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Infotek's FI-30 is identical in all aspects to the Hewlett-Packard 11202A I/O Interface Cable. Please follow all instructions on the attached page for installing your FI-30 card to the H/P 11202 card. Completed FI-30 assembly may now be used in the same manner as the H/P 11202 Interface. The faster I/O speeds of the FI-30 are achieved by using MREAD & MWRITE from the Infotek FB-III Rom.

Chapter 1

GENERAL INFORMATION

INTRODUCTION

The HP 11202A I/O Interface is general-purpose card which provides 8-bit data exchange between a 9800-Series calculator and a peripheral device. The interface transfers data in a 'half-duplex' mode. That is, it can either input or output data, but not both at the same time. The interface provides storage of each input or output data character and also has a device control line and a device ready (flag) line. All data and control lines are compatible with standard TTL levels.

This manual describes how to install and service the 11202A Interface. Also, some typical interface applications are described in Chapter 2.

THE PERIPHERAL CONTROL BLOCK

In general, each calculator must have an appropriate peripheral control block when using this interface. The manual supplied with the block describes how to control and exchange data with peripheral equipment. Contact your nearest HP Sales and Service Office for information on the correct peripheral control block for your calculator system; office locations are listed at the back of this manual.

The 9830A Calculator does not need a peripheral control block if the peripheral is used as a printer only. See Appendix F in the 9830A Operating and Programming Manual for instructions on operating a 'primary printer'.

HARDWARE DESCRIPTION

The interface consists of a circuit board inside a case which plugs into any calculator I/O connector, and a 1.82 metre (6 foot) shielded cable. One end of the cable is connected to the circuit board and the other end is unterminated (see 'Available Options').

TECHNICAL SPECIFICATIONS

I/O Format

The interface sends and receives information in 8-bit-parallel, character-serial fashion. All usable ASCII-coded* characters are listed in the Appendix.

Although the calculator handles only ASCII-coded information, the interface can transfer data in any 8-bit binary code.

Data Input Lines

Eight input lines, each with a low-power 74L04 TTL load and a resistive divider consisting of 1.8KΩ to +5V and 2.7KΩ to ground are available.

*American Standard Code for Information Interchange.

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INTRODUCTION
(continued)

Data Output Lines

Eight output lines with open-collector 7406 TTL inverters are available.

Control Lines

- Device Control ($\overline{CTL}$) – High-to-low transition indicates that the interface is ready to input data or has data to output.
- Device Ready ($\overline{FLG}$) – Peripheral device indicates 'data accepted' or 'data valid' by forcing line low. The $\overline{FLG}$ signal must be greater than 500ns.
- I/O Status (I/O) – Tells device whether calculator has started an input operation (high) or an output operation (low).
- Stop ($\overline{STP}$) – $\overline{STP}$ is low whenever the calculator STOP key is held down.
- Enable Handshake (ECH) – When ECH is connected to ground, the interface cannot drive $\overline{CTL}$ low until the peripheral device forces $\overline{FLG}$ high to indicate 'ready'. When ECH is left open, the interface does not check the $\overline{FLG}$ line before driving $\overline{CTL}$ low.

Signal Levels

All data and control lines use 'negative-true logic' (i.e., <7V indicates 'low' or logic '1' or 'true', and >2.4V indicates 'high' or logic '0' or 'false'). A bar above each line name (e.g., $\overline{CTL}$ and $\overline{FLG}$) indicates that the line goes low when pulsed '1'. All other lines go high when pulsed '1'.

Temperature Range

5°C to 45°C Ambient.

Power

Provided by the calculator.

Dimensions

Case: 12.06cm (4¾ inches) x 15.87cm (6¼ inches).

Cable: 1.82m (6 feet).

AVAILABLE OPTIONS

Each of the optional interfaces listed below consists of a standard 11202A which is wired for use with a specific HP instrument. A wiring diagram of the added connector and operating instructions are furnished with each optional interface.

11202A–	Interfaces with a:
Option A01	2748A/B Tape Reader
Option A02	2895A/B Tape Punch
Option A04	3482A or 3484A Plug-in Unit*
Option A05	3485A Scanner Unit*

*These units are part of a 3480A/B Digital Voltmeter. An 11203A BCD Interface is also needed to transfer data samples from the DVM to the calculator.

INSTALLATION CONSIDERATIONS

SELECT CODE

Since all peripheral devices are connected to the calculator in a party-line fashion, each device must have a unique address so that the calculator can specify which device must respond to each operation. This address, or 'select code', consists of a one or two-digit number and is preset on the interface.

Although the 11202A Interface is set to respond to select code 2 when supplied[1], you can set any one of eight other select codes by following this procedure:

1. Switch the calculator and the peripheral device off.
2. Disconnect the interface from the calculator. Remove the four screws located on the top of the card assembly. Then turn the card over and lift-off the bottom cover.

[1]Some optional interfaces are preset to select code 1. See their accompanying operating notes.

INSTALLATION CONSIDERATIONS
(continued)

3. Raise the hinged cover on the select code switch (see Figure 1-1). Using a small, flat-blade screwdriver, *carefully rotate* the selector tab until it is positioned at the desired select code number. Numbers are printed on the side and on the cover of the switch (switch position '0' is not usable). Before closing the cover, be sure that the slot in the selector tab is at a right angle to the length of the switch.

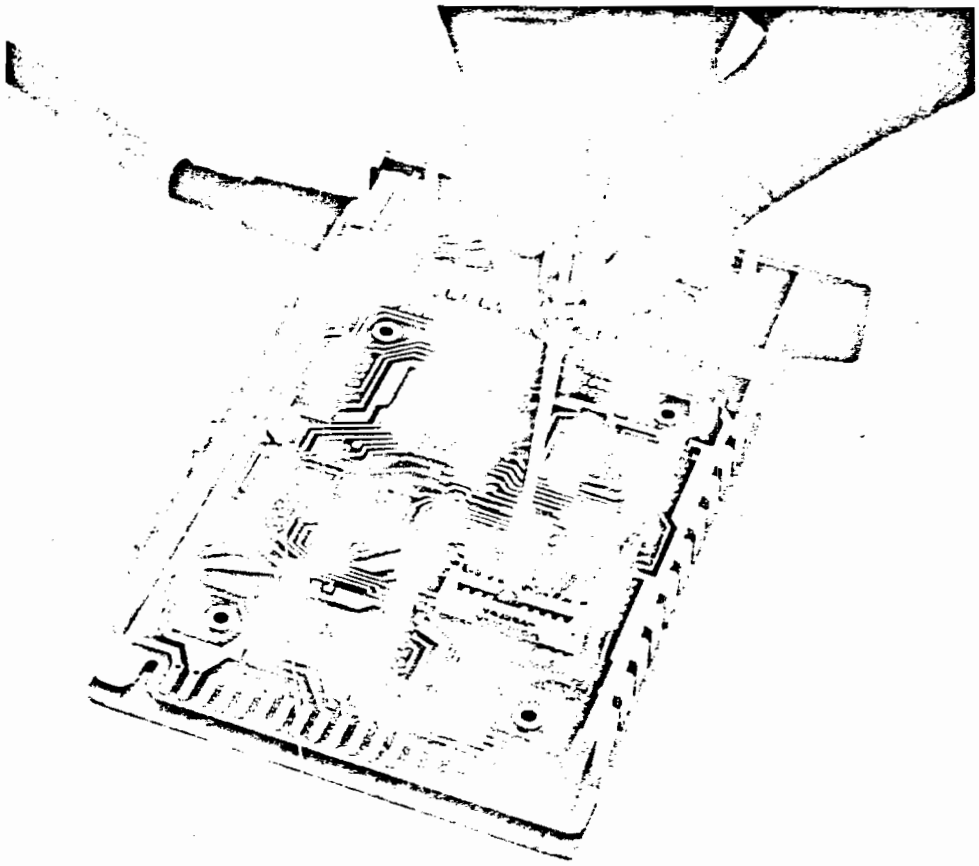


Figure 1-1. Setting the Select Code

4. Close the switch cover and replace the interface bottom cover. Secure the cover with the four screws previously removed.

5. Place a select code label on the peripheral device or on the interface case to indicate the new select code. A package of labels is supplied with the interface.

6. Reconnect the interface to the calculator, and turn the calculator and the device on. Verify that the desired select code is set by executing an I/O operation (or running a program) which specifies the new select code.

INPUT DATA STABILITY

Each data item placed on the interface input lines must be settled *before* the 'data ready' signal ($\overline{FLG}$ line) is transmitted. Then the data must be held stable for at least 500ns.

RECOMMENDED RECEIVING CIRCUITS

Each output signal from the interface is transmitted from an SN7406 TTL inverter, which has an open-collector output. The current-sinking capability of each inverter is 40mA and the breakdown voltage is 30V.

Here are typical specifications:

$$V_{ol} \begin{cases} @\ (I_{ol} = 16ma) = 0.4V\ max. \\ @\ (I_{ol} = 40ma) = 0.7V\ max. \end{cases}$$

V_{oh} (Open Collector) = 30V max.

I_{ol} = 40 mA max.

I_{oh} @ (V_{oh} max.) = 250 μA

Since each transmitter has an open collector, the peripheral receiving circuit must have a positive pull-up voltage (not to exceed 30V) and must be restricted to sourcing (back to the transmitter) less than 40mA. Recommended receiving circuits are shown in Figure 1-2.

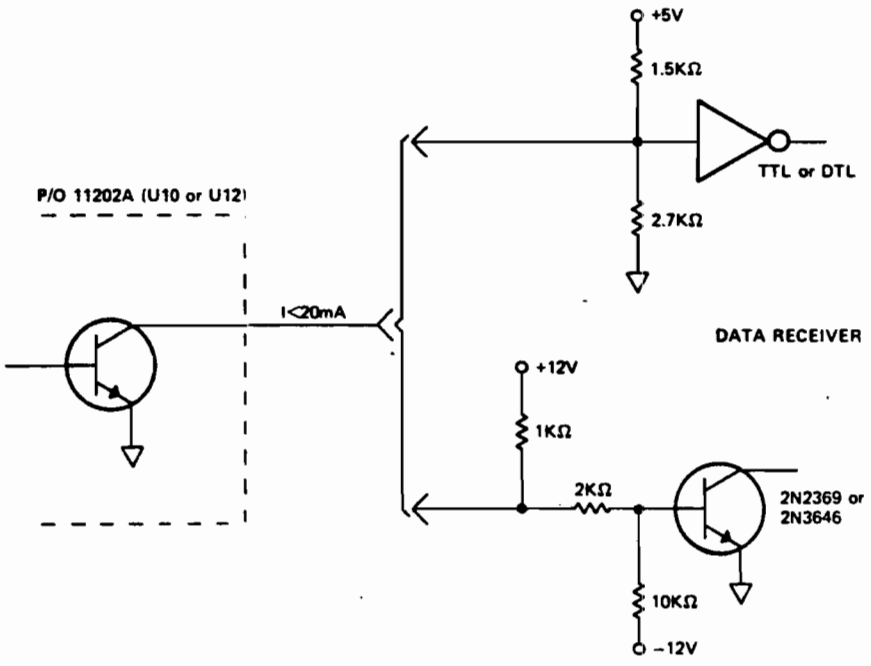


Figure 1-2. Recommended Peripheral Receiver Circuits

INSTALLATION CONSIDERATIONS
(continued)

RECOMMEDED TRANSMITTING CIRCUITS

Each data-input line on the interface (except $\overline{FLG}$) contains an SN74L04 low-power inverter. A resistive divider connected to each input line holds the voltage at about 3V when the cable is disconnected. The input voltage must not exceed 5.5V.

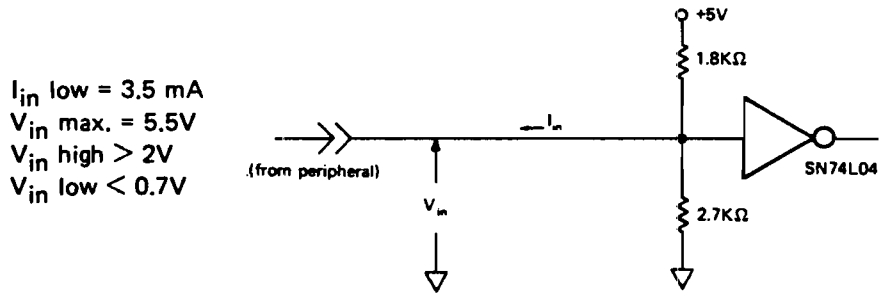


Figure 1-3. Interface Data Receiver Circuit

Recommended peripheral transmitting circuits are shown below.

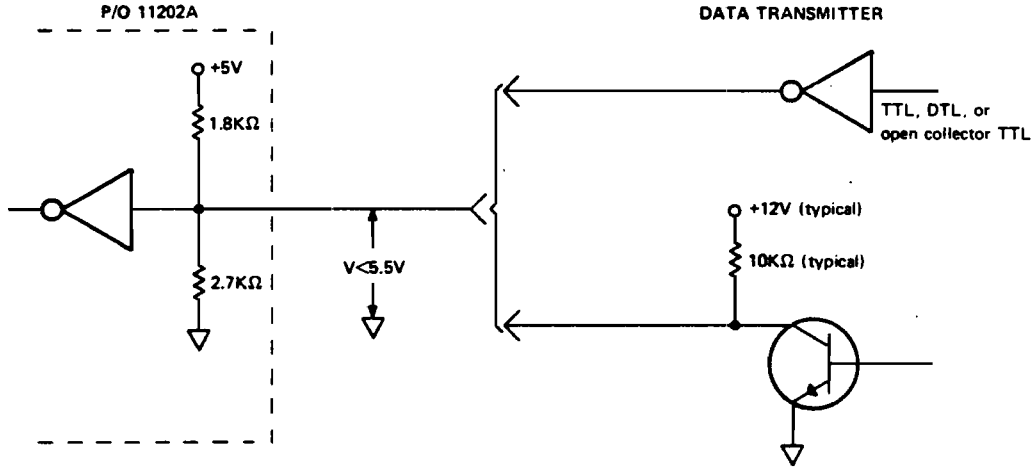


Figure 1-4. Recommended Transmitting Circuits

The device ready signal ($\overline{FLG}$) is received by an SN 7413 Schmitt trigger circuit. This circuit accepts signals with slow rise and fall times, and provides good noise margins. Although the voltage on the flag line must not exceed 5.5V, there is no restriction on the input rise and fall time. Either of the transmitting circuits shown in Figure 1-4 may also be used as a flag transmitter.

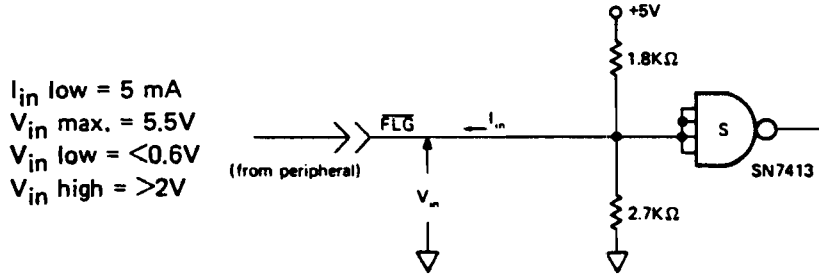


Figure 1-5. Interface Flag Receiver Circuit

Chapter 2

APPLICATIONS

This chapter describes some typical applications of the 11202A I/O Interface. Although your application may be quite different from those shown here, the interfacing requirements and I/O routine will be similar.

DATA OUTPUT

A popular application for the 11202A is as an interface to the HP Model 2895B/8100A Option 004 Tape Punch. Figure 2-1 shows a simplified functional diagram of the tape punch and the interface.

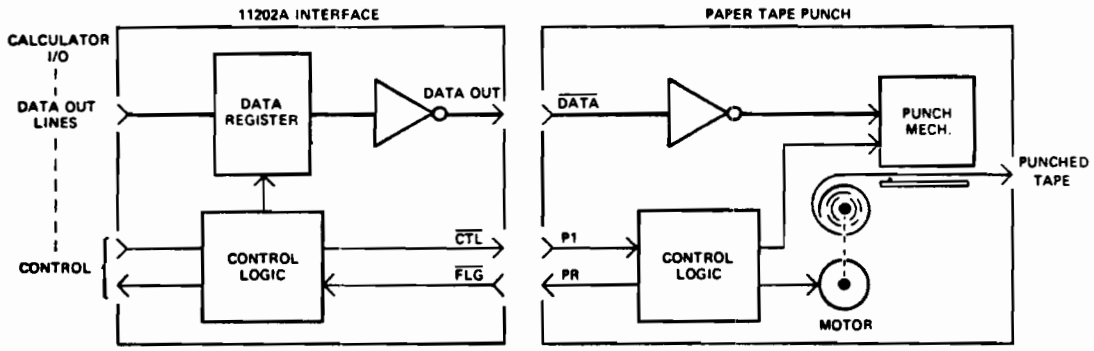


Figure 2-1. Diagram of a Tape Punch and Interface

After the tape punch is readied with a blank tape, this sequence occurs to output and punch data:

1) A DATA OUTPUT or WRITE operation is executed from the calculator. The specified format determines how many characters are output with each data item.
2) After the calculator outputs the first character to the interface, the interface latches the data onto its output lines and sends a P1 ($\overline{CTL}$) signal to the tape punch. The P1 signal causes the tape punch to decode and punch the data. Then the motor advances the paper and the tape punch outputs a PR($\overline{FLG}$) signal, indicating that it is ready for more data.
3) The $\overline{FLG}$ signal returns the interface to its ready state and outputs an SIØ signal to the calculator.
4) If the calculator has more characters to output, the sequence is repeated (see step 2).

DATA INPUT

Another popular application for the I/O Interface is as an interface to a high-speed paper tape reader, such as the HP Model 2748B Tape Reader. A simplified functional diagram of that system is shown in the next figure.

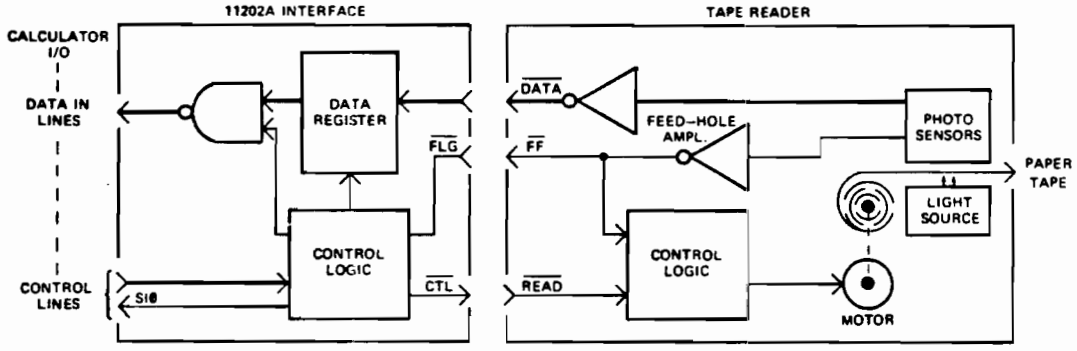


Figure 2-2. Diagram of a Tape Reader and Interface

After the tape reader has been readied with a tape, this sequence occurs to read the information:

1) A DATA INPUT or READ operation is executed from the calculator. The specified format and the sequence of data on the paper tape determine how many characters are read during each operation.
2) The interface outputs a READ($\overline{CTL}$) signal, which causes the tape reader motor to advance the tape. When a feed hole is detected on the tape, the motor stops and the data character is read. After the data is output on the DATA lines, a $\overline{FF}$($\overline{FLG}$) signal is output.
3) Upon receiving the $\overline{FLG}$ signal, the interface transfers the data character to the calculator.
4) After the calculator reads the data, it either stores the data and requests more (return to step 2) or it terminates the input operation.

HANDSHAKE MODE

As described in the previous sections, the interface normally interacts with the peripheral in a 'handshake' fashion - each device waits for the other to be ready before sending or receiving data. This section describes an alternate method of interface/peripheral control called the 'Handshake Mode'.

The Handshake mode is enabled by grounding the ECH line (see Figure 3-1). The term 'handshake' refers to the interface-peripheral interaction occuring on the $\overline{CTL}$ and $\overline{FLG}$ lines (see Figure 3-4).

When in the Handshake mode, the interface waits for a high $\overline{FLG}$ line before transferring each successive data character. (Normally, the interface resumes data transfer immediately after the $\overline{FLG}$ line goes low.)

The calculator can be programmed to detect the interface busy state by executing a Status Check or Read Status operation* *before* beginning an I/O operation. If the interface is found to be busy, the calculator can then branch to do other operations while periodically checking interface status. Once a Status Check operation indicates that the interface is ready, the calculator can begin the I/O operation.

See your PC 2 Block or Extended I/O ROM Operating Manual for information on using the Status Check operation.

EXTERNAL RELAY CONTROL

Figure 2-3 shows a scheme for using the 11202A as a relay-driver card. Up to eight relays can be controlled independently with any 9800-Series calculator**.

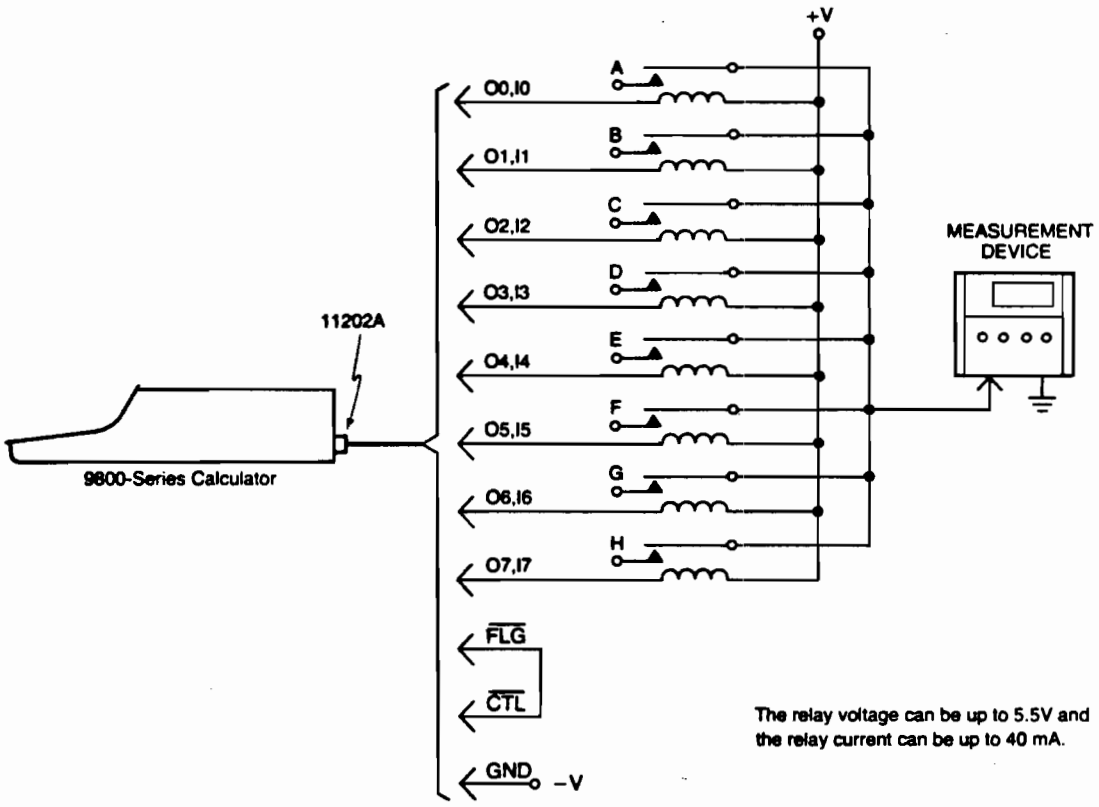


Figure 2-3. Relay Control Application

*Available only with a PC 2 Block (Model 9810A, 9820A or 9821A) or an Extended I/O ROM (Model 9830A).

**With a 9820A or 9821A Calculator, only six lines can be independently controlled unless the WRITE BYTE statement (PC2 Block) is used.

EXTERNAL RELAY CONTROL

(continued)

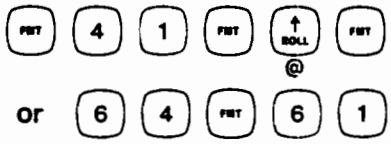
To select an input to the device, the calculator must output an ASCII character that causes all output lines to remain high except one – the low output causes current flow through the selected relay. Since the interface data-output lines are connected to the data-input lines, the output character will remain valid (holding the selected relay closed) until the next character is output.

Here is a list of usable ASCII output characters*:

To select this input:	Output this ASCII character:		or WRITE BYTE:
A	SOH	(00000001)	1
B	STX	(00000010)	2
C	EOT	(00000100)	4
D	FE_0	(00001000)	8
E	DC_0	(00010000)	16
F	space	(00100000)	32
G	@	(01000000)	64
H	———	———	128
(no input)	NULL	(00000000)	0

For example, to select input G, the appropriate line below could be executed (select code 1 is assumed):

Model 10:



or

(PC 2 only)

Model 20 or 21:

```
FMT "@",Z;WRT 1⊢
```

or `WTB 1,64⊢` (PC 2 only)

Model 30:

```
10 FORMAT B
20 WRITE (1,10)"@";
```


After the character '@' is output, its binary equivalent form is held on the interface output lines as shown on the next page ('0'=high, '1'=low).

*Also, see the list of ASCII characters at the back of this manual.

Output line:	State:	Relay (condition):
OØ	0	A(open)
O1	0	B(open)
O2	0	C(open)
O3	0	D(open)
O4	0	E(open)
O5	0	F(open)
O6	1	G(closed)
O7	0	H(open)

An application of the relay controller scheme just described is shown in Figure 2-4. The system is used to measure and plot diode V-I characteristics.

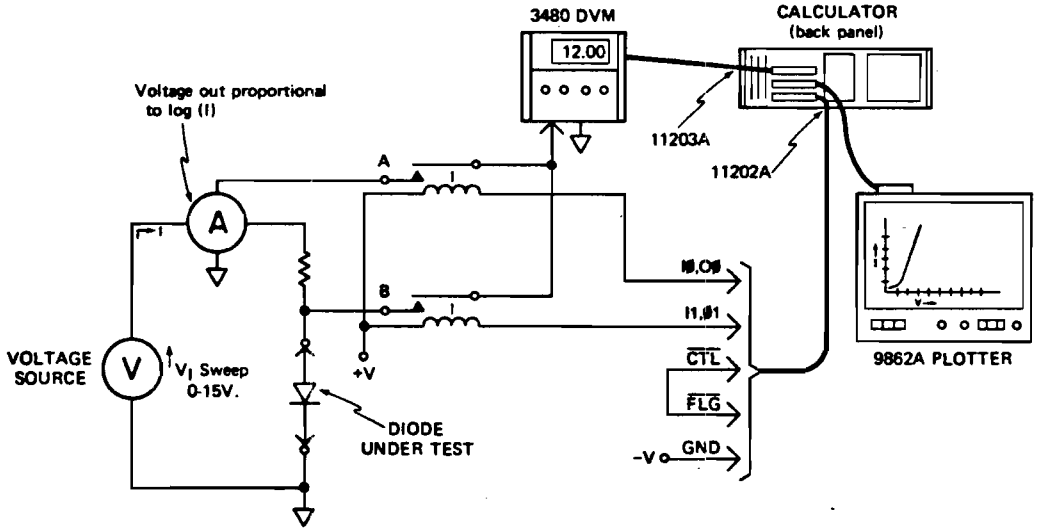
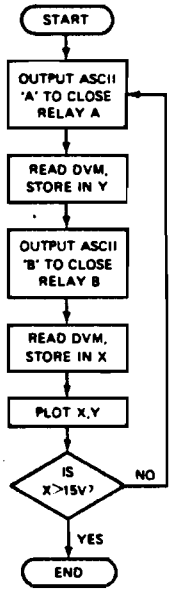


Figure 2-4. Sample Application

To operate the system, a program is used to alternately output two ASCII characters and then take readings from the DVM's BCD output using an 11203A BCD Interface. The program could either plot sets of V-I readings as they are taken (see the flowchart), or store a series of readings and plot them later. The plotting method used depends upon the voltage sweep time, the program execution time, and the number of V-I readings (sample density) required.



Chapter 3

SERVICE

This chapter contains a brief description of interface operation and instructions to help you troubleshoot and repair the interface. A complete circuit diagram and a list of replaceable parts are at the back of this chapter.

If you have difficulty repairing the interface or if you would rather have HP repair it, contact the nearest Sales and Service Office for assistance; office locations are listed at the back of this manual.

When ordering a replacement circuit board, specify HP Part No. 11202-66591.

CALCULATOR I/O LINES

Here is a definition of each calculator interface line used with the 11202A Interface:

> **NOTE**
>
> A bar above each line name indicates that the line goes low (<0.7V) when pulsed '1'. All other lines go high (>2.4V) when pulsed '1'.

CO0
CO1
CO2
CO3

Peripheral Address lines — used to address the correct device.

$\overline{CEO}$

Control Enable line — provides the correct timing for interface operations.

$\overline{DI0}$
$\overline{DI1}$
$\overline{DI2}$
$\overline{DI3}$
$\overline{DI4}$
$\overline{DI5}$
$\overline{DI6}$
$\overline{DI7}$

Calculator Data Input lines — data is transferred in bit-parallel, character-serial, ASCII code.

DO0
DO1
DO2
DO3
DO4
DO5
DO6
DO7

Calculator Data Output lines — same I/O format as Data Input lines.

(continued)

SIØ — **Service Interrupt line** – indicates when the interface is busy (high) or ready (low).

$\overline{SIH}$ — **Calculator Service Inhibit line** – indicates when the calculator permits the interface to place data on the calculator input lines.

SO3 — **Calculator Status line** – indicates when the calculator is starting an input operation (high) or an output operation (low).

$\overline{STP}$ — **Calculator Stop line** – indicates when the STOP key is pressed. A $\overline{STP}$ signal terminates any I/O operation.

THEORY OF OPERATION

In general, the 11202A is an 8-bit, bi-directional data buffer. Although the interface has separate input and output lines, it handles data in only one direction at a time. The SO3 signal determines whether the input or output mode is set.

A simplified block diagram of the interface is shown below.

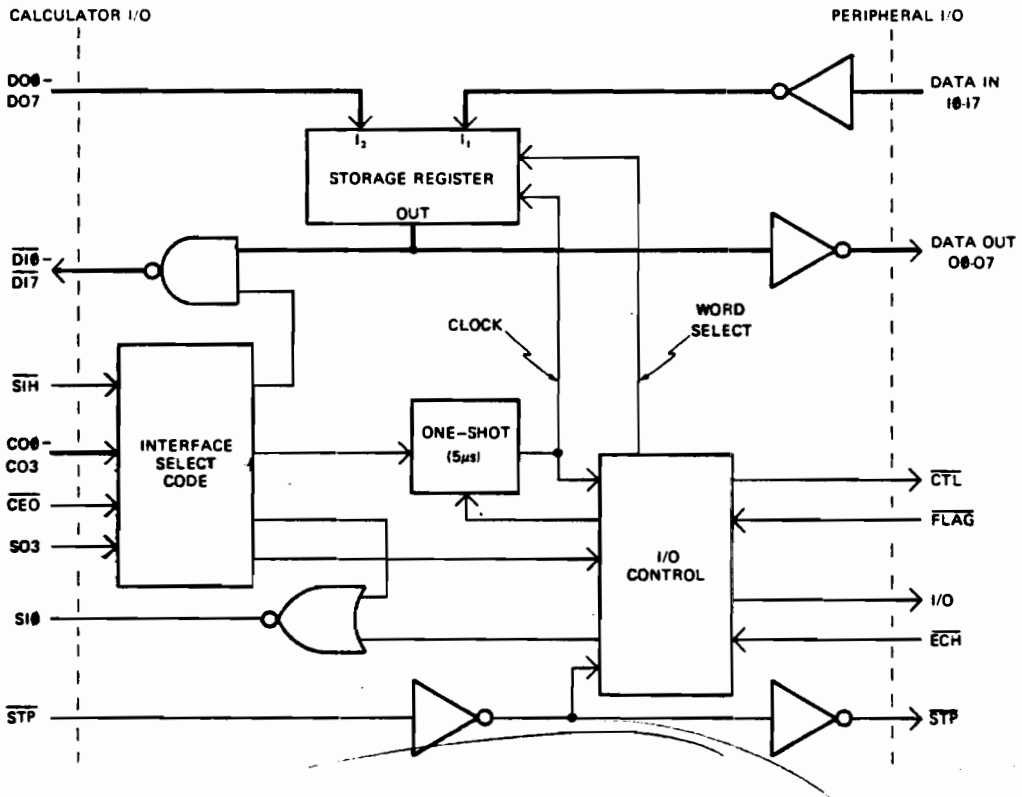


Figure 3-1. Simplified Block Diagram

DATA OUTPUT SEQUENCE (see Figure 3-2)

This sequence occurs for each output character:

1. After an appropriate OUTPUT Command or WRITE Statement is executed from the calculator, a Select Code signal is output.

2. The calculator checks interface status on the SIØ line. If the interface is not busy, data is held on the calculator output lines (DOØ-DO7) and an SO3 signal sets the I/O line low to indicate that a data-output operation has started.

3. A $\overline{\text{CEO}}$ and a Select Code signal are output. If the Select Code signal corresponds to the setting of S1, data is transferred to the interface output lines. 5μs later, the $\overline{\text{CTL}}$ line is forced low.

4. Data is held on the output lines until the peripheral device indicates 'done' by forcing $\overline{\text{FLG}}$ low. Then data on the interface input lines is loaded into the storage register and onto the output lines.

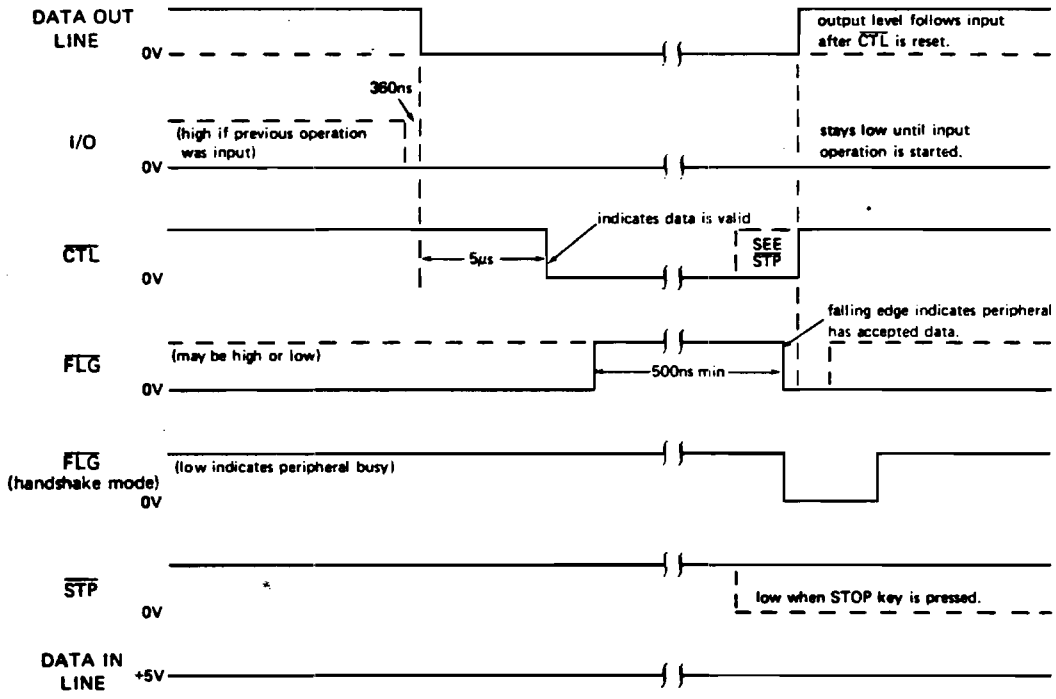


Figure 3-2. Data -Output Timing Diagram

(11202A peripheral I/O lines are shown)

THEORY OF OPERATION
(continued)

DATA INPUT SEQUENCE (see Figure 3-3)

This sequence occurs for each input character:

1. After an INPUT command or READ statement is executed from the calculator, a Select Code signal is output.

2. The calculator checks interface status on the SIØ line. If the interface is not busy, an SO3 signal sets the I/O line high to indicate that a data-input operation has started.

3. The calculator outputs $\overline{CEO}$ and Select Code signals. If the Select Code signal corresponds to the setting of S1, the $\overline{CTL}$ line is forced low. Now the calculator monitors the SIØ line, waiting until the peripheral device has output data and indicated 'done' by forcing the $\overline{FLG}$ line low. 300ns later, data is loaded into the interface and transferred to its output lines.

4. The interface then forces the SIØ line low and the calculator inputs the data on the next $\overline{SIH}$ pulse.

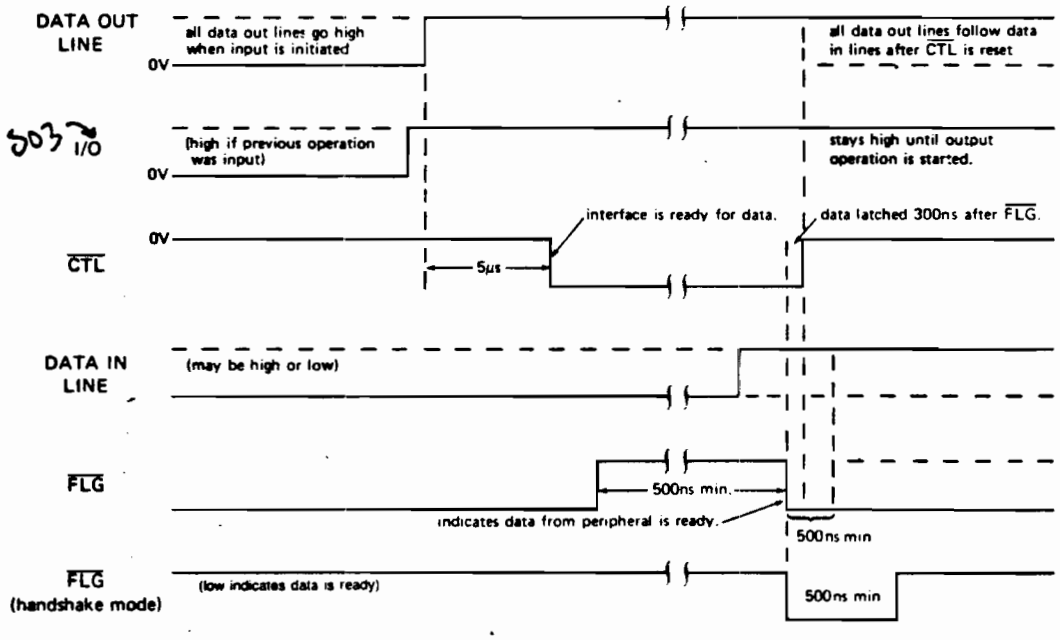


Figure 3-3. Data-Input Timing Diagram
(11202A peripheral I/O lines are shown)

OPT. 01 CABLE OPTION FOR FI-30

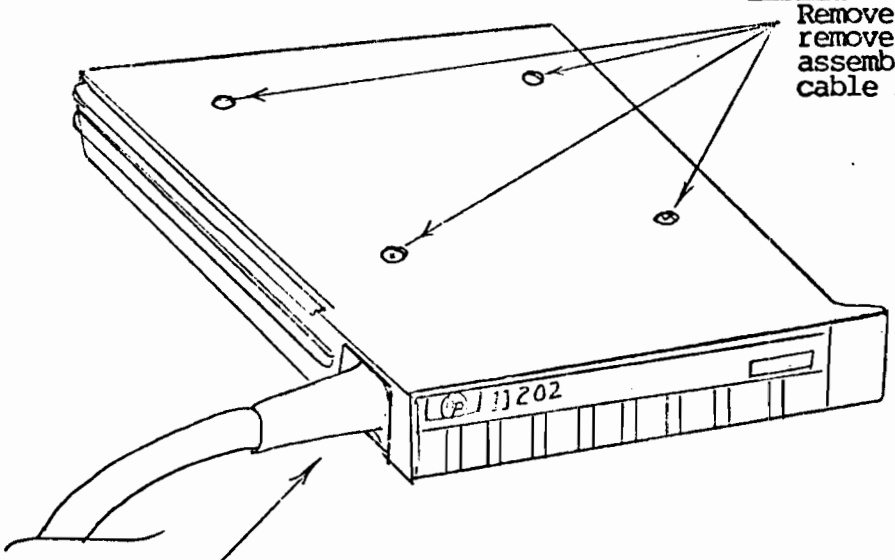
(See Figure 3-1)

SIGNAL	CONNECTOR	WIRE COLOR
I0	16	Black (0)
I1	15	Brown (1)
I2	14	Red (2)
I3	13	Orange (3)
I4	12	Yellow (4)
I5	11	Green (5)
I6	10	Blue (6)
I7	9	Violet (7)
O0	T	White-Black (90)
O1	S	White-Brown (91)
O2	R	White-Red (92)
O3	P	White-Orange (93)
O4	N	White-Yellow (94)
O5	M	White-Green (95)
O6	L	White-Blue (96)
O7	K	White-Violet (97)
CTL	H	White-Gray (98)
STP	J	White-Black-Red (902)
I/O	F	White-Black-Brown (901)
FLG	C	Gray (8)
ECH	B	White (9)
GND	U	White-Black-Orange (903)
GND	V	White-Black-Yellow (904)
GND	17	Pink

INFOTEK FI-30 FAST TTL I/O CARD INSTALLATION
USING H-P 11202 CABLE

STEP 1

Remove 4ea. screws. Open box and remove circuit board and cable assembly by sliding square molded cable retainer out of slot.



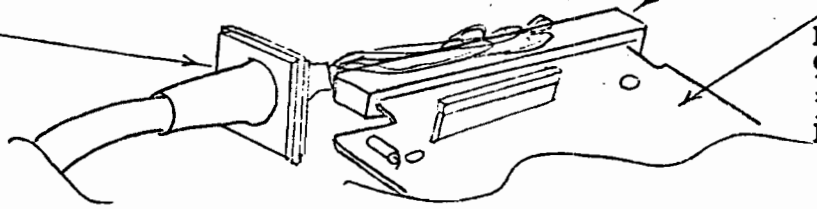
Circuit board edge connector

H-P 11202 circuit card

Molded cable retainer. Cable fits in slot in Infotek FI-30 case and case lid

STEP 2

Remove H-P board from connector and plug in Infotek FI-30 card. Insert in slot in FI-30 case.



STEP 3

4ea. ¼ inch 4/40 screws fasten lid in place with cable retainer in slots.

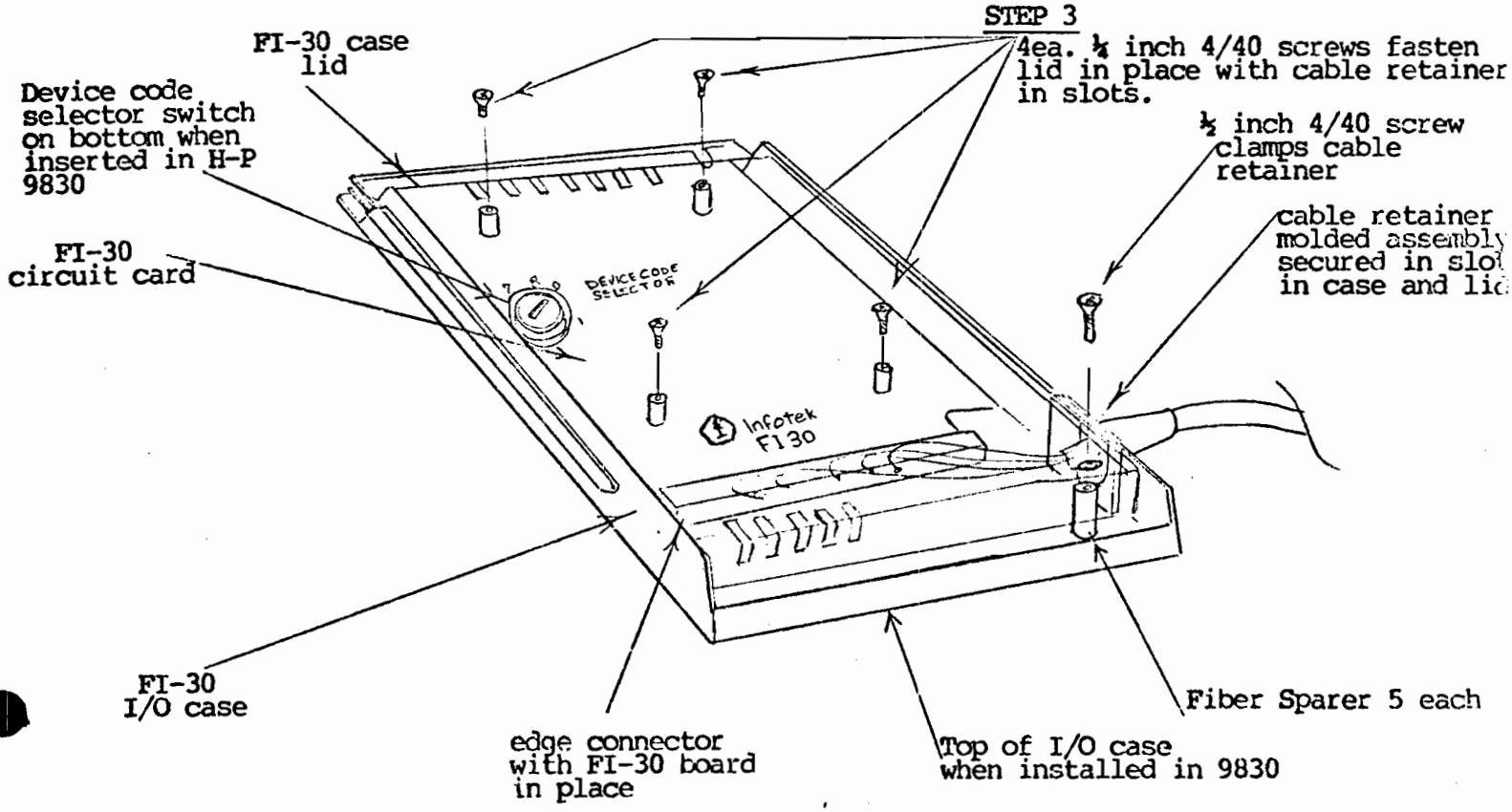
FI-30 case lid

Device code selector switch on bottom when inserted in H-P 9830

½ inch 4/40 screw clamps cable retainer

cable retainer molded assembly secured in slot in case and lid

FI-30 circuit card



FI-30 I/O case

edge connector with FI-30 board in place

Top of I/O case when installed in 9830

Fiber Sparer 5 each