

HEWLETT-PACKARD

82153A
WAND

SERVICE MANUAL





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General Information

1-1. INTRODUCTION

1-2. This service manual contains information necessary to troubleshoot and repair the HP 82153A Wand.

1-3. The manual is divided into five sections, which give:

- a. A description of the wand (section I).
- b. An explanation of how it works (section II).
- c. Information for disassembly and reassembly (section III).
- d. Steps for troubleshooting and testing the wand (section IV).
- e. A list of replaceable parts (section V).

1-4. DESCRIPTION

1-5. The HP 82153A Wand (figure 1-1) is a plug-in accessory for HP-41C style calculators. It permits printed "bar code" to be optically read into the calculator, providing rapid entry of programs and data into

the calculator's memory. In the same manner, HP-41C functions can be directly executed using the wand. The specifications of the HP 82153A Wand are summarized in table 1-1.

1-6. Service procedures for the wand make use of a special built-in test function and bar-code tests. An HP-41C test calculator gives a visual output of the test results.

1-7. IDENTIFICATION

1-8. The date code on the bottom of the plug-in module is used for determination of warranty status. Its format is described below.

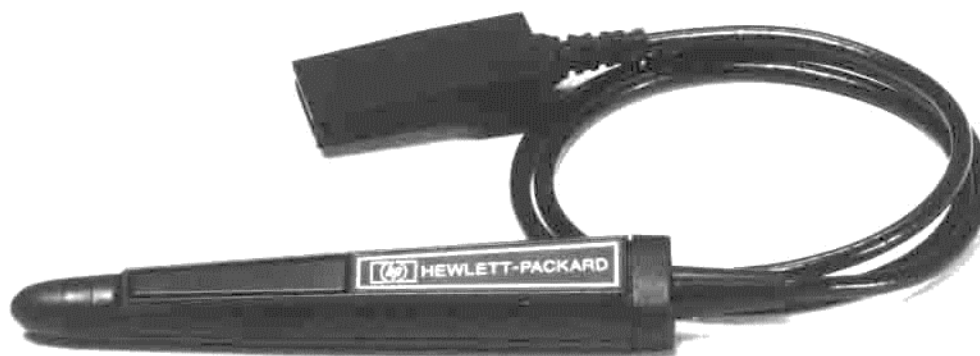
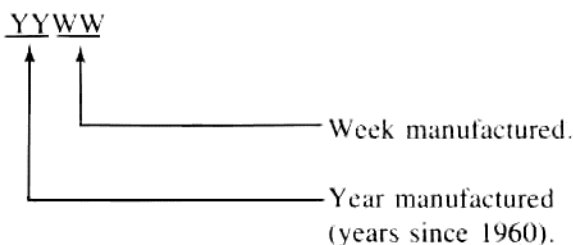


Figure 1-1. HP 82153A Wand

Table 1-1. Specifications

<p>Physical Properties</p> <ul style="list-style-type: none"> ● Length: 13.0 centimeters (5.12 inches). ● Diameter: 2.3 centimeters (0.92 inch) maximum. ● Cable Length: 81 centimeters (32 inches). ● Weight: 55 grams (1.9 ounces). <p>Compatibility</p> <ul style="list-style-type: none"> ● Plugs into HP-41C style calculator. ● Reads HP-41C bar code. <p>Temperature</p> <ul style="list-style-type: none"> ● Operating: 0° to 45°C (32° to 113°F). ● Storage: -20° to 65°C (-4° to 149°F). 	<p>Power Requirements</p> <ul style="list-style-type: none"> ● Voltages: Regulated 6 Vdc supplied by calculator. Unregulated 6 Vdc supplied by batteries in calculator. ● Current: 2 μA maximum (read switch off, calculator off). 65 mA maximum (read switch on, calculator on). <p>Operating Limits</p> <ul style="list-style-type: none"> ● Scan Angle: Within 25° of perpendicular (10° to 20° optimum). ● Scan Speed: 7.6 to 76 cm/s (3 to 30 in/s).
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Theory of Operation

2-1. FUNCTIONAL DESCRIPTION

2-2. The HP 82153A Wand design (see figure 2-1) consists of four primary electrical components:

- The optical sensor.
- The converter circuit.
- The interface IC (integrated circuit).
- The ROM (read-only memory) IC.

2-3. CMOS (complementary metal-oxide-semiconductor) circuitry is used in the hybrid circuit, which consists of the interface IC and the ROM. The hybrid circuit is contained in the plug-in interface module. The converter circuit consists of a conventional bipolar IC and associated discrete components. This circuit and the optical sensor are contained in the wand case.

2-4. Optical Sensor

2-5. The optical sensor unit contains an LED (light-emitting diode) operating in the visible range, a photodiode detector, and precision optics. Light energy, when externally reflected back toward the sensor, activates the detector and generates a low-level current at its output.

2-6. Converter Circuit

2-7. A read switch on the wand activates the converter circuit and the optical sensor. This circuit amplifies the photocurrent from the sensor and converts it to a rectangular-shaped waveform. This output signal is essentially a two-level signal that indicates the presence or absence of a photocurrent from the sensor. The signal is low when sensor current is being generated (when light is being reflected back into the sensor); the signal is high when no current is being generated (when no light is reflected, or when the read switch is off).

2-8. Interface IC

2-9. The interface IC coordinates the transfer of data from the wand to the CPU in the calculator. It

consists of three basic sections: the controller, the counter, and the buffers.

2-10. Timing signals ($\Phi 1$, $\Phi 2$, and SYNC) from the calculator are used by the controller section to synchronize its operation with the CPU. (Signal names are listed in table 2-1.) Instructions from the calculator on the ISA line are decoded and implemented by the controller. It also decodes the V_o signal from the converter circuit into a sequence of zeros and ones and passes it to the buffer section. The controller uses the FI line to inform the calculator that the wand is turned on and that data is ready to be sent to the CPU.

2-11. The counter section measures the time interval between transitions in the V_o signal, as detected by the controller section. The $\Phi 2$ signal is used as the timing reference. A reference interval used to compare with the measured interval is stored in the counter section.

2-12. The buffer section contains two 128-bit primary registers and an 8-bit shift register. When eight bits have been accumulated in the shift register, the controller section shifts the bits into the proper primary register. At the appropriate time, the controller sends eight bits of data from a register to the CPU.

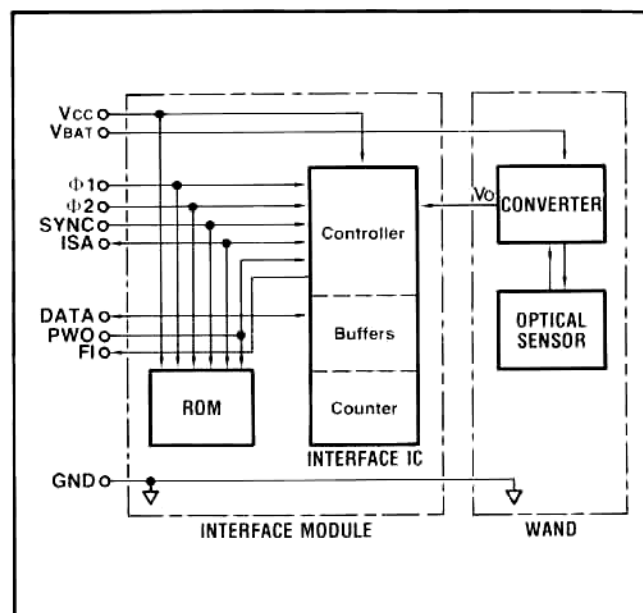


Figure 2-1. HP 82153A Wand Block Diagram

Table 2-1. Signal Names

SIGNAL	DESCRIPTION
DATA	Data Signal
FI	Flag Interface Signal
GND	Ground
ISA	Instruction/Address Signal
PWO	Power On/Off Signal
SYNC	Timing/Information Signal
V _{BAT}	Battery Voltage
V _{CC}	System Voltage
V _O	Optical Output Voltage
Φ1	Timing Signal
Φ2	Timing Signal

2-13. Read-Only Memory

2-14. The ROM contains 4096 10-bit microprogrammed instructions. These instructions are used by the CPU in the calculator to control the wand's operation.

2-15. SYSTEM OPERATION

2-16. The following paragraphs describe how the wand processes bar-code information and interacts with the calculator system.

2-17. Bar code (see figure 2-2) consists of a row of dark-colored bars printed on a light-colored surface. Each bar represents a binary bit. The value of the bit is determined by the width of the bar relative to the constant spacing between bars and widths of previous bars. A bar whose width is equal to the width of a space is equivalent to a "0"; a bar that is twice as wide as a space is a "1". The data in a line of bar code is formatted in multiples of eight bars (called a byte), including one byte for checksum verification. Two additional bars at each end of the line provide an initial timing reference and identify each end. The reference bars and left direction bar are all 0; the right direction bar is a 1.

2-18. When the read switch is pressed and the sensor is placed against a light-colored (reflective) surface, converter output V_O goes low. If the calculator system is inactive (PWO is low), the interface IC sets the ISA line high, signaling the CPU to place the system in its active RUN mode (PWO high).

2-19. As the sensor is moved along the line of bar code, the interface IC establishes and continually up-

dates the reference interval (the number of clock counts to scan one space or one "0" bar). As each bar is decoded to a binary bit, it is passed to the eight-bit shift register. Each time eight bits are accumulated, they are passed to one of the primary buffers in the interface IC. The order of this transfer depends upon the direction that the bar-code line is scanned, which is indicated by the left/right direction bars. In this way, data is always stored in proper order, regardless of the direction in which it is scanned. One primary buffer can store data from a full line of bar code (up to 16 bytes, or 128 bits).

2-20. When the scan of a line has been completed, the interface IC senses the extended white "space," enables the primary register to send its contents to the CPU, and signals the CPU via the FI line that data is ready to be sent. The CPU sends a data-transfer instruction on the ISA line, and the interface IC then transfers the data from its enabled primary register on the DATA line. Data is transferred eight bits per word time (56 clock cycles). When all of the data has been sent, the FI signal is discontinued. The CPU then verifies the received data using the checksum byte, generating a short beep if the data is valid or a long beep if it finds an error.

2-21. While data is being transferred to the CPU from one primary register, the other primary register is able to receive decoded data from the shift register. The interface IC alternates the functions of its two registers as each line of bar code is scanned.

2-22. If the read switch is off and no data is waiting to be sent to the calculator, the absence of a signal on the FI line lets the CPU deactivate the calculator. When the calculator reverts to an inactive state, it sets PWO low. This signal disables the interface and ROM IC's so that they do not respond to spurious signals.

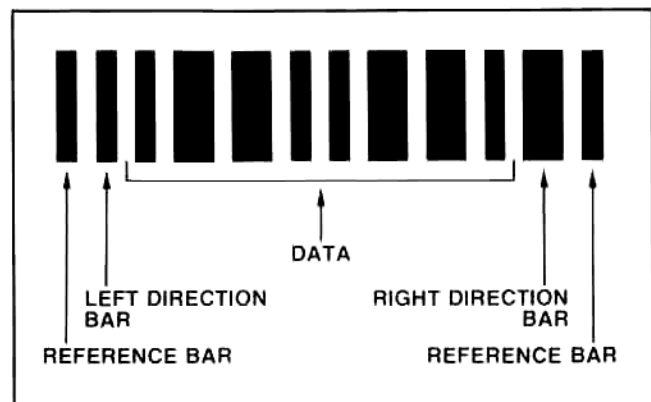


Figure 2-2. Bar Code Structure

Disassembly and Reassembly

The following procedures describe the steps necessary to disassemble and reassemble the HP 82153A Wand in order to replace components or assemblies that are faulty. The case is sealed with epoxy to provide electrostatic protection for the internal circuits. If the case is opened, a new top case, bottom case, and front collar must be installed and the case sealed with epoxy.

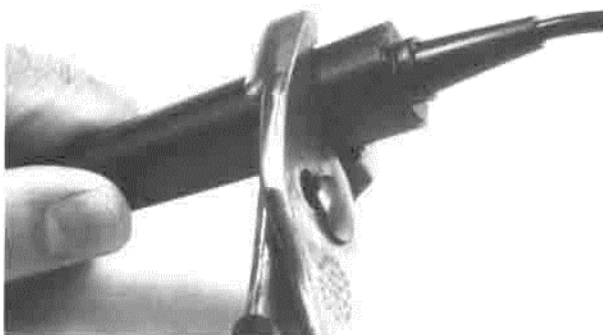
CAUTION

Ensure that adequate precautions are taken regarding electrostatic protection. Use the antistatic desoldering tool (8690-0227) and work at a bench setup that is electrostatically protected. Otherwise, IC's may be damaged.

1

CASE SEPARATION

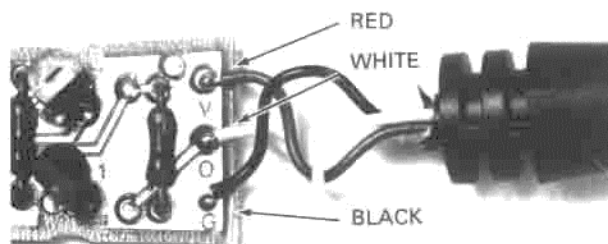
- a. **Pry off the back collar** from the wand using the collar removal tool (T-550930).
- b. **Unscrew the tip** from the wand.
- c. **Crack the epoxy bond** along the sides of the case, using extreme care not to damage internal components. Use a 6-inch slip-joint pliers and squeeze gently until you feel or hear the seam crack. Start about 1 cm ($\frac{1}{2}$ in.) from the back end (as shown) and work along the seams to the back end; then work along the seams to the front collar (as shown).



2 PCA AND CABLE ASSEMBLY REPLACEMENT

After separating the case (procedure 1):

- a. **Unsolder the three wires** from the PCA.
- b. **Check the rear collar** to be sure it is on the cable assembly.
- c. **Solder the three wires** to the PCA, being careful to observe the indicated color coding: red (V), white (O), black (G).



3 CASE REASSEMBLY

Note: If your repair volume permits, you should not reassemble the wand until you have accumulated three or more wands. The epoxy used to seal the case has a shelf life of only 30 minutes—but one batch can seal more than 10 wands.

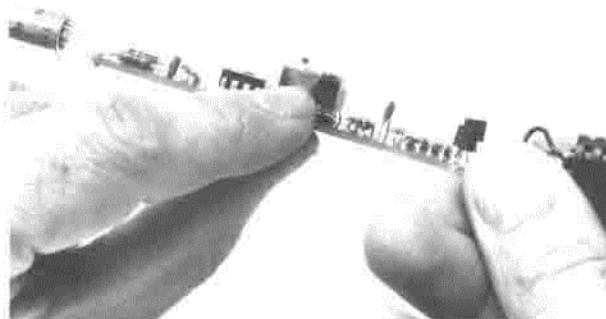
After gathering the necessary new parts and preparing a syringe of epoxy:

- a. **Remove any epoxy** from the PCA or sensor. Scrape it off using a pointed knife.
- b. **Check the leads on the sensor** to be sure they are straight and do not touch each other.

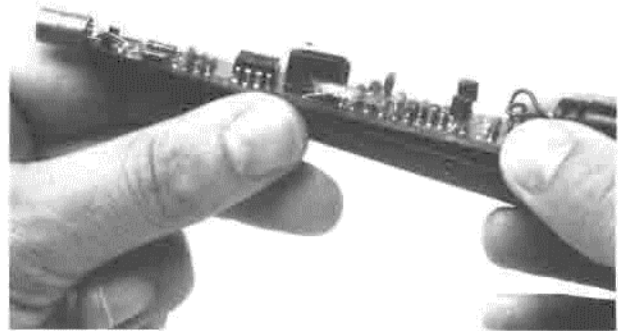
CAUTION

Be sure the loop of tape does not hold down or touch the button on the switch. If it does, the wand will not operate properly or the switch action may be impaired.

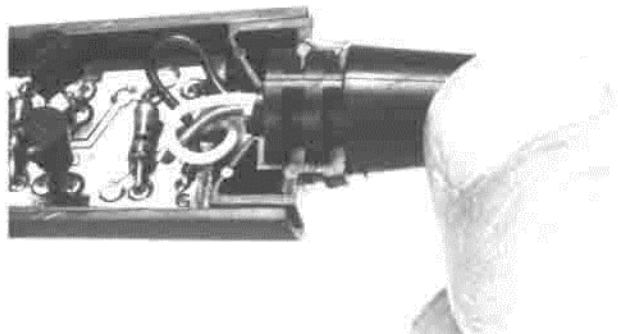
- c. **Install a loop of tape** (0460-1467) across the top of the switch on the PCA. Use two pieces of tape to make a 2-cm by 2½-cm (¾-in. by 1-in.) piece. Then fasten the shorter length across the top of the switch, lining up the front end of the tape with the front end of the switch. The tape loop must just clear the top of the switch button.



- d. **Install the PCA** in a new bottom case. Be sure that the sensor is flush with the front ring on the case and that the sensor tab aligns with the tab on the case.

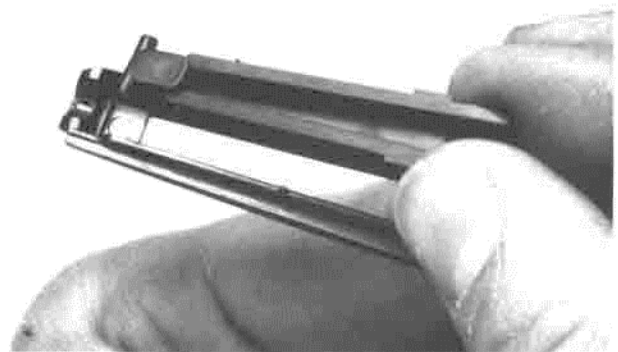


- e. **Insert the cable strain relief** into the retainer in the bottom case. The crosswise and lengthwise ribs on the strain relief should line up with the corresponding grooves in the case.

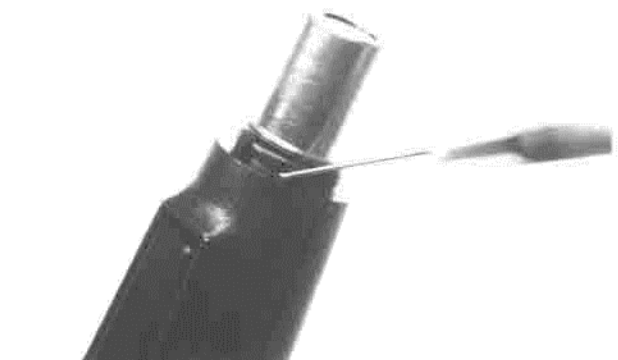


- f. **Insert the switch lever** into a new top case. The hinge tabs on the lever are positioned in the grooves at the front of the case.

- g. **Place the two case parts together.**



- h. **Deposit a narrow bead of epoxy** around the base of the front rim (where the front collar will seat). Do not use an excessive amount.
- i. **Place a new front collar** into the front collar fixture (T-191238), keeping the smaller end down.
- j. **Align the slots** in the front collar with the tabs on the case rim.



- k. **Press the wand case into the front collar.** Do this by forcing the case straight down into the collar. This requires very firm pressure.

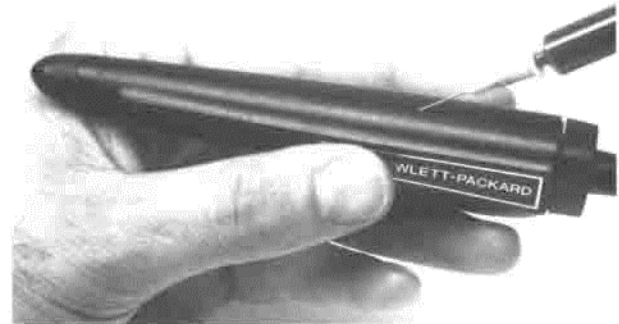


- l. **Snap the rear collar onto the case,** keeping the slots in the collar aligned with the tabs on the case. This requires very firm pressure. If the collar does not fit tightly, replace the collar or case parts.
- m. **Coat the threads of the tip** with silicone grease (6040-0297). This prevents epoxy from bonding to the tip.
- n. **Screw the tip** into the front of the wand.

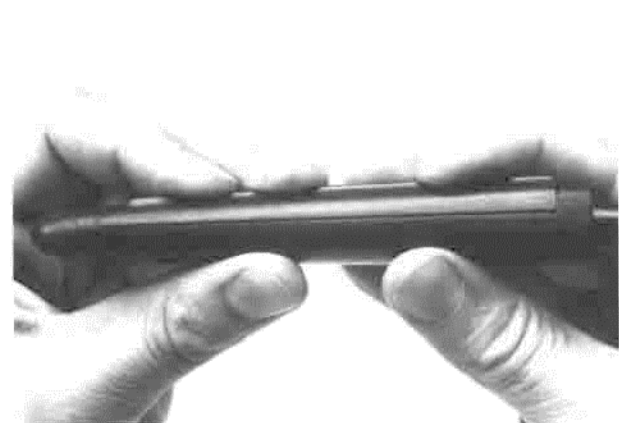


- o. **Deposit epoxy in the two case seams** along the entire length of the wand. The grooves should be almost full. *Do not* get epoxy on the rear collar.

Note: The tip of the syringe should fit into the grooves. This prevents epoxy from getting on the surface of the case. If necessary, carefully file or pinch the sides of the tip so that it fits into the grooves.



- p. **Squeeze the case halves together** along top and bottom of the wand to settle the epoxy in the grooves.
- q. **Wipe the case** with a lint-free tissue to remove any traces of epoxy.



Troubleshooting and Testing

4-1. INTRODUCTION

4-2. This section contains the procedures required to troubleshoot and test the HP 82153A Wand. Tools that facilitate service are listed in table 4-1.

4-3. The troubleshooting and test procedures use a test calculator and plug-in service module. Use of these units checks the operation of the wand and tests a portion of its circuitry.

4-4. INITIAL PREPARATION

4-5. Perform the following steps before attempting to troubleshoot the wand:

- a. **Visually inspect the wand** for physical damage. Replace any components that are visibly damaged. Replace the tip if its shape is disfigured or the opening is distorted.

Table 4-1. Recommended Tools

HP PART/ MODEL NUMBER	DESCRIPTION
ET-11966	Service Module, for HP-41C/HP 82104A
or	or
ET-11968	Service Module, for HP 82143A
HP-41C	Calculator
82153-90033	Bar Code Test Card
T-550930	Collar-Removal Tool
T-191238	Front Collar Fixture
9301-0381	Syringe
9301-0211	Syringe Tip
0470-1132	Epoxy
6040-0297	Silicone Grease
8690-0227	Desoldering Tool, antistatic
8690-0253	Desoldering Tool Tip, antistatic
8690-0129	Soldering Iron
8690-0132	Soldering Iron Stand
HP 1220A*	Oscilloscope
0960-0062	Continuity Tester
HP 3469B*	Multimeter. Accurate to 0.01 Vdc.
HP 10004D*	Oscilloscope Probe
* Or equivalent.	

- b. **Check the opening and lens** for dirt by unscrewing the tip. If necessary, clean the opening using a cotton swab and liquid detergent. Clean the lens with a lint-free cloth and liquid glass cleaner. *Do not* spray cleaner on the sensor.
- c. **Determine the customer's concern, if possible.** If the customer notes a particular method of using the wand, try testing it in a similar manner.

CAUTION

Ensure that the bench setup for troubleshooting and repair has adequate electrostatic protection. Otherwise, IC's may be damaged.

4-6. TEST AND REPAIR

4-7. Perform the following steps to determine the causes of improper operation and to make the necessary repairs. For reference information concerning component locations and part numbers, use figures 4-1 and 5-1 and tables 4-2 and 5-1.

- a. **Be sure the test calculator is off.**
- b. **Insert a service module** into the calculator's lower left (#3) I/O port. Use one of the following modules:
 - ET-11966 (calculator/card-reader service module).
 - ET-11968 (printer service module).
- c. **Plug in the wand** using the calculator's lower right (#4) I/O port. (Port #4 *must* be used if the calculator/card-reader service module is used; any port may be used with the printer service module.)
- d. **Turn on the calculator** by pressing its **ON** key.
 - If two or three beeps are sounded and **SELECT TEST** is displayed, the calculator is ready to continue.
 - If any other response occurs, turn off the calculator, unplug the wand, then repeat this step. If the calculator now operates correctly, replace the cable assembly of the wand. Then repeat the test and repair sequence.

e. **Test the ROM in the wand:**

- For the calculator/card-reader service module, press the **[SST]** key. **AP1 MOD TEST** should appear in the display.
- For the printer service module, press the **[B]** key. **GEN ROM TEST** should appear in the display.

Observe the results of the ROM test:

- If **AP MOD OK** or **WN-1x OK** is displayed, the ROM is good. Continue testing.
- Any other response indicates improper operation. Check that the wand is installed properly. Then replace the cable assembly and repeat the test and repair sequence.*

f. **Turn off the calculator** by pressing its **[ON]** key.

g. **Remove the service module.**

h. **Press and hold the read switch** on the wand while observing the sensor (by looking into the opening in the tip).

- If the sensor lights up red, the sensor's emitter is operating properly.
- If the calculator turns on (and the tip of the wand is not against a light-colored surface), replace the PCA in the wand.* Then repeat the test and repair sequence.
- If the sensor does not light up, determine the cause using table 4-2.

Table 4-2. Troubleshooting Procedure for Inoperative Sensor

Use this procedure to determine the cause of the sensor not lighting up when the read switch is pressed.		
STEP	SPECIFICATION	ACTION
1. Separate the wand case. (Refer to section III.) 2. Plug the wand into the calculator. 3. Measure V_{BAT} (at the red cable wire).	3.0 to 6.5 Vdc	If low, check batteries and calculator, then replace cable assembly.* If within range, check continuity of switch, then replace PCA.*

Table 4-3. Troubleshooting Procedure for Improper Turn-On

Use this procedure to determine the cause of the wand not properly turning on the calculator.		
STEP	SPECIFICATION	ACTION
1. Separate the wand case. (Refer to section III.) 2. Plug the wand into the calculator. 3. Place the tip over the end of the sensor. 4. Place the tip of the wand against a white surface and hold the read switch ON. 5. Measure V_{i1} (at the white cable wire)	0 to 1.0 Vdc	If high, replace the PCA.* If within range (but calculator does not turn on), replace cable assembly.*

*Do not reassemble the case if it is opened for repair. Continue testing the wand out of the case. Scan bar code by slipping the tip over the end of the sensor and pressing the switch button.

i. **Hold the wand's tip against a white surface** while pressing the read switch. The wand should be perpendicular to the surface.

- If the calculator turns on, the wand has responded properly.
- If the calculator does not turn on, determine the cause using the procedure in table 4-3.

j. **Lay the wand aside.**

k. **Execute** $\overline{\text{W}}\overline{\text{N}}\overline{\text{D}}\overline{\text{T}}\overline{\text{S}}\overline{\text{T}}$ on the calculator. Either press $\overline{\text{X}}\overline{\text{E}}\overline{\text{O}}$ $\overline{\text{A}}\overline{\text{L}}\overline{\text{P}}\overline{\text{H}}\overline{\text{A}}$ $\overline{\text{W}}\overline{\text{N}}\overline{\text{D}}\overline{\text{T}}\overline{\text{S}}\overline{\text{T}}$ $\overline{\text{A}}\overline{\text{L}}\overline{\text{P}}\overline{\text{H}}\overline{\text{A}}$ or press a key to which this function has been manually assigned. In order for this test to work properly, at least 17 data storage registers must be available before executing $\overline{\text{W}}\overline{\text{N}}\overline{\text{D}}\overline{\text{T}}\overline{\text{S}}\overline{\text{T}}$. (Execute $\overline{\text{S}}\overline{\text{I}}\overline{\text{Z}}\overline{\text{E}}$ 017 to allocate 17 registers.)

- If **W: READY** is displayed, the system is ready to read a line of bar code.
- If any other result occurs repeatedly, replace the cable assembly.*

l. **Read the first line of bar code** on the test card (82153-90033). Press the read switch and move the wand rapidly and steadily along the line, tilting it about 10-20 degrees from perpendicular. Bar code may be read left-to-right or right-to-left.

- If the following results are obtained, the wand has responded properly. Each line is normally displayed for about 3 seconds, and will have periods separating the digits (unless flag 29 is set). (If flag 21 is set, press $\overline{\text{R}}\overline{\text{S}}$ to view each line.)

B1= 00001111
B2= 00001111
B3= 00001111
B4= 00001111
B5= 00001111
B6= 00001111
B7= 00001111
B8= 00001111

B9= 00001111
B10= 00001111
B11= 00001111
B12= 00001111
B13= 00001111
B14= 00001111
B15= 00001111
B16= 00001111

- If improper patterns are obtained, this can be verified by repeating steps *k* and *l* (or by pressing $\overline{\text{R}}\overline{\text{S}}$ and repeating step *l*). Try replacing the cable assembly as the most likely cause of the incorrect result, then repeat the test and repair sequence. The wand PCA is a less likely cause.*
- m. **Read the second line of bar code** on the test card. Do not press any keys before reading the line.
- If **READ OK** is displayed, the wand is operating properly.
 - If **W: CKSUM ERR**, **W: DATA ERR**, or another error message is displayed, replace the cable assembly.* Then repeat the test and repair sequence.
- n. **Read the third line of bar code** on the test card. This line contains defective bar code. Do not press any keys before reading the line.
- If **W: CKSUM ERR** is displayed, the wand has correctly detected the defective bar code.
 - Any other result, including any other error message, indicates improper operation. Repeat this step to verify the results. Then replace the cable assembly and repeat the test and repair sequence.*
- o. **Reassemble the wand** if it has been opened for repair. (Refer to section III.)

Note: If your repair volume permits, you should not reassemble the wand until you have accumulated three or more wands. The epoxy used to seal the case has a shelf life of only 30 minutes—but one batch can seal more than 10 wands.

*Do not reassemble the case if it is opened for repair. Continue testing the wand out of the case. Scan bar code by slipping the tip over the end of the sensor and pressing the switch button.

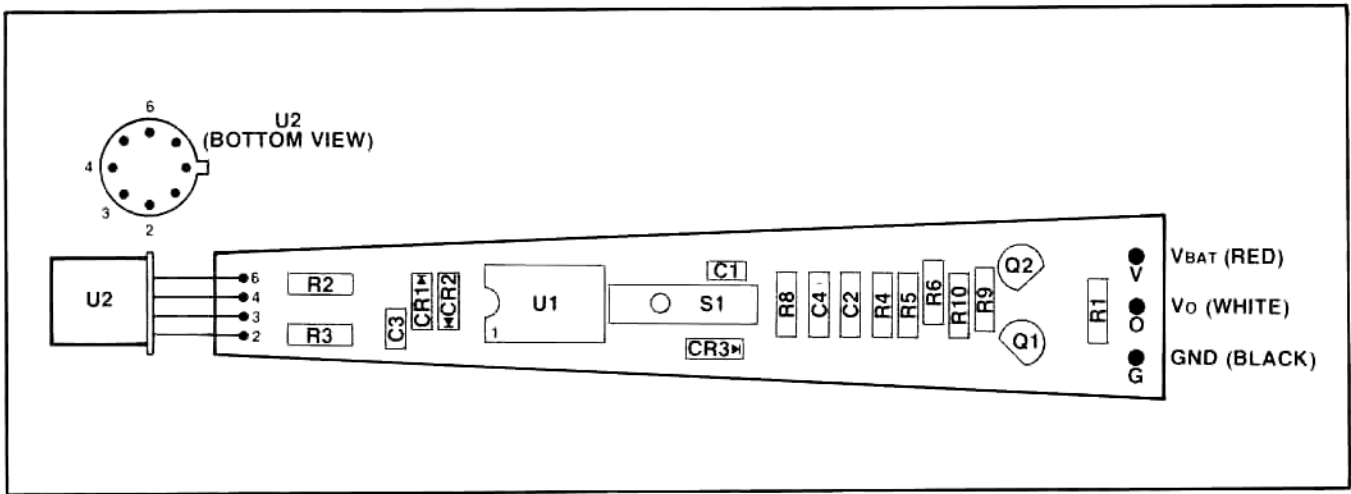


Figure 4-1. Component Location Diagram for Sensor/PCA

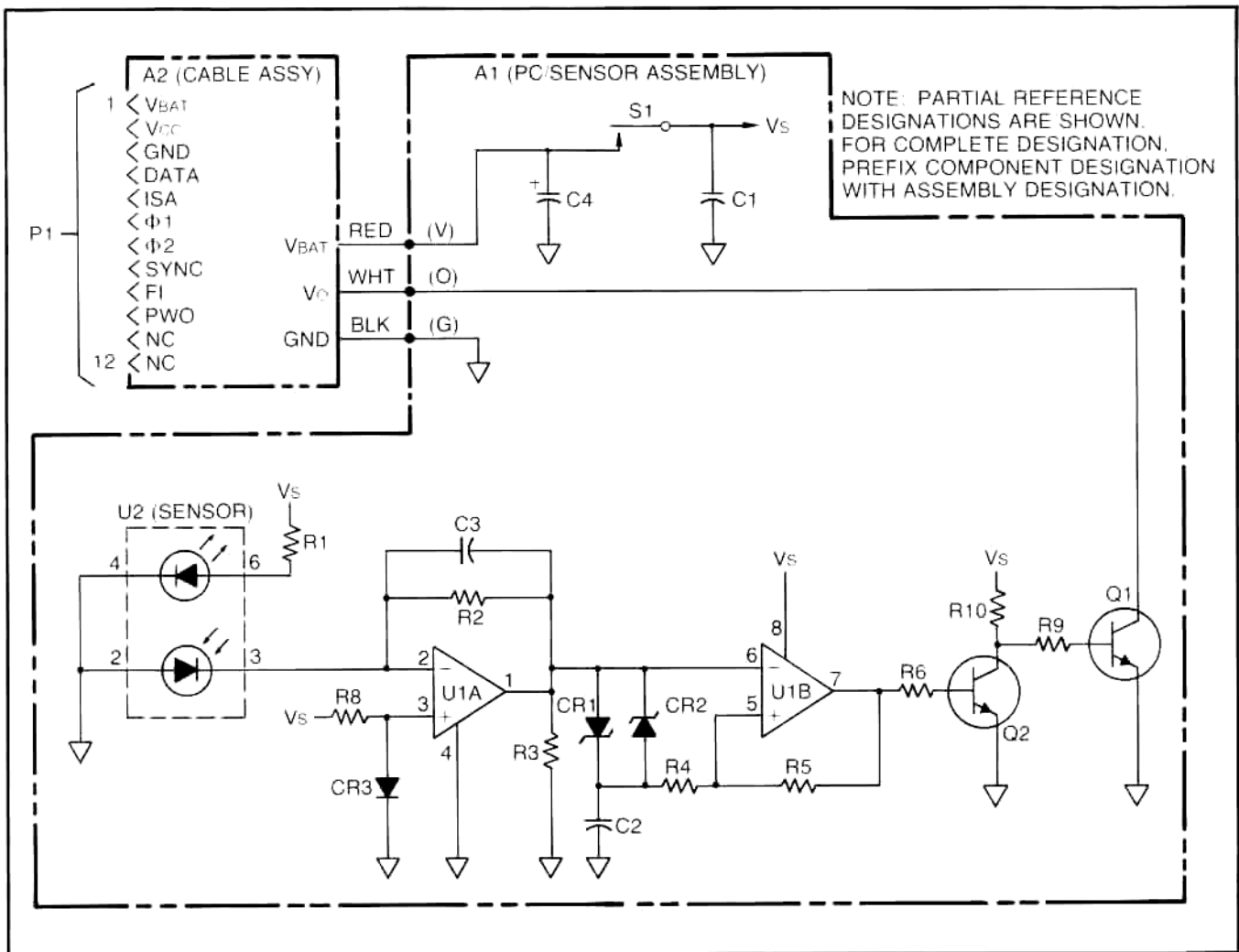


Figure 4-2. HP 82153A Wand Schematic Diagram

Replaceable Parts

5-1. INTRODUCTION

5-2. This section contains information pertaining to the parts used in the HP 82153A Wand, illustrated in figure 5-1. Part descriptions, HP part numbers, quantities, and reference designations (where applicable) are given in table 5-1.

5-3. ORDERING INFORMATION

5-4. To order replacement assemblies or parts,

address order or inquiry to Corporate Parts Center or Parts Center Europe. Specify the following information for each part ordered:

- a. Model and date code.
- b. HP part number.
- c. Description.
- d. Complete reference designation (if applicable).

Table 5-1. HP 82153A Wand Replaceable Parts

INDEX NUMBER, FIGURE 5-1	HP PART NUMBER	DESCRIPTION	QTY
1	82153-60901	ASSEMBLY, cable (A2)	1
2	7120-8629	● LABEL, module	1
		ASSEMBLY, wand	1
3	QEDS-3098	● ASSEMBLY, printed-circuit/sensor (A1)	1
	3103-0421	● SWITCH (S1)	1
4	5040-9902	● CASE, bottom	1
5	5040-9901	● CASE, top	1
6	5040-9903	● COLLAR, front	1
7	5040-9904	● COLLAR, rear	1
8	7120-8624	● LABEL, wand	1
9	5040-9905	● LEVER, read-switch	1
10	5040-9906	● TIP	1
11	0460-1467	TAPE, ½-inch	

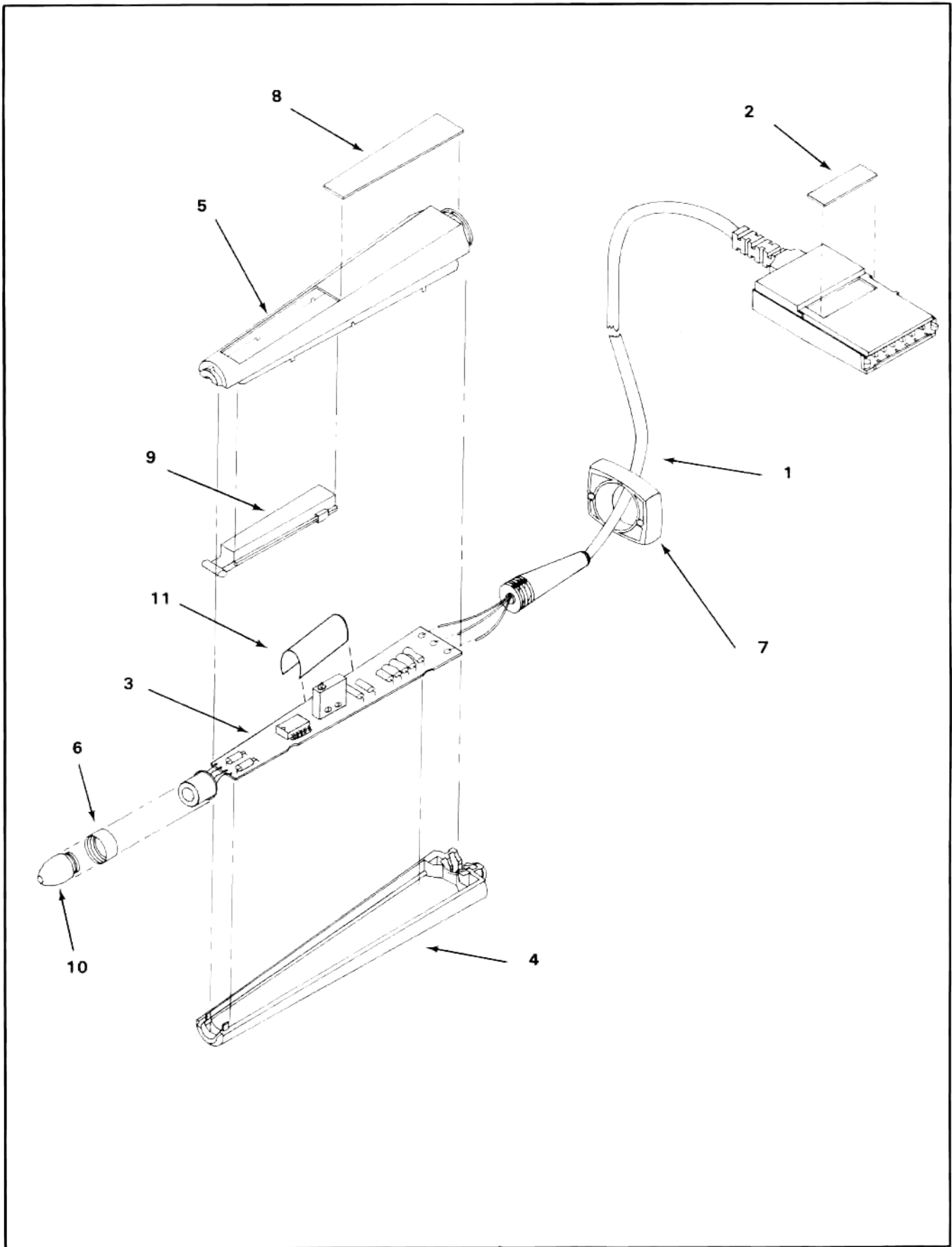


Figure 5-1. HP 82153A Wand Exploded View

