through it. (A 5/8-inch screw length is recommended for surfaces up to 1/16 inch thick.)

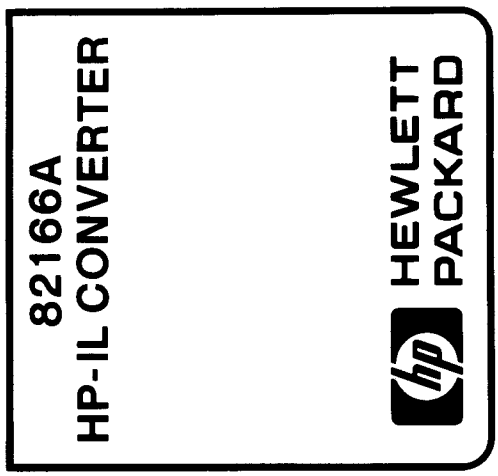
If desired, the converter's HP-IL front plate can be installed through a cutout in a panel.



Note: All dimensions are in inches.







Specifications

The tables that follow describe the temperature limits, electrical characteristics, and timing characteristics of the HP 82166A HP-IL Converter. The electrical and timing characteristics describe conditions for the converter's GPIO interface.

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
Supply Voltage	V_{CC}	4.75	5.25	Vdc	
Supply Ripple Voltage	V_r		1.0	V p-p	
Supply Current	I_{CC}		90	mA	
Input Voltage, High Level	V_{IH}	2.0	5.8	V	
Input Voltage, Low Level	V_{IL}	−0.3	0.8	V	
Input Current, High Level	I_{IH}		10	μA	
Input Current, Low Level	I_{IL}		−1.6	mA	$V_{IL} = 0.4V$
Input Capacitance	C_I		15	pF	
Output Current, High Level*	I_{OH}		−100 −30	μA μA	$V_{OH} = 2.4V$ $V_{OH} = 3.9V$
Output Current, Low Level*	I_{OL}	1.8		mA	$V_{OL} = 0.4V$
Output Rise Time*	t_r		350	ns	$R_L = 47\ K\Omega$ $C_L = 50\ pF$
Output Fall Time*	t_f		80	ns	
Output Fanout*		1† 1† 10† 5† 1† 20†			74 Series 74H Series 74L Series 74LS Series 74S Series CMOS
WKUP Voltage, High Level	V_{WH}	4.5		V	
WKUP Voltage, Low Level	V_{WL}	−0.6	1.0	V	
WKUP Pulse Width	PW_{WK}	0.6	1.5	μs	
WKUP Load Resistance	R_{WK}	200		KΩ	
WKUP Load Capacitance	C_{WK}		3	pF	

*All lines except WKUP.

†Typical value.

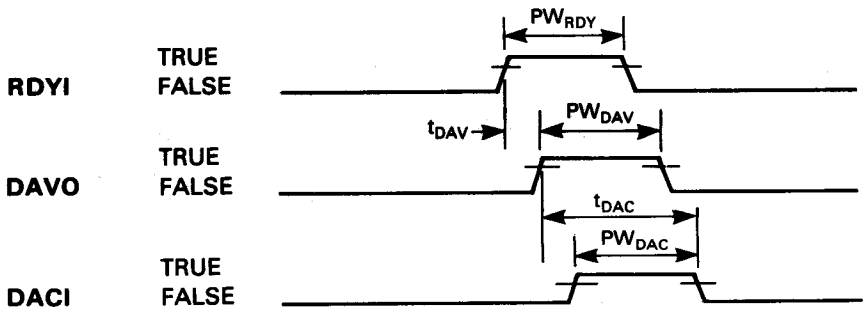
Timing Characteristics

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
$\overline{\text{DCLO}}$ Output Pulse Width		350	450	µs
$\overline{\text{GETO}}$ Output Pulse Width		750	850	µs
$\overline{\text{PWDN}}$ Output Pulse Width		2.5	3.5	ms

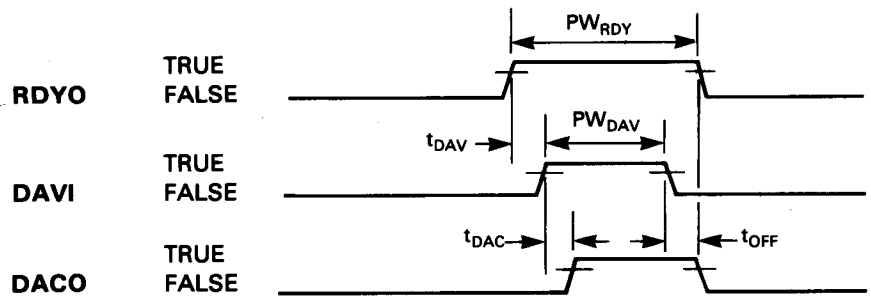
*Unless R01-7 equals 1.

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

Output (HP-IL → GPIO) Timing:



Input (HP-IL ← GPIO) Timing:



Care, Warranty, and Service Information

Care of the Converter

The HP 82166A HP-IL Converter 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 converter's GPIO interface, be sure the GPIO connector is disconnected from the converter. Plug in the connector *after* all of its external connections have been made.
- Take precautions against damage to the converter's circuitry from electrostatic discharge. Work at a grounded surface when handling exposed components and signal lines.
- Observe the electrical specifications listed on page 18.
- Observe the temperature limits listed on page 18.

Verifying Proper Operation

If at any time you suspect that your converter is not operating properly, you can verify its operation using the following tests.

If the problem might be related to electrostatic discharge (such as the converter being reset unexpectedly), try changing the connection between the converter's two grounds. By connecting pin 1 to the signal ground (pins 7 and 33) as close as possible to the power supply's single point ground, you improve the converter's ESD immunity.

Evaluation Test

This test uses the evaluation board supplied with the converter to check the operation of two converters.

1. Connect two converters and a power supply to the evaluation board, as shown in the first installation in appendix C.
2. Connect only the controller and the two converters in a *single* interface loop.
3. Using the controller, send from 1 to 32 Data Bytes to one of the converters.
   - If the Data Bytes are passed around the loop and back to the controller, the converters and HP-IL cables have proper continuity.
   - If Data Bytes don't return to the controller, try it again with only one converter in the loop at one time. This may indicate which converter is causing the problem.
4. Using the controller, retrieve the previous Data Bytes from the *other* converter.
   - If the retrieved Data Bytes match the original Data Bytes, both converters are operating properly.
   - If the retrieved Data Bytes don't match the original Data Bytes, perform the Converter/HP-IL test (described below) for each converter.
   - If Data Bytes can't be retrieved, try to determine which converter isn't transferring the data by checking the status of each converter. For example, one converter may indicate that the other isn't completing the required handshake. You can also perform the Converter/HP-IL test for each converter.

Converter/HP-IL Test

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

1. Connect only the converter and HP-IL controller in the interface loop.
2. Using the controller, make the converter a listener and send it a Device Dependent Listener 1 message. This sets the converter to its converter/HP-IL test condition.
3. Using the controller, send one or more Data Bytes to the converter.
   - If the HP-IL messages (including Data Bytes) are passed around the loop and back to the controller, the converter 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 converter. 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 converter, then the converter requires service.
4. Using the controller, make the converter a talker and retrieve the previous Data Bytes from the converter. This ends the test.
   - If the retrieved Data Bytes match the original Data Bytes, the tested part of the converter is good. (Only the GPIO interface part of the converter is not tested by this test.)
   - If the retrieved Data Bytes don't match the original Data Bytes, the converter requires service.

Limited 90-Day Warranty

What We Will Do

The HP 82166A HP-IL Converter is warranted by Hewlett-Packard against defects in materials and workmanship for 90 days 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 90-day period. During the warranty period, we will repair or, at our option, replace at no charge a unit that proves to be defective, provided you return the unit, shipping prepaid, to a Hewlett-Packard service center.

What Is Not Covered

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

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

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

Warranty for Consumer Transactions in the United Kingdom

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

Obligation to Make Changes

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

Warranty Information

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

- In the United States:

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

- In Europe:

Hewlett-Packard S.A.
7, rue du Bois-du-lan
P.O. Box
CH-1217 Meyrin 2
Geneva
Switzerland
Telephone: (22) 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 90-day 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 82166A HP-IL Converter 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) 35.16.20

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
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 90 days from date of service.

Shipping Instructions

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

- A completed Service Card, including a description of the problem and system setup when the problem occurred.
- A sales receipt or other documentary proof of purchase date if the 90-day 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 82166A HP-IL Converter 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 converter does cause interference to radio or television reception, which can be determined by turning the converter 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 converter with respect to the receiver.
- Move the converter away from the receiver.
- Plug the converter'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 82166A HP-IL Converter contains 19 control registers. These registers control the way that the converter operates, as discussed thoughout this manual. The tables shown below summarize the effects of the control registers.

When power is first supplied to the converter, 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 11.)

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 Requests 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 Number (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 Character	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 82166A HP-IL Converter. These examples illustrate the types of GPIO interfacing that may be used.

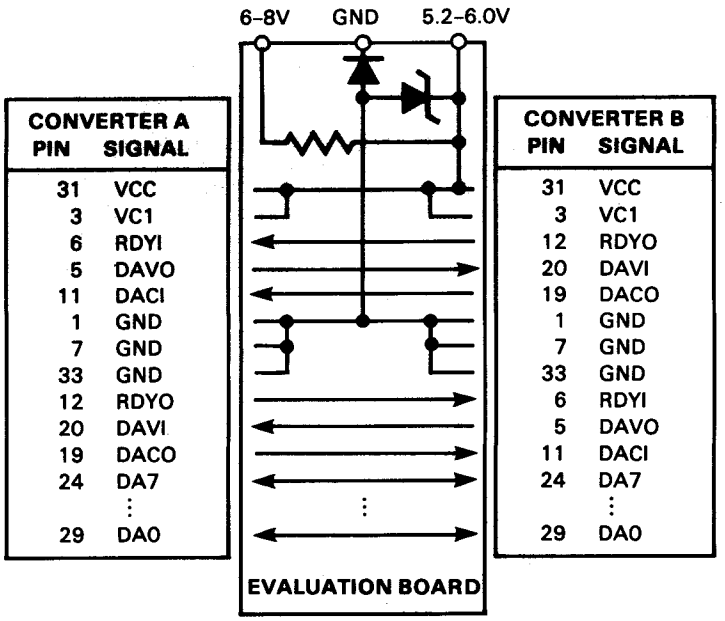
Converter to Converter

Two converters 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 converter—one for HP-IL → GPIO Operation and one for HP-IL ← GPIO Operation. The control registers are set to their default conditions.

The evaluation board supplied with the converter makes all of the connections required for this installation. This enables you to connect and use two converters in a simple system that requires no additional peripherals. The evaluation board accepts two ranges of the supply voltage: 5.2 to 6.0 Vdc and 6 to 8 Vdc. Components on the evaluation board limit the supply voltage to the range required by the converter and protect against improper connections.

CAUTION

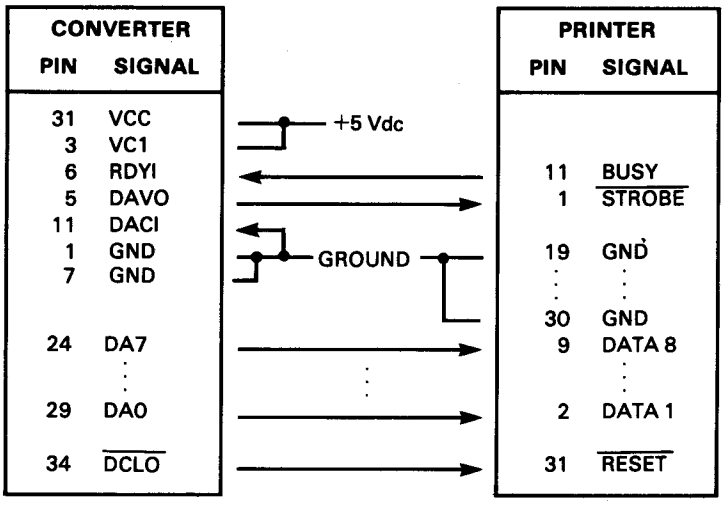
Never supply power to the evaluation board unless the two converters are connected. Otherwise, components on the evaluation board may be damaged.



This connection can also be used to check the operation of two converters. You can join the interconnected converters in the same HP-IL system, then send data to one converter and retrieve it from the other. (Refer to appendix A.)

Converter to Parallel Printer

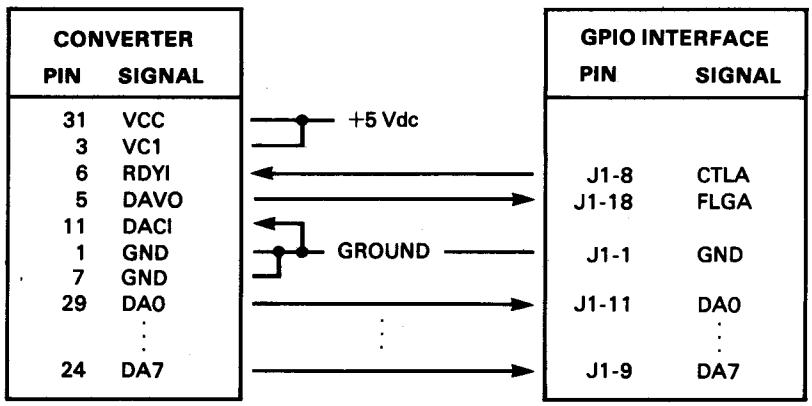
The converter may be connected to a printer that uses a standard printer interface, often called the "parallel printer" or "Centronics-type" interface. Using this installation, the HP-IL controller can print information on a standard printer. The control registers are set to their default conditions. Note that DACI is connected to ground, making this signal always true. The $\overline{\text{DCLO}}$ connection is optional; it allows the HP-IL controller to reset the printer.



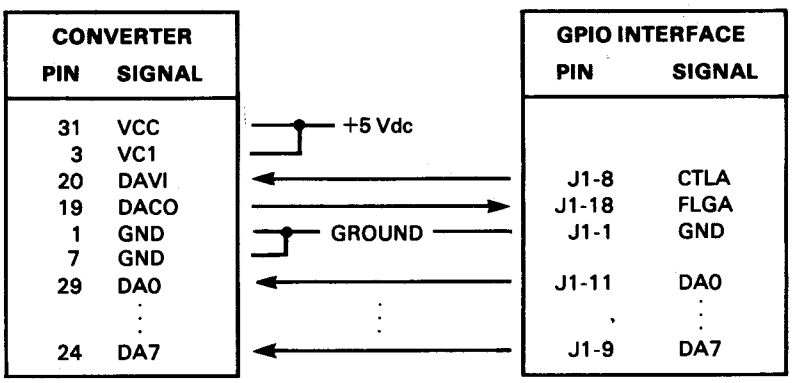
Converter to HP 82940A GPIO Interface

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

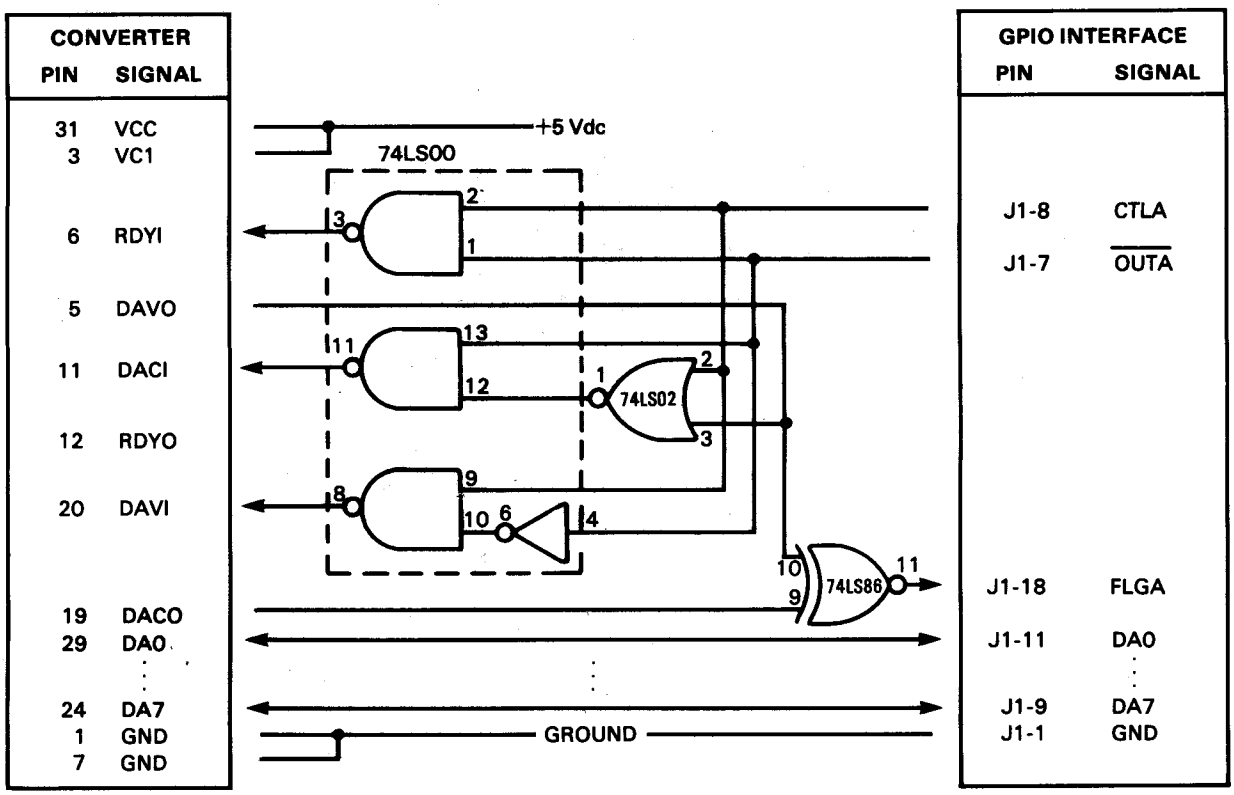
The first installation provides one-way communication from the converter to the GPIO interface. The converter's control registers use their default values. (The GPIO interface must have bit 5 of register 4 equal to 1—Busy to Ready; other registers use their default values.)



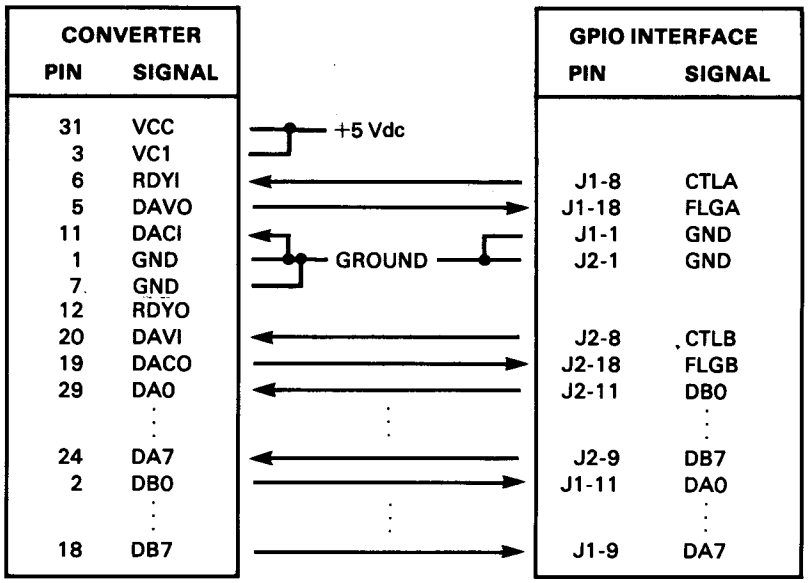
The second installation provides one-way communication from the GPIO interface to the converter. The converter uses the default values for its control registers. (The GPIO interface must have bits 4 and 0 of register 3 equal to 1—FLGA and CTLA negative-true—and bit 0 of register 8 equal to 1—Output Enable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



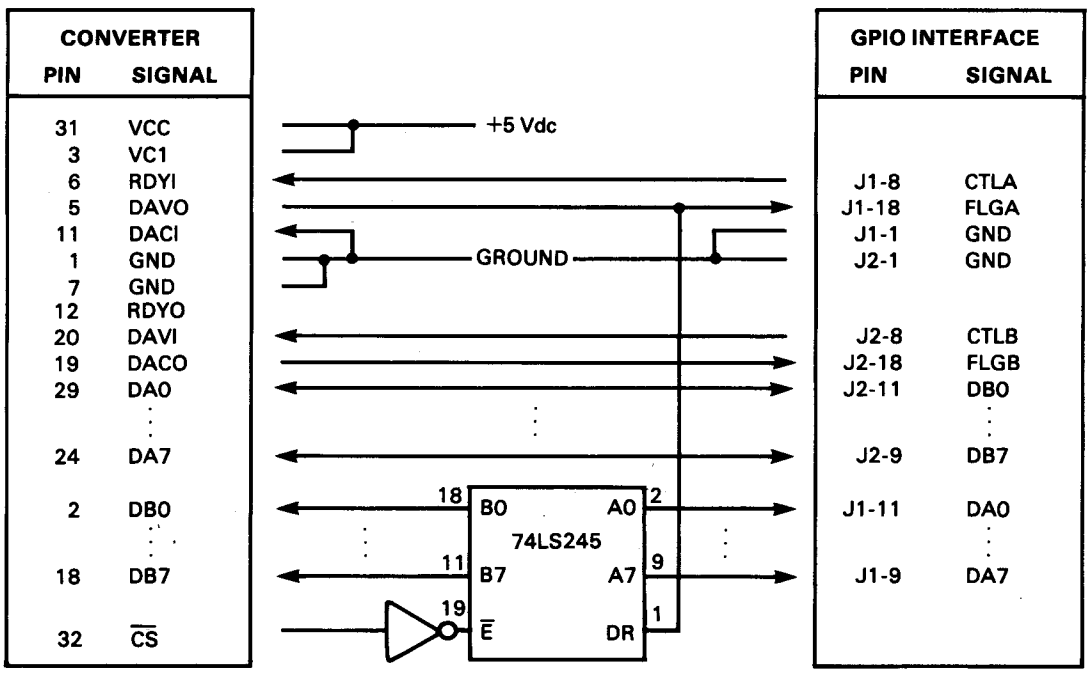
The next installation uses an 8-bit bidirectional data bus. The extra circuitry eliminates the need to modify the converter's control registers—the default values can be used. (The GPIO interface must have bit 0 of register 8 equal to 1—Output Enable A; other registers use their default values.)



This installation uses an 8-bit unidirectional data bus. It doesn't require any extra circuitry, although the converter'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 registers 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 register 8 equal to 1—Output Enable B and Output Enable A; other registers use their default values.) Notice that the bus transceiver isolates the GPIO interface from Data Bus B while the $\overline{CS}$ signal is low.



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 converter and its external device. The following interface control functions are useful for sending instructions and sending and receiving information.

Function	Response
Calculator ➡ Converter	
[OUTA]*	Sends the character codes of the characters in the ALPHA register to the converter 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 converter and external device. No end-of-line indicator is sent.
[PRA]†	Sends the character codes of the characters in the ALPHA register to the converter 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 converter 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 converter and external device, followed by an end-of-line indicator.
[ACCHR]†	Sends the character code specified in the X-register to the converter 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 converter and external device.
[PRBUF]†	Sends an end-of-line indicator to the converter and external device.
[PWRDN]	Makes the converter signal the external device on the $\overline{\text{PWDN}}$ line.
[TRIGGER]*	Makes the converter signal the external device on the $\overline{\text{GETO}}$ line.
Calculator ⬅ Converter	
[INA]‡	Fetches the character codes of up to 24 characters from the converter's transfer buffer. The characters are stored in the ALPHA register.
[IND]‡	Fetches the character codes of a sequency of digits from the converter's transfer buffer. The characters are interpreted as a number, which is placed in the X-register.
[INSTAT]‡	Fetches one number (byte) representing the converter'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 **HP82166**, the address of the converter is placed in the X-register.

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

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

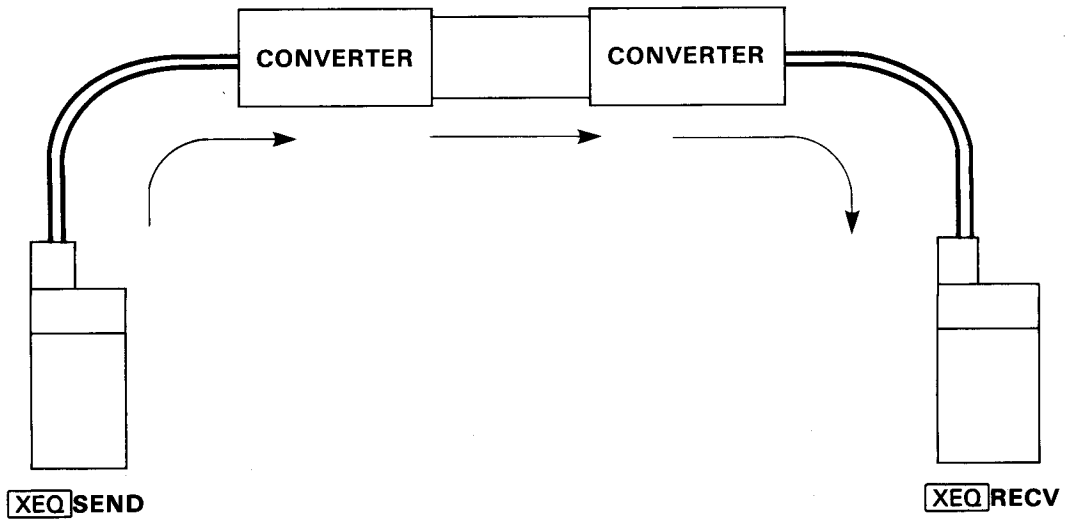
‡The converter must be the primary device selected by the HP-41.

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 the 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 converter 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 converter is the primary device selected by the HP-41 and that the calcualtor 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 converter's control registers*—you must use the converter with the default values in its control registers. (Also, the calculator and HP-IL module can't perform the Converter/HP-IL test described in appendix A.)

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



The following program is stored in each calculator. Execute RECV on the calcualtor 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"
02  XEQ "SELCON"
03♦LBL 01
04  INSTAT
05  FC? 01
06  GTO 01
07  INA
08  AVIEW
09  GTO 01
10♦LBL "SEND"
11  XEQ "SELCON"
12♦LBL 02
13  "MESSAGE?"
14  AON
15  PROMPT
16  AOFF
17  OUTA
18  GTO 02
19♦LBL "SELCON"
20  "HP82166"
21  FINDID
22  X=0?
23  STOP
24  SELECT
25  CF 17
26  RTN
```

Program to receive ALPHA data.
Selects converter as primary device.

Fetches current converter status.
Tests bit 1 of status (Data Ready For HP-IL).
Branch for "0" in bit 1.
Fetches ALPHA data.
Displays ALPHA register.
Branches to status loop.
Program to send ALPHA data.
Selects converter as primary device.

Enters prompt message.
Activates ALPHA mode.
Prompts for ALPHA input.

Sends ALPHA data.

Subroutine to select converter as primary device.
Specifies converter's identity.
Places converter's address in X-register.

Stops execution if converter isn't in loop.
Selects converter as primary device.
Specifies use of end-of-line indicators.

Application: Controlling a Printer. In this application, an HP-41 controls a converter connected to a parallel printer—in this example, a Centronics 737-1 printer. (The printer is connected to the converter 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 converter is the primary device and that the calcualtor 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 82166A HP-IL Converter
Technical Manual

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82166-90002

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Addendum

This addendum contains information regarding the *HP 82166A HP-IL Converter Technical Manual,* part number 82166-90002, dated November 1981.

Page 6, just before Internal Design. Insert the following note:

Note: Not all controllers can use all of the converter's features. Some controllers may require an I/O (input/output) enhancement—a module, or ROM—in order to control certain aspects of the converter's operation. (Refer to the appendices for additional information.)

Page 12, Service Requests. Add the following clarification:

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.

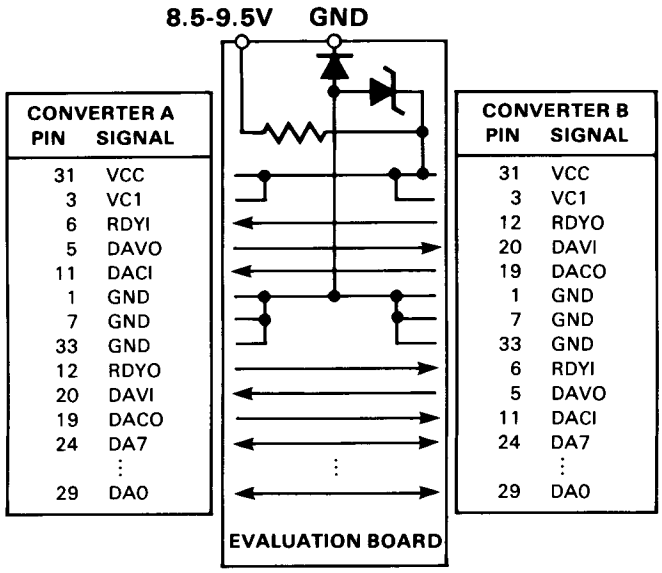
Page 18, Electrical Specifications. Change the Supply Ripple Voltage specification to:

Supply Ripple Voltage (V_r)	0.25 V_{p-p} maximum

Page 29, just before Converter to Converter. Insert the following note:

Note: The converter's data lines do not have consecutive pin numbers. The diagrams below don't show the pin number for each data line—for pin numbers, refer to the pin assignment diagram on page 17 or to the label on the converter.

Page 29, Converter to Converter. The evaluation board has been changed to accept only one supply voltage: 8.5 to 9.5 Vdc. Change the second paragraph accordingly, and revise the diagram of the board as shown below.



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