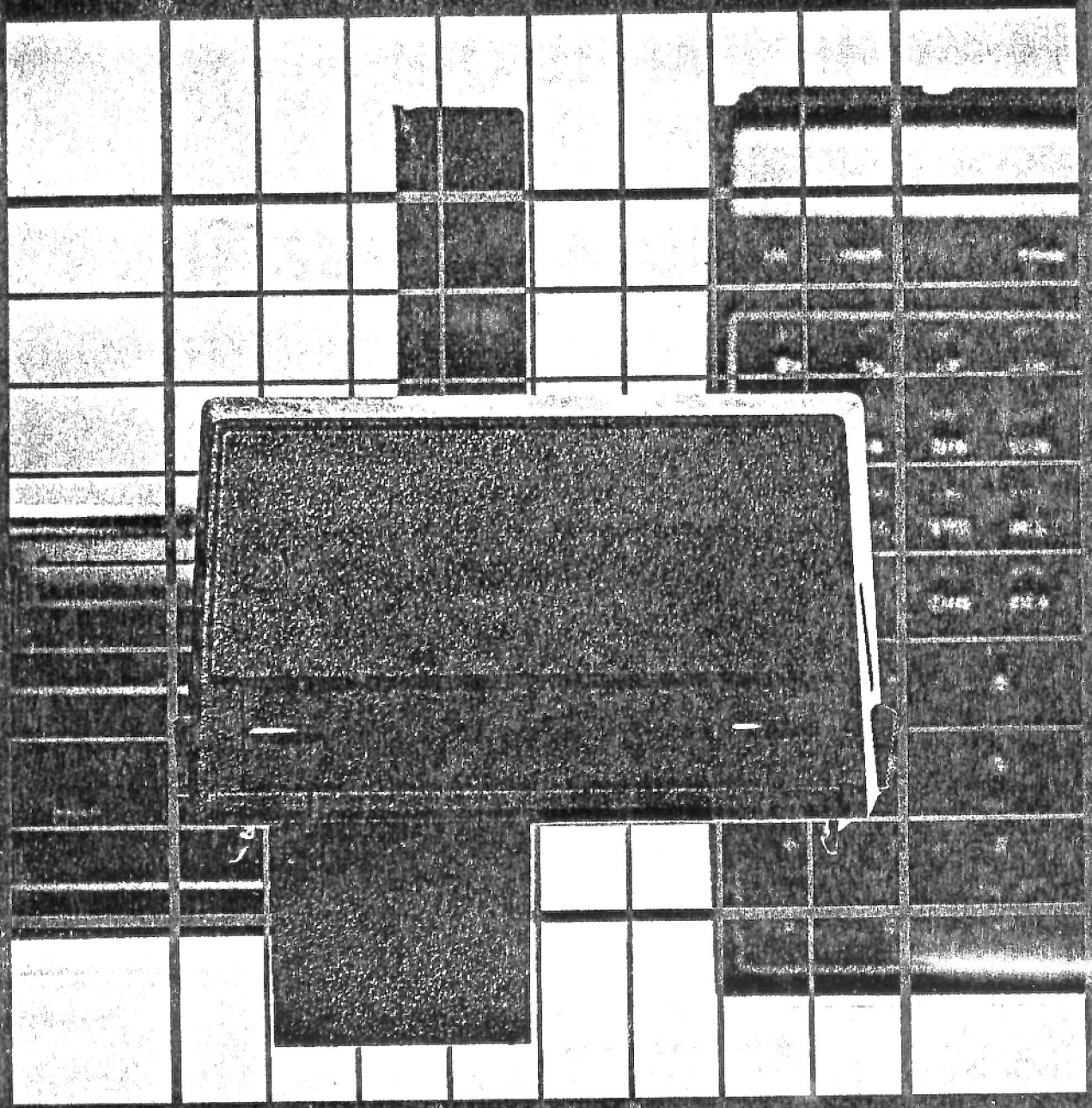
HEWLETT-PACKARD

82104A
CARD READER
SERVICE MANUAL



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SECTION I

General Information

1-1. INTRODUCTION

1-2. This service manual contains information necessary to troubleshoot and repair the HP 82104A Card Reader.

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

a. A description of the card reader (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 card reader (section IV).

e. A list of replaceable parts (section V).

1-4. DESCRIPTION

1-5. The HP 82104A Card Reader (figure 1-1) is a plug-in accessory for HP-41C style calculators, and is capable of reading and writing magnetic cards compatible with these systems. It is also capable of reading cards intended for HP-67/97 calculators.

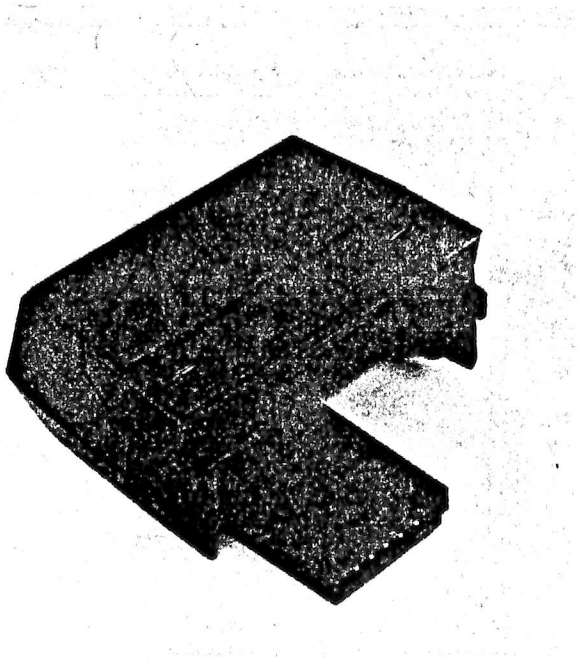


Figure 1-1. HP 82104A Card Reader

1-6. Service procedures for the card reader are simplified by the following features:

a. The use of a plug-in service module and a crystal-controlled HP-41C test calculator gives a reliable check of the major functions of the card reader and produces a visual output of the diagnosis.

b. The incorporation of nonadjustable switch contacts in the reader mechanism eliminates the critical procedure of switch adjustment while providing more reliable operation.

c. A variable trim resistor in the motor circuit eliminates the need to replace a fixed resistor in order to adjust motor current.

1-7. The specifications of the HP 82104A Card Reader are summarized in table 1-1.

Table 1-1. Specifications

Physical Properties

- Length: 7.29 centimeters (2.87 inches).
- Width: 7.93 centimeters (3.12 inches).
- Height: 3.52 centimeters (1.39 inches).
- Weight: 92 grams (3.2 ounces).

Compatibility

- Plugs into HP-41C style calculator.
- Also reads HP-67/97 magnetic cards.

Power Requirements

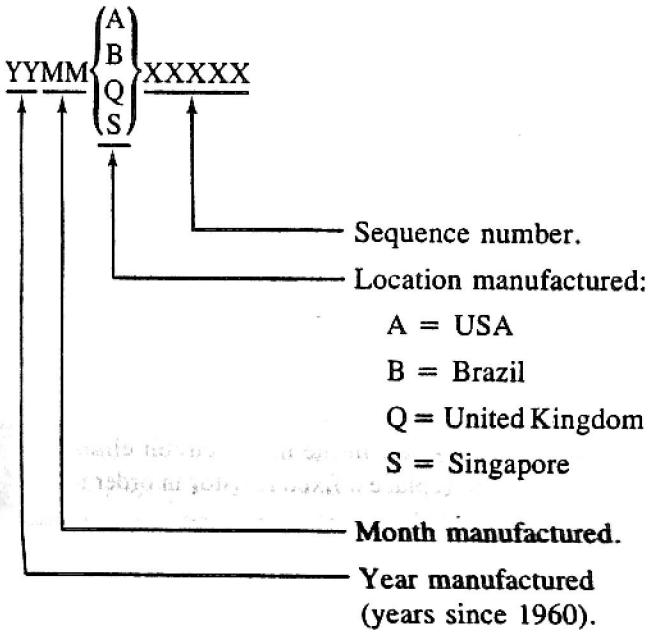
- Voltages: Regulated 6 Vdc supplied by calculator.
  Unregulated 6 Vdc supplied by calculator batteries.
- Current: 2 mA max (no card inserted).
  200 mA max (card inserted, motor off).
  500 mA max (card inserted, motor on).

Temperature

- Operating: 10° to 45°C (50° to 113°F).
- Storage: −40° to 75°C (−40° to 167°F).

1-8. IDENTIFICATION

1-9. The serial number of the card reader is used for identification and determination of warranty status. It is located adjacent to the input/output extension on the bottom of the reader. Its format is described below:



Theory of Operation

2-1. FUNCTIONAL DESCRIPTION

2-2. The HP 82104A Card Reader design (see figure 2-1) is based on five primary electrical components:

a. The CRC (card reader chip) integrated circuit.

b. The sense amplifier integrated circuit.

c. The ROM (read-only memory) integrated circuit.

d. The power supply modular circuit.

e. The motor control circuit.

2-3. The CRC and ROM integrated circuits (IC's) employ CMOS (complementary metal-oxide-semiconductor) circuitry. The sense amplifier is a conventional bipolar IC. The power supply is a module made up of discrete components. The motor control circuit consists of the timer IC and discrete components.

2-4. Magnetic cards are sensed by three switch circuits, driven by a permanent-magnet-field motor, and read and recorded by a two-channel magnetic head.

2-5. The card reader interfaces with the calculator through an input/output (I/O) port on the calculator. The I/O port electrically connects the card reader circuits directly to the main system lines. (Signal names are listed in table 2-1.)

2-6. CRC

2-7. The CRC consists of three functional sections: the instruction/flag processor, the read/write buffer, and the read/write control logic.

2-8. The instruction/flag processor decodes instructions arriving on the ISA line, maintains eight flags that indicate the status of the reader mechanism and the buffer, and sends to the calculator via the FI line the condition of any selected flag.

2-9. Three 28-bit shift registers constitute the read/write buffer. Each register can hold seven four-bit digits.

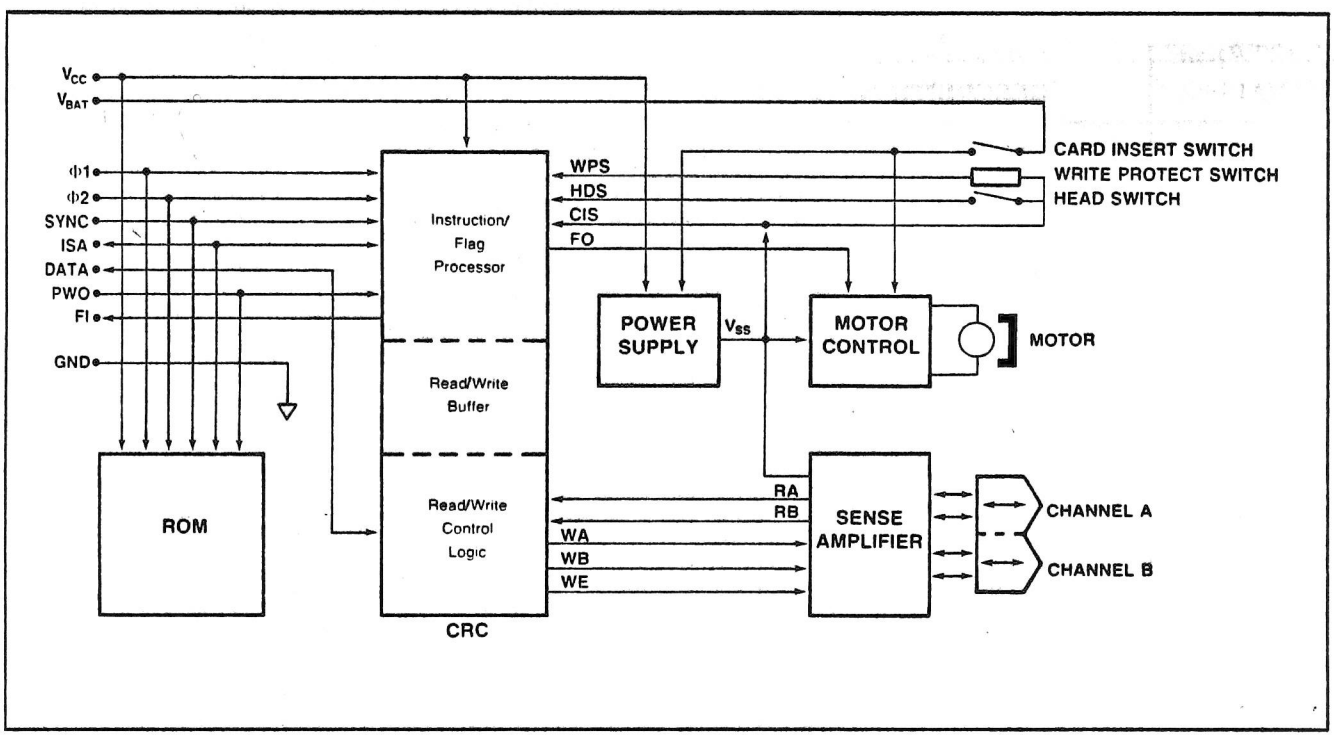


Figure 2-1. HP 82104A Card Reader Block Diagram

2-10. The read/write control logic directs the transfer of data into and out of the three buffer registers and provides timing for reading and writing operations. Data is sent to and received from the calculator on the DATA line. The control logic also encodes or decodes data being transferred between the buffer and sense amplifier. During a write operation, the bits in a buffer register are encoded into a two-channel signal that is transmitted to the sense amplifier. A "0" bit is represented as a transition in the logic state of channel A (channel B does not change state); a "1" bit is represented as a transition in channel B. During a read operation, the control logic decodes the two-channel signal from the sense amplifier into a sequence of 0's and 1's.

2-11. Sense Amplifier

2-12. The sense amplifier is a two-channel interface between the magnetic head and the read/write control logic in the CRC. During a write operation, the sense amplifier detects "0" and "1" logic levels (sent from the control logic) and generates electrical currents having the corresponding directions. The magnetic polarity produced on the card by the magnetic head is determined by the current direction. During a read operation, a change of magnetic polarity on the card induces an electrical current in the head. The sense amplifier detects this current and changes the logic level of its signal to the CRC control logic.

Table 2-1. Signal Names

SIGNAL	DESCRIPTION
CIS	Card-insert signal line
DATA *	Data line
FI *	Input flag line
FO	Motor flag line
GND *	Ground
HDS	Head-switch line
ISA *	Instruction/address line
PWO *	Power on/off line
RA and RB	Read signal lines
SYNC *	Timing/information line
V_{BAT} *	Battery voltage
V_{BB}	Switched battery voltage
V_{CC} *	Calculator voltage
V_{SS}	Regulated supply voltage
WA and WB	Write signal lines
WE	Write-enable line
WPS	Write-protect signal line
Φ1 *	Timing line
Φ2 *	Timing line

* Interfaces with calculator.

2-13. ROM

2-14. The ROM (read-only memory) contains 4096 10-bit microprogrammed instructions. These instructions are used by the CPU in the calculator to process data read from or written onto a magnetic card, to allocate data storage, and to interpret instructions read from an HP-67/97 card.

2-15. Power Supply

2-16. The power supply module provides a regulated voltage to the sense amplifier and motor control circuit whenever a magnetic card is inserted in the card reader. The V_{CC} line from the calculator serves as a reference for the regulated voltage (V_{SS}); the unregulated V_{BAT} line from the batteries in the calculator provide the power for the supply module. This arrangement minimizes the current drain on the calculator's regulated power supply while providing enough regulated power to operate the card reader mechanism.

2-17. Motor Control Circuit

2-18. The motor control circuit (figure 2-2) ensures that the motor speed remains within the proper range by using a feedback technique. When the card insert switch is closed by an inserted card, V_{BB} is turned on and V_{SS} is produced by the power supply. The FO line is subsequently set low by the CRC, causing the TR input to timer U3 to fall below an internal trigger level. This sets the OUT pin high, turning on transistor Q1 and powering motor B1 from the V_{BB} line. The low TR input also lets the DIS pin float, allowing capacitor C4 to charge through resistor R3. When the THR input exceeds an internal threshold level, the DIS pin is brought low, discharging C4. Also, the OUT pin is set low, turning off Q1 and removing power from the

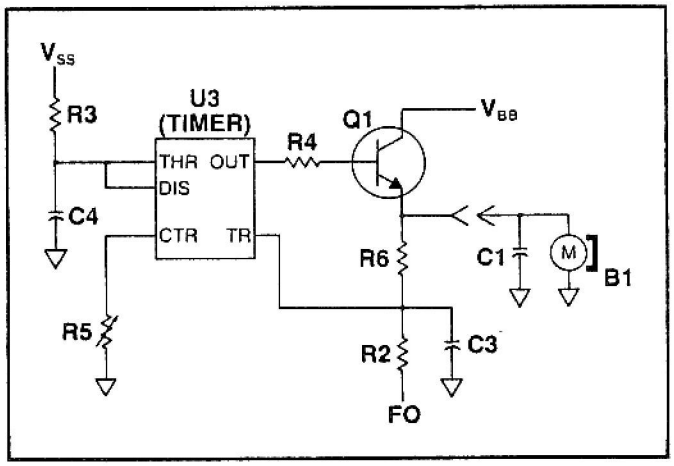


Figure 2-2. Motor Control Circuit

motor. The rotating motor generates a voltage which is directly related to the motor speed and which is monitored at the TR input via the voltage-divider formed by R2 and R6. (The TR input is above its trigger level when Q1 is on or the motor is coasting at its proper speed.) As the motor slows, the TR input falls below the trigger level, beginning the cycle again. This cycle repeats as needed to maintain the proper motor speed. The internal trigger and threshold levels, which are adjusted by resistor R5, determine the speed at which the motor operates.

2-19. SYSTEM OPERATION

2-20. The following paragraphs describe how the card reader interacts with the calculator system.

2-21. When the calculator system is operating, the CRC in the card reader monitors the ISA and DATA lines. If the proper instruction is received on these lines, the CRC is enabled and executes the instructions it receives, such as the transfer of data between its buffer and the CPU in the calculator. The CRC is disabled at the appropriate time by a subsequent instruction on the ISA and DATA lines.

2-22. When a card is inserted into the card reader, the card insert switch is closed, activating the power supply module, which in turn signals the CRC. If the calculator is inactive (PWO is low), the CRC sets ISA high until the calculator wakes up (setting PWO high). The CRC then signals the CPU in the calculator via the FI line that a card has been inserted. The CPU instructs the CRC to activate the motor control circuit, which powers the motor. A roller, driven by the motor, passes the card through the card reader.

2-23. When the leading edge of the card reaches the magnetic head, the head switch is closed, signaling the CRC. The CPU instructs the CRC whether a read or write operation is required. For a write operation, data is read into the buffer on the DATA line. As each register is filled, its contents are passed to the sense amplifier at a rate of one bit every six word times. The sense amplifier drives the head, which records the information on the card. During a read operation, the process is reversed. Timing for the detected signal is provided by the CRC, which senses the signal transition for each bit. Data is transferred from the buffer to the calculator as each register is filled. When the card has gone completely past the card insert switch, the switch opens, turning off power to the power supply and motor control circuit, thereby signaling the CRC which sets FO high.

2-24. Information is recorded as a magnetic track (channels A and B) along the edge of a card. Both edges of the card can be used. A header at the beginning of the track indicates the type of card (program, data, status, "write-all," HP-67/97 program, or HP-67/97 data card) plus other information depending upon the card type. If an improper card type is detected or the head switch is not activated, the CPU causes ***CARD ERROR*** to be displayed by the calculator. At the end of the track is a checksum that is used by the CPU to check for reading errors. If a reading error is detected, ***MALFUNCTION*** or ***CHKSUM ERR*** is displayed.

2-25. Data is not normally written onto a card with a clipped corner. When a card reaches the head switch, a resistive-capacitive circuit (C1, C2, and R1; see figure 4-4) pulses the MI input on the sense amplifier. This causes the sense amplifier to pulse the VM line and momentarily light diode DS1. At the same time, the CRC monitors the write-protect signal line (WPS). If the card has a clipped corner, it allows light from DS1 to reach phototransistor A3CR1 on the switch printed-circuit board, setting WPS high. If the calculator's write-protect flag is not set, the high WPS signal causes the CRC to inhibit the write operation and to inform the CPU in the calculator. In this case, ***PROTECTED*** is displayed by the calculator.

2-26. When the calculator reverts to an inactive state, it sets PWO low. This signal disables the CRC and ROM so that they do not respond to spurious signals.

Disassembly and Reassembly

The following procedures describe the steps necessary to disassemble and reassemble the HP 82104A Card Reader in order to make adjustments or to replace components that are faulty:

1. Case Separation.
2. Reader Assembly Removal.
3. Reader Disassembly and Reassembly.
4. Motor Installation and Adjustment.
5. Logic/Auxiliary PCA Removal and Installation.
6. LED Replacement.
7. Reader Assembly Installation.
8. Switch Contact and Phototransistor Service.
9. Case Assembly.

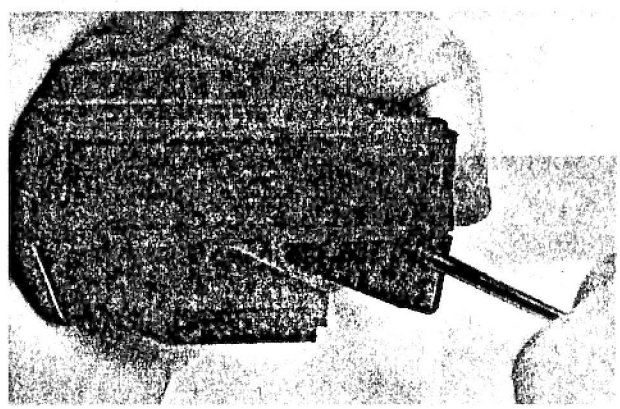
For additional aid, see the exploded views, figures 5-1 and 5-2.

CASE SEPARATION

a. **Remove and discard the label** located in the I/O access slot. Use a pointed knife to peel it off.

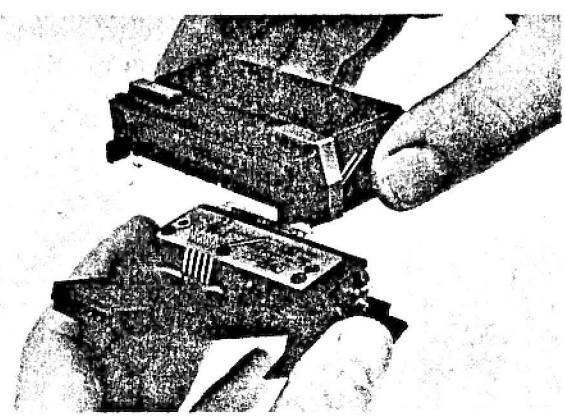
b. **Remove the lower two small screws** holding the case straps just below the baffle. Use a size 0 Phillips screwdriver (8710-0978).

c. **Remove the rear-most screw** in the I/O access slot using a small Phillips screwdriver.

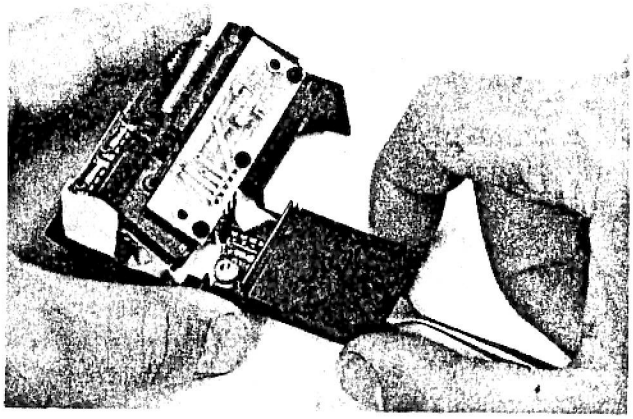


d. **Lift off the top case.** If desired, install a latch retainer (T-109622) on each latch before removing the top case.

e. **If necessary, remove the two latches** by lifting the baffle out of the top case.



f. **If necessary, slide off the I/O cover** after carefully inserting a spatula between the cover and the molded I/O contact. Be careful not to damage the I/O contacts.

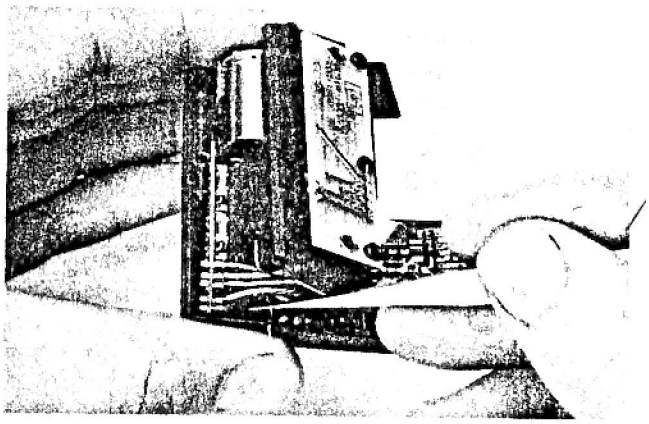


2 READER ASSEMBLY REMOVAL

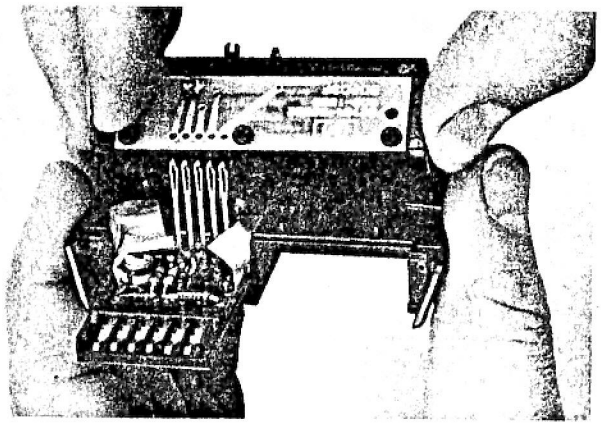
After separating the case (procedure 1):

a. **Disconnect the seven wires** from the head and motor by unplugging them from the logic and auxiliary PCA's (printed-circuit assemblies).

b. **Remove the two reader screws** located in the I/O slot using a small Phillips screwdriver.

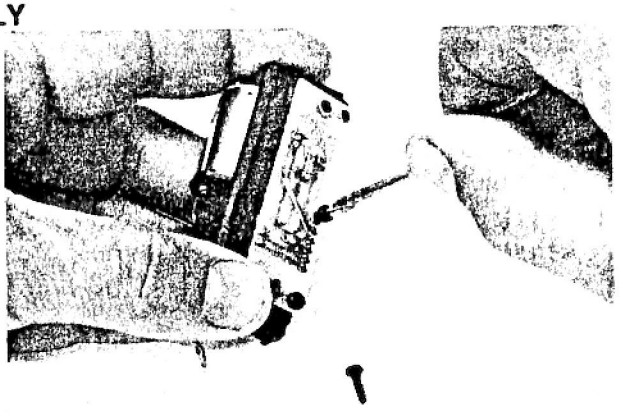


c. **Lift out the reader assembly** by disengaging the switch printed-circuit board from the five-pin connector.



3 READER DISASSEMBLY AND REASSEMBLY

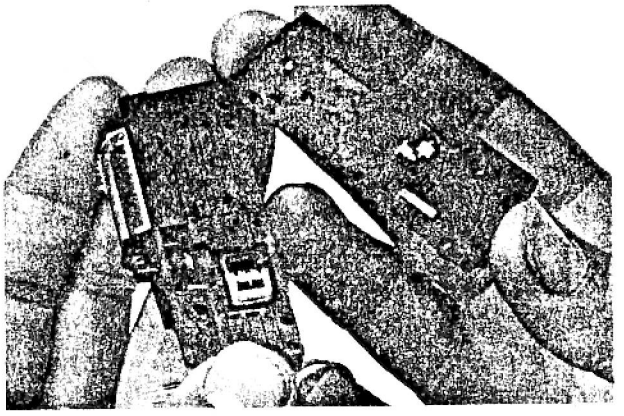
Note: If only the motor assembly is to be replaced, perform steps *c* and *k* only.



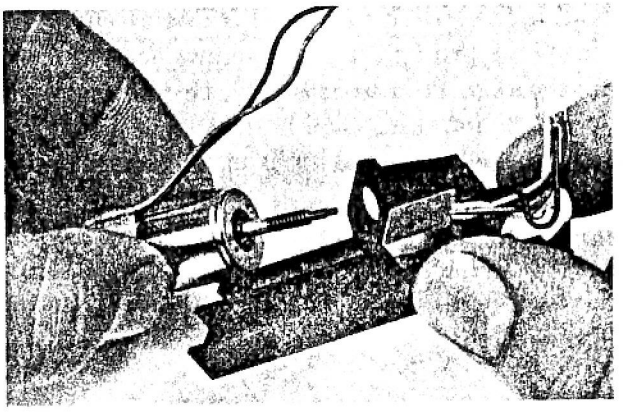
After separating the case and removing the reader assembly (procedures 1 and 2):

a. **Remove the switch printed-circuit board** by unscrewing the three Phillips-head screws that hold it in place.

b. **Remove the switch plate** by unscrewing the two Phillips-head screws, one on each side of the frame assembly. Keep the switch plate down to prevent the pinch roller from falling out. The side-load spring may also be dislodged from the frame.

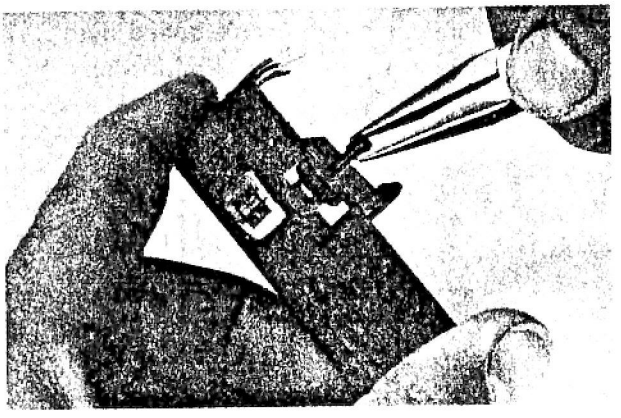


c. **Remove the motor assembly** by unscrewing its two mounting screws and withdrawing the motor and worm gear from the frame.

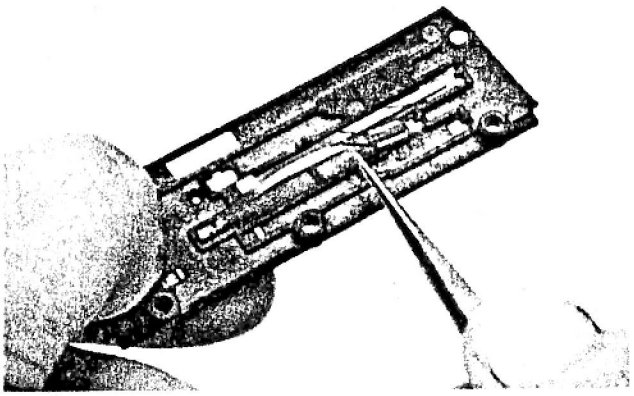


d. **If necessary, remove the drive roller assembly** by pulling out the drive pin using a small pliers.

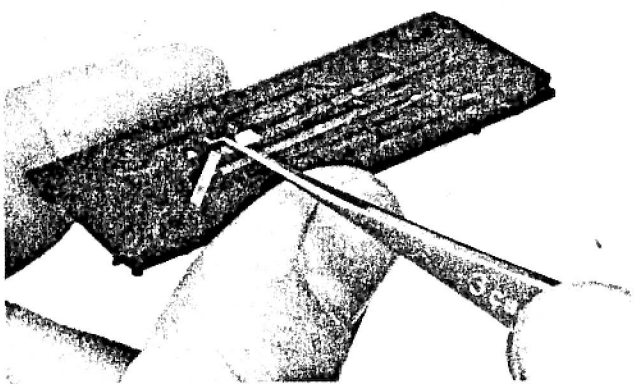
e. **Insert the drive pin into the frame and through the drive roller assembly.** The helical gear should be adjacent to the drive pin head and should rotate freely. The drive pin should fit tightly in the frame with its narrower tip in the inner frame hole.



f. **Replace defective switch contacts and actuators** on the support plate. Lift out the contact by one end; the actuator will fall out of the plate. Insert the flanged end of the new actuator into the opening in the switch plate and seat the actuator's hinge pins into the recesses. While holding the actuator with your finger, insert the forked end of the new switch contact into the contact recess in the switch plate, and then gently insert the other end into the actuator slot by flexing the contact. *Note that no contact is installed in the recess nearest the three screws.*

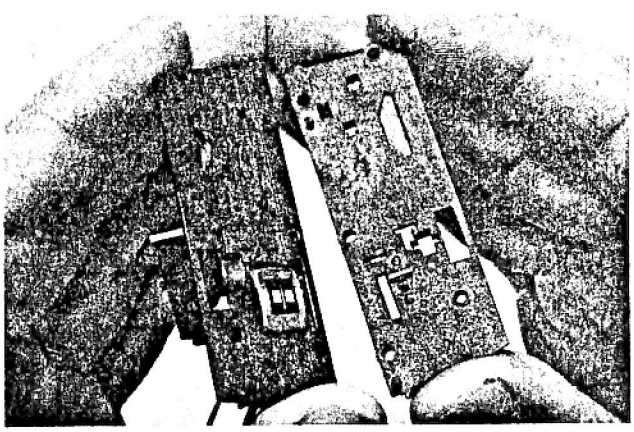


g. **If necessary, replace the card-wrap spring** by removing and installing it from the switch-contact side of the plate. The flat end of the spring should be between the two locating pins.



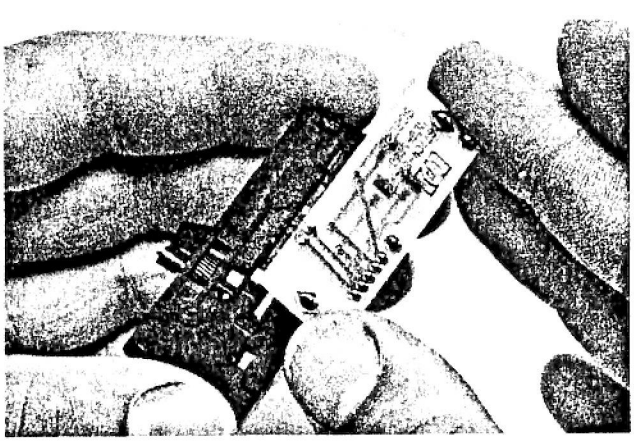
h. **Assemble the switch plate and frame assembly** using the two Phillips-head screws near the motor location. Prior to assembly, be sure that the **pinch roller** is installed in the switch plate and that the **side-load spring** is installed in the frame assembly.

i. **Clean the switch contacts and printed-circuit pads** by spraying the contacting surfaces with freon or isopropyl alcohol and wiping them with a lint-free tissue.



j. **Install the switch printed-circuit board** onto the switch plate using the three Phillips-head screws. Be sure the locating pin engages the board.

k. **Install and adjust the motor assembly** as described in procedure 4.



4 MOTOR INSTALLATION AND ADJUSTMENT

After separating the case (procedure 1), removing the reader assembly (procedure 2), and removing the motor assembly (procedure 3, step *c*):

a. **Check the worm gear alignment on the motor** by manually spinning the gear. Press the worm gear to the side as required to eliminate all gear wobble when it is spun.

b. **Pull the worm gear away from the motor housing** a small distance.

c. **Apply lubricant to the tip and sides of the worm gear.** Use moly-disulfide lubricant.

d. **Install the motor assembly** into the frame by inserting the tip of the worm gear into the thrust bearing hole and installing the two small mounting screws. Be sure that the mounting area is free of plastic burrs which could prevent proper alignment. The motor wires should be located along the motor opposite the frame assembly and taped in position.

e. **Push the worm gear toward the motor housing a slight amount** (less than 0.5 mm or 0.02 inch). This puts the thrust force entirely on the thrust bearing during operation.

f. **Connect a 2.5 Vdc power supply and current meter** to the motor leads. The red wire is positive (+); the black wire is negative (−).

g. **Adjust the motor position** to obtain the lowest current level, then secure the motor in this position.

h. **Insert a card and measure the full-load current** while the card is passing through. Adjust the cam by turning the drive pin to obtain minimum current. If the minimum current is less than 90 mA or greater then 220mA, check for a mechanical problem in the reader assembly. If the current fluctuates more than 10 mA as the card passes through, check for a mechanical problem.

i. **Insert, but hold, a card and measure the hold current** as the motor tries to pull the card through. If the hold current is less than 200 mA, adjust the cam by turning the drive pin until 200 mA current is obtained.

5 LOGIC/AUXILIARY PCA REMOVAL AND INSTALLATION

Note: For some units, resistor R8 on the logic PCA is connected directly to the I/O contact. This is an approved configuration.

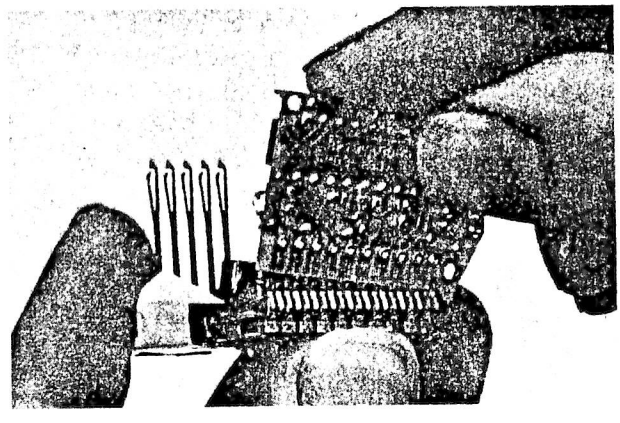
Note: For some units, the logic PCA has a wire that connects the collector of Q1 to the I/O connector (P1 pin 1). For these units, the trace to the collector should have been cut. This is an approved configuration.

After separating the case and removing the reader assembly (procedures 1 and 2):

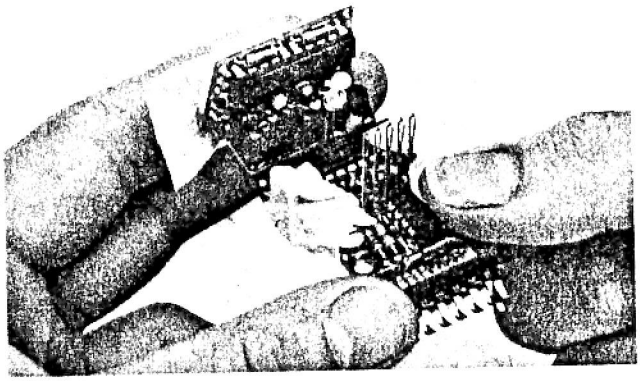
a. **Lift out the logic and auxiliary PCA's** by lifting the front of the logic assembly.

b. **Separate the logic and auxiliary PCA's** by gently pulling the auxiliary PCA out of the clips on the logic PCA.

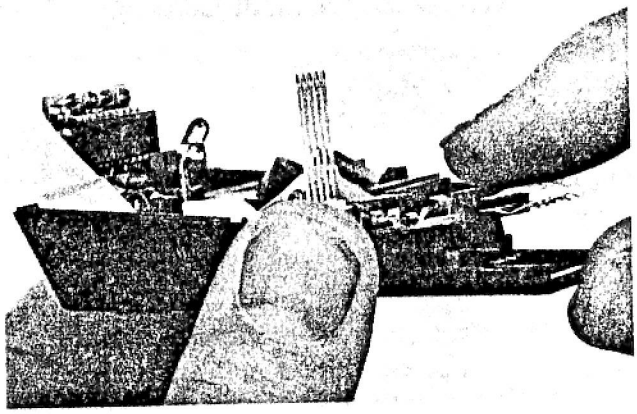
c. **Connect the logic and auxiliary PCA's** by pressing the auxiliary PCA into the clips on the logic PCA. Be sure the clips are aligned with the pads on the auxiliary PC board.



d. **Install three pieces of epoxy tape on the PCA's** as shown. A piece 2½ centimeters (1 inch) long should be centered between the motor connector (J1) and the trim resistor (R5) and wrap around both sides of the PC board. A second piece of the same size should extend from the CRC (U1) to the ROM (U2) with its width wrapped equally around both sides of the board. A piece 4 centimeters (1½ inches) long should extend across the back of the auxiliary PCA, leaving a 1½-centimeter (½-inch) flap to cover the head-wire sockets.



e. **Install the logic and auxiliary PCA's** (as a unit) by lowering them into the bottom case. Press the I/O contact into the slots at the front of the case.

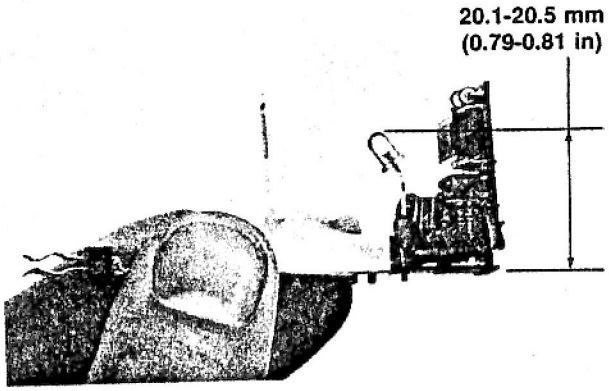


6 LED REPLACEMENT

After separating the case and removing the reader assembly and logic/auxiliary PCA (procedures 1, 2, and 5*a* and *b*):

a. **Remove the LED** by unsoldering it from the logic PCA.

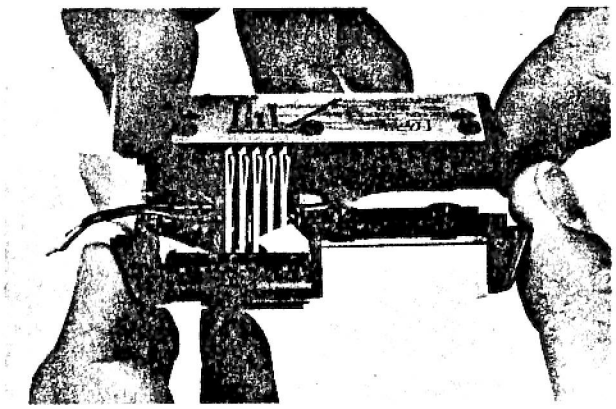
b. **Solder the LED in position** on the logic PCA. Orient the LED so that it faces toward the I/O contact with its leads perpendicular to the board. The distance from the top of the LED to the bottom surface of the board should be 20.1 to 20.5 millimeters (0.79 to 0.81 inches). Be sure to trim the leads.



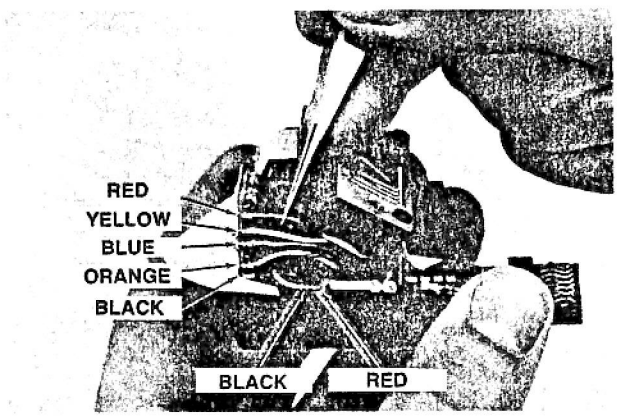
7 READER ASSEMBLY INSTALLATION

a. **Position the reader assembly onto the five-pin connector** on the logic PCA, placing the motor wires on top of the power supply module (PS1). Be sure that the LED (DS1) is located in the recess in the underside of the frame assembly and that the LED leads are not bent out of shape.

b. **Install the two reader screws** through the angled holes in the I/O access slot. Be sure the reader assembly seats flush on the mounting pads.



c. **Connect the seven wires** from the reader assembly by plugging the two motor wires into the logic PCA and the five head wires into the auxiliary PCA. The motor wires should be kept down and away from the head wires.



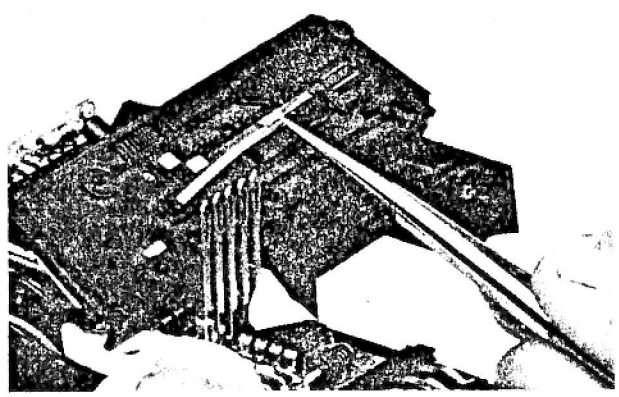
8 SWITCH CONTACT AND PHOTOTRANSISTOR SERVICE

Note: This procedure permits access to the switch contacts and phototransistor when no further reader disassembly is required.

After separating the case (procedure 1):

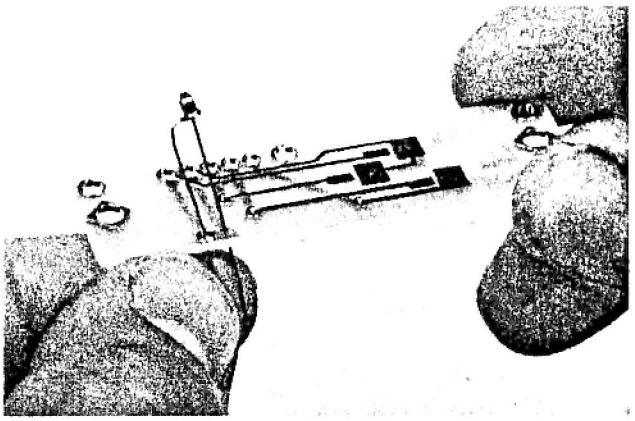
a. **Remove the switch printed-circuit board** by unscrewing the three Phillips-head screws and lifting the board off the five-pin connector.

b. **Replace defective switch contacts** by first lifting out the damaged contact by one end. Using tweezers, insert the forked end of the new contact into the recess in the switch plate, and then gently insert the other end into the actuator slot by flexing the contact.

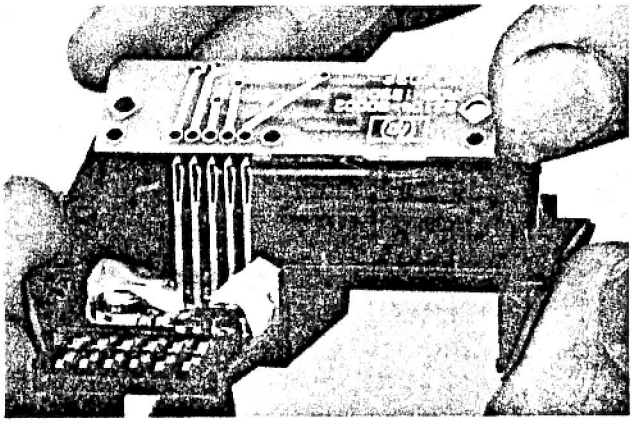


c. **Replace a defective phototransistor** by bending back the side lead and inserting it through the larger hole in the printed-circuit board. The phototransistor case should seat flush on the contact side of the board with the center lead through the square pad.

d. **Clean the switch contacts and printed-circuit pads** by spraying the contacting surfaces with freon or isopropyl alcohol and wiping them with a lint-free tissue.

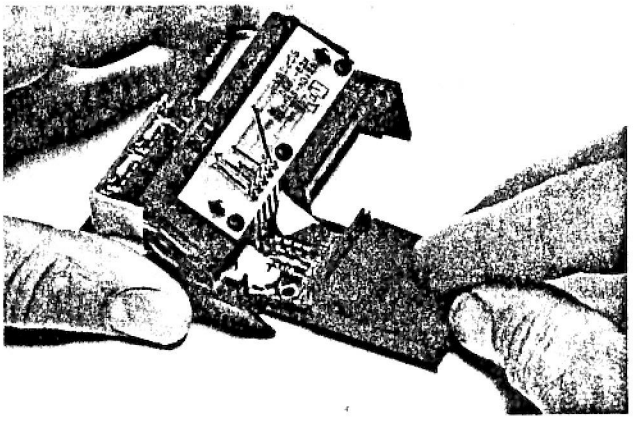


e. **Install the switch printed-circuit board** onto the five-pin connector, fastening it to the reader assembly with the three Phillips-head screws. Be sure the locating pin engages the board.

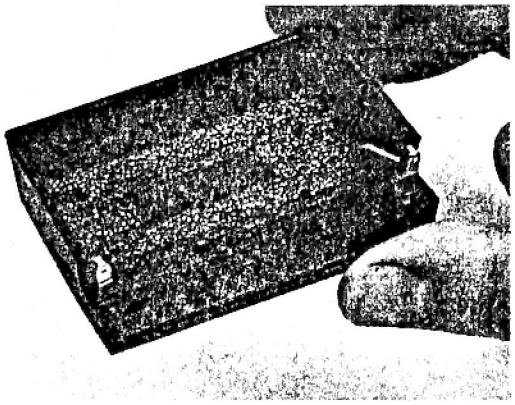


9 CASE ASSEMBLY

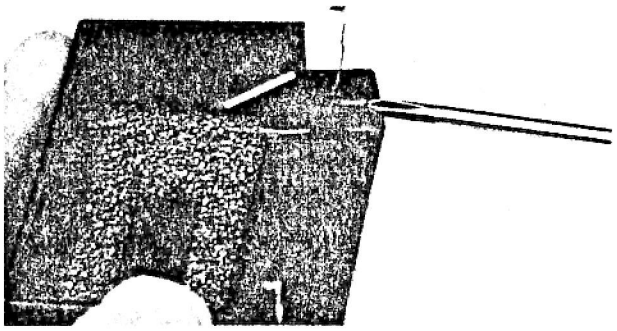
a. **Slide on the I/O contact cover,** being sure that it snaps into place over the I/O contact.



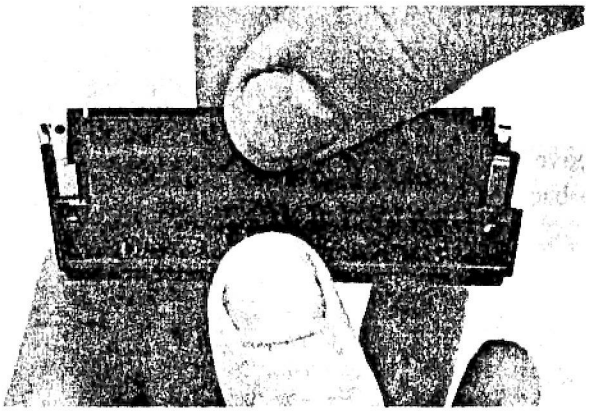
b. **Check the foam pad** inside the top case to be sure that it is not damaged and is correctly positioned against the rear corner.



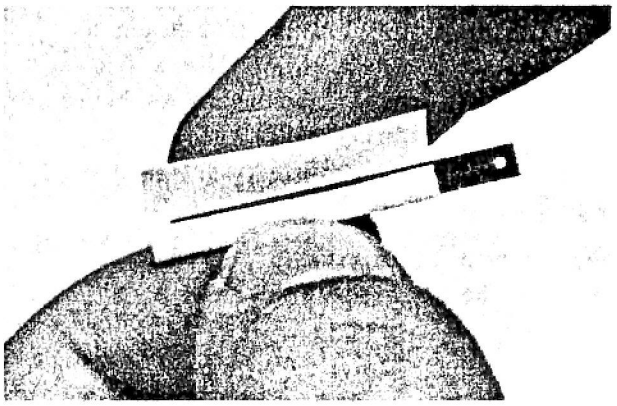
c. **If necessary, install two new case straps** into the top case, keeping the flanges of the clips toward the rear of the case. Use a size 0 Phillips screwdriver to tighten the screws, being careful not to strip the threads.



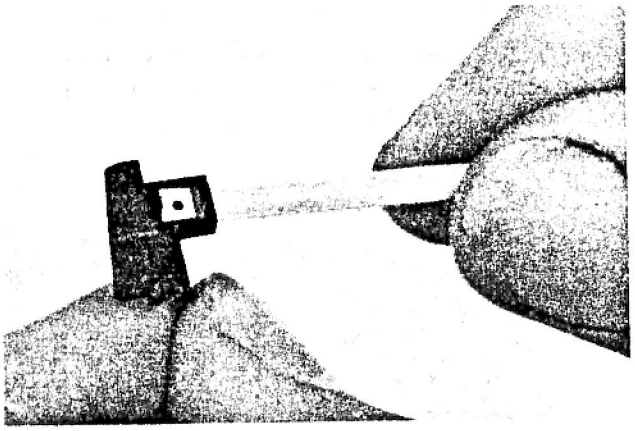
d. **Install the baffle** into the top case. The widest portion of the baffle should be adjacent to the latch openings, and the opposite edge should be in the groove at the front edge of the top case.



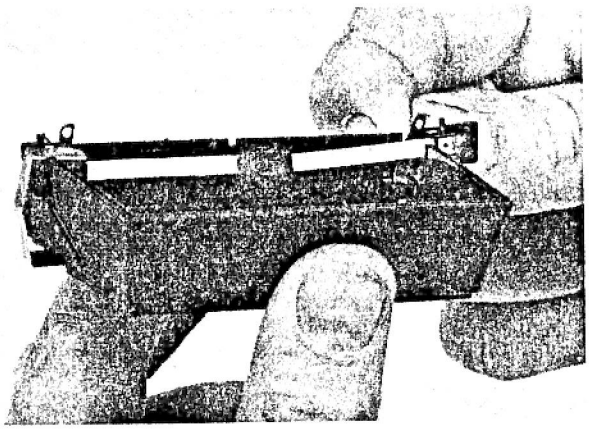
e. **Cover one latch spring with polyester tape** as shown. Use a 1- by 2½-centimeter (½- by 1-inch) piece of tape, trimming off any excess. Be sure that the tape wraps around the spring at least 1½ times and that it seals over the plain end of the spring. Leave ½ centimeter (¼ inch) of the spring uncovered at its perforated end.



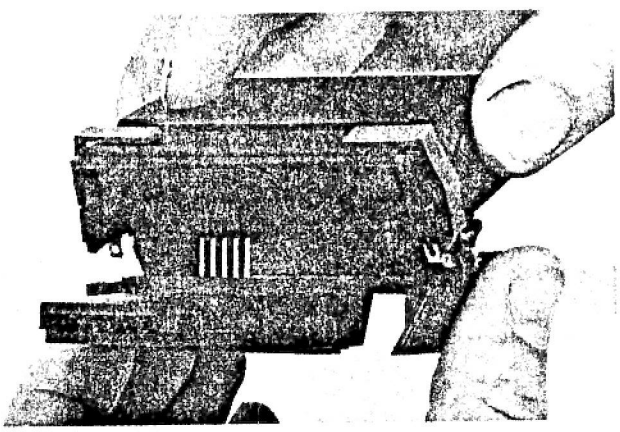
f. **Install a latch spring into each latch** by inserting the perforated end of the spring through the slot in the latch and onto the retaining pin. Be sure the taped spring is installed in the right latch (marked with an "R").



g. **Install each latch into the top case** by inserting the end of the spring through the latch opening in the top case and behind the case strap. Place the latch hinge pin into the socket in the top case and swing the free end of the spring onto the retaining webs. Be sure that the stop tab on the latch is against the inside surface of the top case. Temporarily clamp the latch in position with a latch retainer (T-190622). Note that the left and right latches are tapered in opposite directions to match the slant of the top case surfaces.



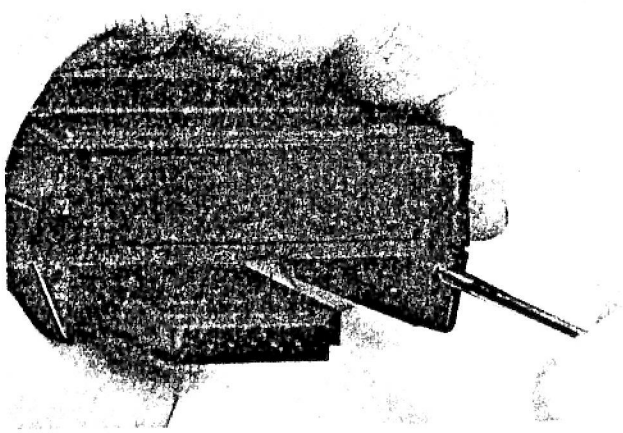
h. **Assemble the top and bottom cases.** First align and join the hinge pins on the latches and the hinge sockets in the bottom case, adjusting the baffle if necessary to permit it to seat in the groove in the bottom case. Then bring together the back edges of the top and bottom cases.



i. **Install the two small screws** that fasten the bottom case to the case straps. Use a size 0 Phillips screwdriver to tighten the screws, being careful not to strip the threads.

j. **Install the case screw** at the back end of the I/O access slot.

k. **Attach a new bottom label** over the screw recesses in the I/O access slot. Press firmly to assure complete adhesion.



Troubleshooting and Testing

4-1. INTRODUCTION

4-2. This section contains the procedures required to troubleshoot and test the HP 82104A Card Reader. Tools that facilitate service are presented in table 4-1.

4-3. The troubleshooting and test procedures use a crystal-controlled test calculator and a plug-in service module. The crystal-controlled calculator is essential for correctly setting the motor speed.* The service module tests the card reader circuitry and facilitates the troubleshooting and adjustment. Key reassignments made by the service module are shown in figure 4-1.

* Each HP 82104A Card Reader must be able to be used with any HP-41C style calculator. The motor speed must therefore be set to its nominal value at a specific system clock frequency.

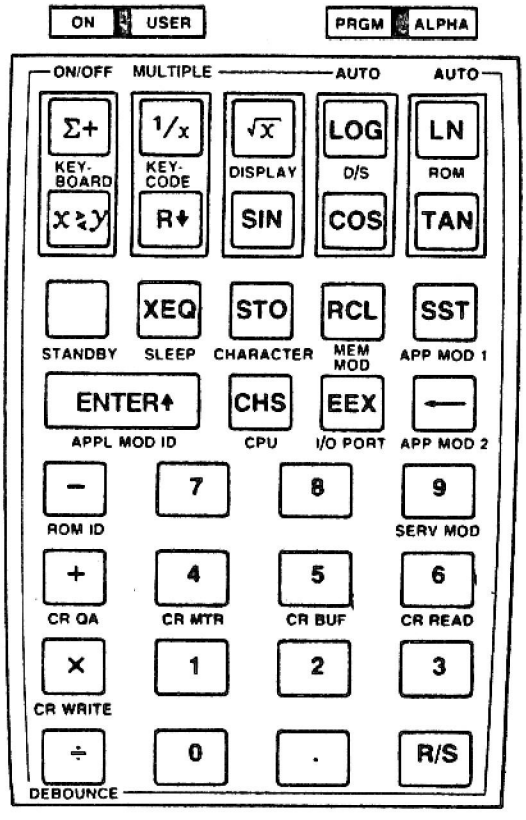


Figure 4-1. Key Assignments for Service Module

4-4. The quality assurance (QA) test described in paragraph 4-8*f* is also used as the performance test to verify the proper operation of the card reader after it is repaired. Read through the entire procedure before attempting to troubleshoot a card reader.

CAUTION

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

Table 4-1. Recommended Tools

HP PART/ MODEL NUMBER	DESCRIPTION
ET-11966	Service Module
T-11945	Port Extender
	Test Calculator Parts:
ET-11944	• Standard Frequency Kit
T-190639	• Modified Keyboard Assembly
T-190638	• Modified Bottom Case
T-190622	Latch Retainer (2 required)
8710-0978*	Phillips Screwdriver, Size 0
8730-0020	Phillips Screwdriver
8690-0227	Desoldering Tool, antistatic
8690-0253	Desoldering Tool Tip, antistatic
8690-0129	Soldering Iron
8690-0132	Soldering Iron Stand
8700-0003	X-acto Knife
8700-0006	X-acto Knife Blade
8730-0008	Small Flat-Blade Screwdriver
HP 180C/ 1801A/1820C†	Oscilloscope. Measures pulse at 0.50 μs; maximum amplitude 13 Vdc.
0960-0062	Continuity Tester
HP 6213C†	Power Supply. Variable supply rated at 10 Vdc at 5A. (Add a 0.1 μf ceramic capacitor across output terminals.)
HP 3469B†	Multimeter. Accurate to 0.01 Vdc.
HP 10004†	Oscilloscope Probe

* Same as tool used for HP-19C.
† Or equivalent.

4-5. INITIAL PREPARATION

4-6. Perform the following steps before attempting to troubleshoot the card reader:

a. **Remove the top case and I/O cover** from the card reader. (Refer to section III, procedure 1.)

b. **Visually inspect the card reader** for physical damage. Replace any components that are visibly damaged.

c. **Determine the customer's concern, if possible.** Frequently the customer includes with the card reader a message describing the problem.

- If the problem relates to the performance of the motor (or if otherwise needed), lubricate and adjust the motor assembly (section III, procedure 4) and then perform the test and repair procedure (paragraph 4-7).
- For other problems with the card reader, perform the test and repair procedure (paragraph 4-7).

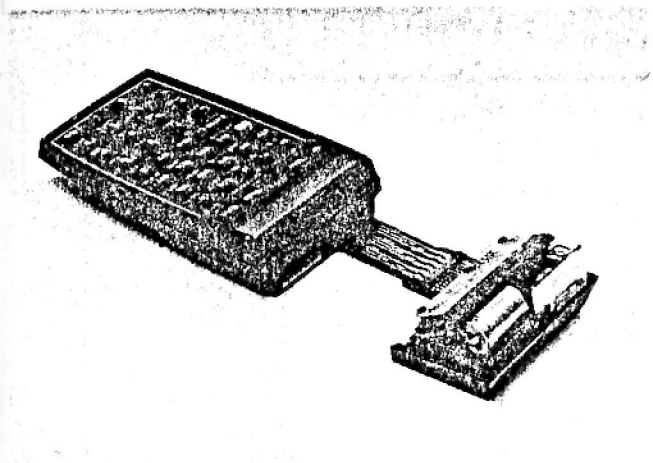


Figure 4-2. Test Setup

4-7. TEST AND REPAIR

4-8. Perform the following steps to determine the causes of improper card reader operation and to make the necessary repairs. For reference information concerning component locations and part numbers, use figures 4-3, 4-4, 5-1, and 5-2 and tables 4-6, 4-7, 5-1, and 5-2.

a. **Be sure the test calculator is off.**

b. **Insert the service module** into the calculator's lower left (#3) I/O port.

c. **Insert a port extender** into the lower right (#4) I/O port.

d. **Connect the card reader** to the port extender. (See figure 4-2.)

e. **Press the ON key.**

- If ***SELECT TEST*** is displayed and three beeps are sounded, the calculator is ready to test the card reader. Go on to step *f*.
- If any other response occurs, repeat the steps above with the card reader removed. If the calculator now operates correctly, then the CRC, ROM, or power supply in the card reader probably interfered with the calculator's operation.

f. **Perform the quality assurance test** that follows. For each step or condition that can occur, the resulting LCD display on the test calculator is shown at the right.

Note: The use of a blank magnetic card is required in a number of tests that follow. Erase a card by passing it across a permanent magnet (such as one obtained from a defective card reader motor).

Quality Assurance Test

1. **Press the + key** to select the entire quality assurance test of the card reader.	***CR Q. A. TEST***
2. **Observe the LCD display.** Watch for:	
• This LCD message indicates that the ROM test is being executed. (The "1" annunciator should be turned on.)	***CR ROM TEST***
• This LCD message indicates that the ROM IC is bad. Turn off the calculator, install a new ROM IC in the card reader, and repeat this test.	***ROM BAD***
• This LCD message indicates that the CRC is bad. Turn off the calculator, install a new CRC, and repeat this test.	***CRC BAD***
• This LCD message requests the insertion of a card for the motor speed check.	***CLIPPED CARD***

Quality Assurance Test (Continued)

3. **Insert a clipped (protected) card** into the reader slot. Listen for excessive reader noise as the card is pulled through.
   - If the motor does not turn on, check the motor control circuit according to the procedure in table 4-2; then repeat this test.
   - If the motor is noisy or its speed is erratic, lubricate and adjust the motor assembly (section III, procedure 4) and, if necessary, check the motor control circuit (table 4-2); then repeat this test.
4. **Observe the LCD display.** Watch for:
   - This momentary LCD message and a single beep indicate that the write protect switch properly detected the clipped corner of the card. If this response is not observed, either the write protect circuit is not functioning properly or an unclipped magnetic card was used. — ***PROTECTED***
   - Either of these LCD messages indicates that the head switch or card insert switch is not functioning properly. Turn off the calculator, repair the switch circuit, then repeat this test. — ***HD SWTCH BAD*** / ***CI SWTCH BAD***
   - This type of LCD display momentarily indicates the motor speed in counts.* If the speed is not 156 ± 5 counts, adjust it at the end of this test using the motor speed test procedure. — ***SPD= 156***
   - This LCD message requests the insertion of a blank card for the write/read check. — ***BLANK CARD***
5. **Insert a blank, unclipped card** into the reader slot. Be sure the card is blank. — ***SAME CARD***
6. **Reinsert the same card** into the reader slot in the same direction.
7. **Observe the LCD display.** Watch for:
   - This LCD message indicates that the write and read operations function properly. — ***WRT/READ O. K.***
   - Either of these LCD messages indicates that the write or read operation is faulty. Check the head-wire connections. Determine the cause of the problem at the end of this test using the write/read test procedure. — ***WRT/READ ERR*** / ***NO DATA***
8. If necessary, steps 5 through 7 may be repeated to verify performance.
9. **Press the [R/S] key** (or any other key) to prepare for the next test. — ***SELECT TEST***

* A 3-count difference represents a 2 percent speed change.

g. **Perform the motor speed test, if indicated** by the QA test. The motor speed test is presented in table 4-3.

h. **Perform the write/read test, if indicated** by the QA test. The write/read test, presented in table 4-4, should be performed with the logic, auxiliary, and reader assemblies removed as a unit from the bottom case. Unscrew the two reader screws in the I/O access slot and remove the unit by lifting the front of the logic assembly.

i. **Test the card reader after repairing it** by performing the quality assurance test described above. If additional repairs are required, be sure to rerun the QA test.

Table 4-2. Motor Control Circuit Troubleshooting Procedure

Use this procedure if the motor does not turn on, if the motor speed is unstable or cannot be adjusted, or if unexplained write/read errors occur. Repair each defect as it is found.

STEP	LOCATION	SPECIFICATION	CHECK AND REPAIR IF OUT OF SPECIFICATION
1. Turn on the calculator (with service module).			
2. Measure V_{CC}.	Pin 2 of I/O connector (A1P1)	6.0 to 6.5 Vdc	I/O connector (A1P1), excessive IC load.
3. Measure V_{BAT}.	Pin 5 of switch PC connector (A1X2)	3.4 to 5.5 Vdc (4.4 to 5.5 Vdc with motor off)	I/O connector (A1P1).
4. Press the [x] key (selects "write" mode).			
Insert a card prior to each of the following steps:			
5. Measure V_{BB}.	Pin 4 of switch PC connector (A1X2)	V_{BAT} Vdc	Card insert switch.
6. Measure V_{SS}.	Pin 2 of switch PC connector (A1X2)	5.4 to 6.9 Vdc	Power supply (A1PS1).
7. Measure FO.	Resistor A1R2 lead adjacent to access slot	0 to 1 Vdc	CRC (A1U1).
8. Observe OUT signal.	Resistor A1R7 lead closest to access slot	0-V_{SS} rectangular wave*	Timer IC (A1U3).
9. Observe motor signal.	Red motor lead (A1J1 or motor terminal)	0-V_{BB} rectangular wave*	Transistor A1Q1, motor assembly (A3A2), mechanical interference.
10. Listen to motor speed while adjusting A1R5.		Decreasing speed with clockwise adjustment	Timer IC (A1U3), resistor A1R5.

* Signal should be high no more than 50% of cycle for no load; "off" time decreases for increased load. Varying duty cycle for no load indicates mechanical interference or a bad timer IC (A1U3).

Table 4-3. Motor Speed Test

Use this procedure to adjust the motor speed. Be sure that the motor assembly is properly lubricated and adjusted before starting.

STEP	DISPLAY
1. **Press the [4] key** to select the motor speed test. (***CRC BAD*** indicates that the CRC is bad and should be replaced.)	***CR MTR TEST***
2. **Insert a card** into the reader mechanism.	
3. **Observe the LCD display.** Watch for:	
• This type of LCD display indicates the motor speed in *counts*.* If the speed is not 156 ± 5 counts, adjust resistor A1R5, then return to step 2. A *clockwise* adjustment *increases* the count; a *counterclockwise* adjustment *decreases* the count.†	***SPD=*** ~~156~~ 170 ± 5
• This momentary LCD message and a single beep indicate that the write protect switch detected a clipped corner on the magnetic card. If an unclipped card was used and this response is observed, then the write protect circuit is not functioning properly.	***PROTECTED***
• Either of these LCD messages indicates that the head switch or card insert switch is not functioning properly. Turn off the calculator, repair the switch circuit, then repeat this test.	***HD SWTCH BAD*** ***CI SWTCH BAD***
4. If necessary, repeat steps 2 and 3 to verify the speed.	
5. **Press the [R/S] key** (or any other key) to prepare for the next test.	***SELECT TEST***

* A 3-count difference represents a 2 percent speed change.

† If the motor speed cannot be adjusted, check the motor control circuit according to the procedure in table 4-2.

Table 4-4. Write/Read Test

Use this procedure to determine which component causes write/read errors. Before starting, be sure that the motor assembly is properly lubricated and adjusted and that the logic, auxiliary, and reader assemblies are removed as a unit from the bottom case.

STEP	DISPLAY
This test sequence may be stopped by pressing the [R/S] key (or any other key) after any step.	
1. **Press the [x] key** to select "write" mode. (***CRC BAD*** indicates that the CRC is bad and should be replaced.)	***CR WRITE BLANK CARD***
2. **Insert a blank card and monitor the HA signal** (blue head wire) using an oscilloscope. **Repeat** while monitoring the HB signal (red head wire). *Do not* use a clipped (protected) card. (A clipped card prevents the write operation and causes ***PROTECTED*** to be displayed momentarily.)	
• A uniform 0 to 6 volt spiked signal on each line indicates proper output from the sense amplifier. Go on to step 4 to check the read circuit.	***BLANK CARD***
• Any other type of signal on either of these lines indicates that the write circuit in the CRC or sense amplifier may be bad. After checking the head-wire connections, perform step 3 to determine which component is bad.	***BLANK CARD***
3. **Insert a blank card and monitor the WA signal** (pin 8) at the PCA connector using an oscilloscope. **Repeat** while monitoring the WB signal (pin 10). *Do not* use a clipped (protected) card.	
• A uniform 0 to 6 volt square-wave signal on each line indicates proper output from the CRC. Verify that similar signals exist beyond resistors A2R2 and A2R1 (at the sense amplifier inputs, pins 15 and 13). Then install a new sense amplifier and repeat the QA test.	***BLANK CARD***
• Any other type of signal on either of these lines indicates that the CRC is bad. Install a new CRC and repeat the QA test.	***BLANK CARD***
4. **Press the [R/S] key** (or any other key) to go on to the next step.	***SELECT TEST***
5. **Press the [6] key** to select "read" mode.	***CR READ TEST SAME CARD***
6. **Insert a recorded card and monitor the HA signal** (blue head wire) using an oscilloscope. Use a card successfully recorded during step 2 above. **Repeat** while monitoring the HB signal (red head wire).	
Note: The card reader will not read a card correctly with an oscilloscope connected to the head.	
• A uniform spiked signal of 6 to 10 mV peak-to-peak amplitude on each line indicates that the magnetic head properly recorded and read the card. Go on to step 7.	***READ ERR***
• Any other type of signal on either of these lines indicates that the reader assembly is bad. Inspect the reader assembly for mechanical problems (such as loose connections, a bad head wrap spring, or a shifted head). If none are found, install a new head assembly and repeat the QA test.	***READ ERR***
• Any of these LCD messages should be verified by the QA test. (***READ O. K.*** indicates proper operation.)	***HD SWTCH BAD*** ***NO DATA*** ***READ O. K.***

Table 4-4. Write/Read Test (Continued)

STEP	DISPLAY
7. **Reinsert the recorded card and monitor the RA signal** (pin 2) at the PCA connector using an oscilloscope. **Repeat** while monitoring the RB signal (pin 3).	
• A uniform 0 to 4 volt square-wave signal on each line indicates proper output from the sense amplifier. Install a new CRC and repeat the QA test.	***READ ERR***
• Any other type of signal on either of these lines indicates that the sense amplifier may be bad. After checking the head-wire connections, install a new sense amplifier and repeat the QA test.	***READ ERR***
• Any of these LCD messages should be verified by the QA test. (***READ O. K.*** indicates proper operation.)	***HD SWTCH BAD*** ***NO DATA*** ***READ O. K.***
8. **Press the [R/S] key** (or any other key) to prepare for the next test.	***SELECT TEST***

Table 4-5. Buffer/Speed Test

This test uses the recorded data on a magnetic card to determine motor speed and speed stability. Be sure that the motor assembly is properly lubricated and adjusted before starting.

STEP	DISPLAY
1. **Press the [5] key** to select the buffer/speed test. (***CRC BAD*** indicates that the CRC is bad and should be replaced.)	***CR BUF TEST***
2. **Insert a recorded card** into the reader mechanism. Relative motor speed is accurately computed only if you use a card recorded at the nominal motor speed. Speed *stability* may be checked with *any* card recorded on the card reader and test calculator after the most recent service modification; however, the relative speed will usually be inaccurate. Other cards will give inaccurate results.	
3. **Observe the LCD display.** Watch for:	
• Any one of these types of LCD messages indicates the motor speed relative to the speed at which the card was recorded. If the deviation is more than 3 percent from *nominal speed,* adjust resistor A1R5, then return to step 2. A *clockwise* adjustment *decreases* the motor speed; *a counterclockwise* adjustment *increases* the speed.*	***SPD 02% SLOW*** ***SPD 03% FAST*** ***SPD TOO SLOW*** ***SPD TOO FAST***
• This momentary LCD message and a single beep indicate that the card was not passed at a constant speed. Check for mechanical problems such as improper motor lubrication or adjustment, a dirty or deformed roller, or a dirty card.*	***SPD UNSTABLE***
• Either of these LCD messages indicates that the head switch or card insert switch is not functioning properly. Turn off the calculator, repair the switch circuit, then repeat this test.	***HD SWTCH BAD*** ***CI SWTCH BAD***
• This LCD message indicates that either the card is blank or the read operation is faulty.	***NO DATA***
4. If necessary, repeat steps 2 and 3 to verify the performance.	
5. **Press the [R/S] key** (or any other key) to prepare for the next test.	***SELECT TEST***

* If the speed cannot be adjusted or the speed is unstable, check the motor control circuit using the procedure in table 4-2.

Table 4-6. Auxiliary PCA Replaceable Parts

REFERENCE DESIGNATION	HP PART NUMBER	DESCRIPTION	QTY
	82104-80007	BOARD, printed-circuit	1
C1	0180-2664	CAPACITOR, 3.3 μF, 20%, 15V	1
C2, C3	0180-2663	CAPACITOR, 6.8 μF	2
C4, C5	0180-0450	CAPACITOR, 22 μF	2
CR1, CR2, CR3	1901-1098	DIODE, switching	3
U1	1826-0322	INTEGRATED CIRCUIT, sense amplifier	1
R3, R4	0675-4721	RESISTOR, 4.7K, 10%	2
R1, R2	0683-6825	RESISTOR, 6.8K, 5%, 1/4W	2
J1-J5	1251-0691	SOCKET, single-contact	5

Table 4-7. Logic PCA Replaceable Parts

REFERENCE DESIGNATION	HP PART NUMBER	DESCRIPTION	QTY
	82104-80001	BOARD, printed-circuit	1
C1, C5	0180-2663	CAPACITOR, 6.8 μF	2
C2	0180-2764	CAPACITOR, 1 μF	1
C4	0160-0573	CAPACITOR, 4700 pF	1
C3	0160-0571	CAPACITOR, 470 pF	1
XA2	1600-0828	CLIP, ten-contact	1
XA3	1600-0817	CONNECTOR, five-pin	1
P1	5041-1167*	CONTACT, I/O	1
DS1	1990-0722	DIODE, light-emitting	1
CR1	1901-0535	DIODE, Schottky	1
U1	1LA2-0001	INTEGRATED CIRCUIT, CRC	1
U2	1LA3-0023	INTEGRATED CIRCUIT, ROM	1
U3	1826-0180	INTEGRATED CIRCUIT, timer	1
PS1	0950-1628	POWER SUPPLY	1
R4, R7	0683-1515	RESISTOR, 150-ohm, 5%, ¼W	2
R8	0698-8759	RESISTOR, 1K, 5%, ⅛W	1
R1	0675-4721	RESISTOR, 4.7K, 10%	1
R6	0683-4745	RESISTOR, 470K, 5%, ¼W	1
R2	0683-1055	RESISTOR, 1M, 5%, ¼W	1
R3	0683-2255	RESISTOR, 2.2M, 5%, ¼W	1
R5	2100-3695	RESISTOR, variable, 20K, ½W	1
J1, J2	1251-0691	SOCKET, single-contact	2
Q1	1854-0668	TRANSISTOR, NPN	1

* Clip off both locking arms from the contact before using.

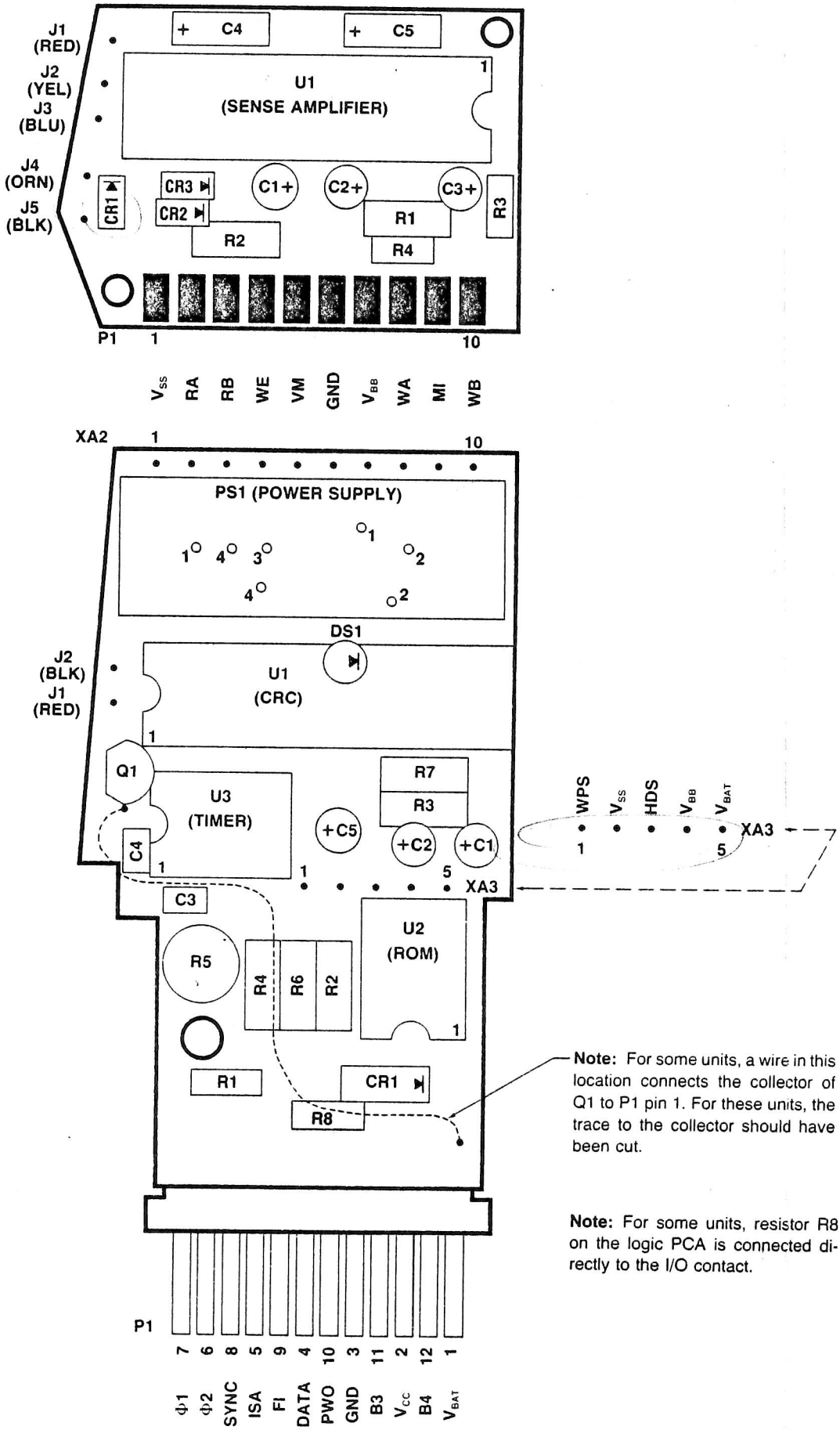


Figure 4-3. Component Location Diagram for PCA's

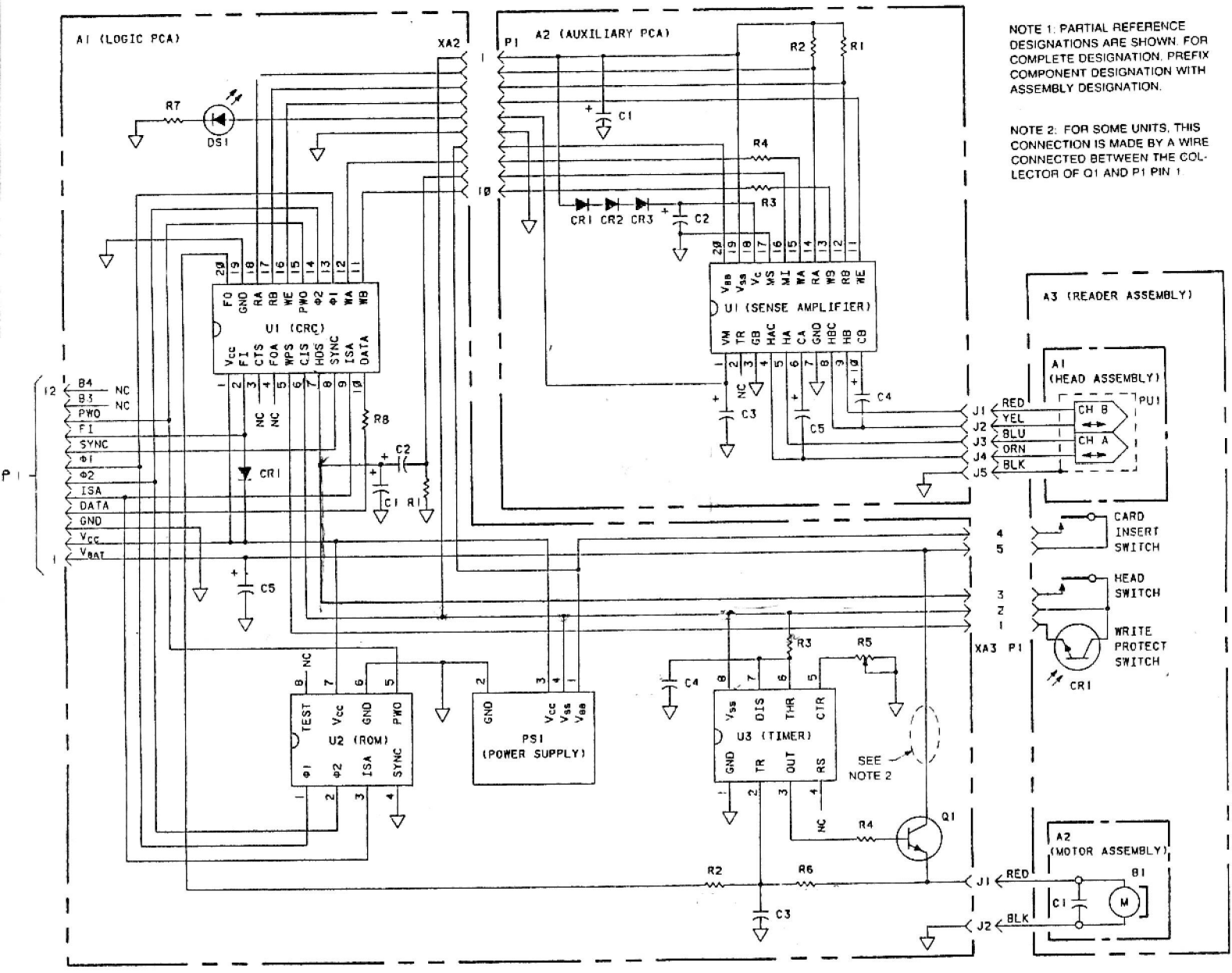


Figure 4-4. HP 82104A Schematic Diagram

Replaceable Parts

5-1. INTRODUCTION

5-2. This section contains information pertaining to the parts used in the HP 82104A Card Reader, illustrated in figure 5-1. Part descriptions, HP part numbers, quantities, and reference designations (where applicable) are given in table 5-1.

5-3. Replaceable parts for the reader assembly (figure 5-2) are listed in table 5-2.

5-4. Replaceable parts for the logic PCA and auxiliary PCA are listed opposite the corresponding component location diagrams in section IV.

5-5. ORDERING INFORMATION

5-6. 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 serial number.

b. HP part number.

c. Description.

d. Complete reference designation (if applicable).

Table 5-1. HP 82104A Card Reader Replaceable Parts

INDEX NUMBER, FIGURE 5-1	HP PART NUMBER	DESCRIPTION	QTY
1	82104-60007	ASSEMBLY, auxiliary PC (A2)	1
2	82104-60001	ASSEMBLY, logic PC (A1)	1
3	82104-60006	ASSEMBLY, reader (refer to table 5-2)	1
4	82104-60005	ASSEMBLY, top case	1
5	82104-40003	BAFFLE	1
6	82104-40002	CASE, bottom	1
7	82104-40007	COVER, I/O	1
8	0403-0279	FOOT	1
9	7120-8303	LABEL	1
10	82104-40005	LATCH, left	1
11	82104-40006	LATCH, right	1
12	9220-3128	PAD, foam	1
13	0624-0435	SCREW, 0.250-inch	2
14	0624-0443	SCREW, 0.438-inch	1
15	0624-0454	SCREW, specialty	4
16	1600-0796	SPRING, latch	2
17	1600-0820	STRAP, case	2
18	0460-1528	TAPE, epoxy	
19	0460-0042	TAPE, polyester	

Table 5-2. Reader Assembly Replaceable Parts

INDEX NUMBER, FIGURE 5-2	HP PART NUMBER	DESCRIPTION	QTY
1	82104-40011	ACTUATOR, long	1
2	82104-40010	ACTUATOR, short	1
3	00067-60910	ASSEMBLY, drive roller, service	1
4	82104-60003	ASSEMBLY, head (A3A1)	1
5	00067-60904 00067-60913	ASSEMBLY, motor, service (A3A2)	1
6	82104-80002	BOARD, printed-circuit, switch	1
7	0363-0155	CONTACT, switch	2
8	1990-0723	PHOTOTRANSISTOR	1
9	5040-9797	PIN, drive	1
10	82104-40008	PLATE, switch	1
11	4040-1488	ROLLER, pinch	1
12	0624-0431	SCREW, 0.313-inch	5
13	0516-0072	SCREW, motor	2
14	1460-1741	SPRING, card-wrap	1
15	1460-0558	SPRING, side-load	1

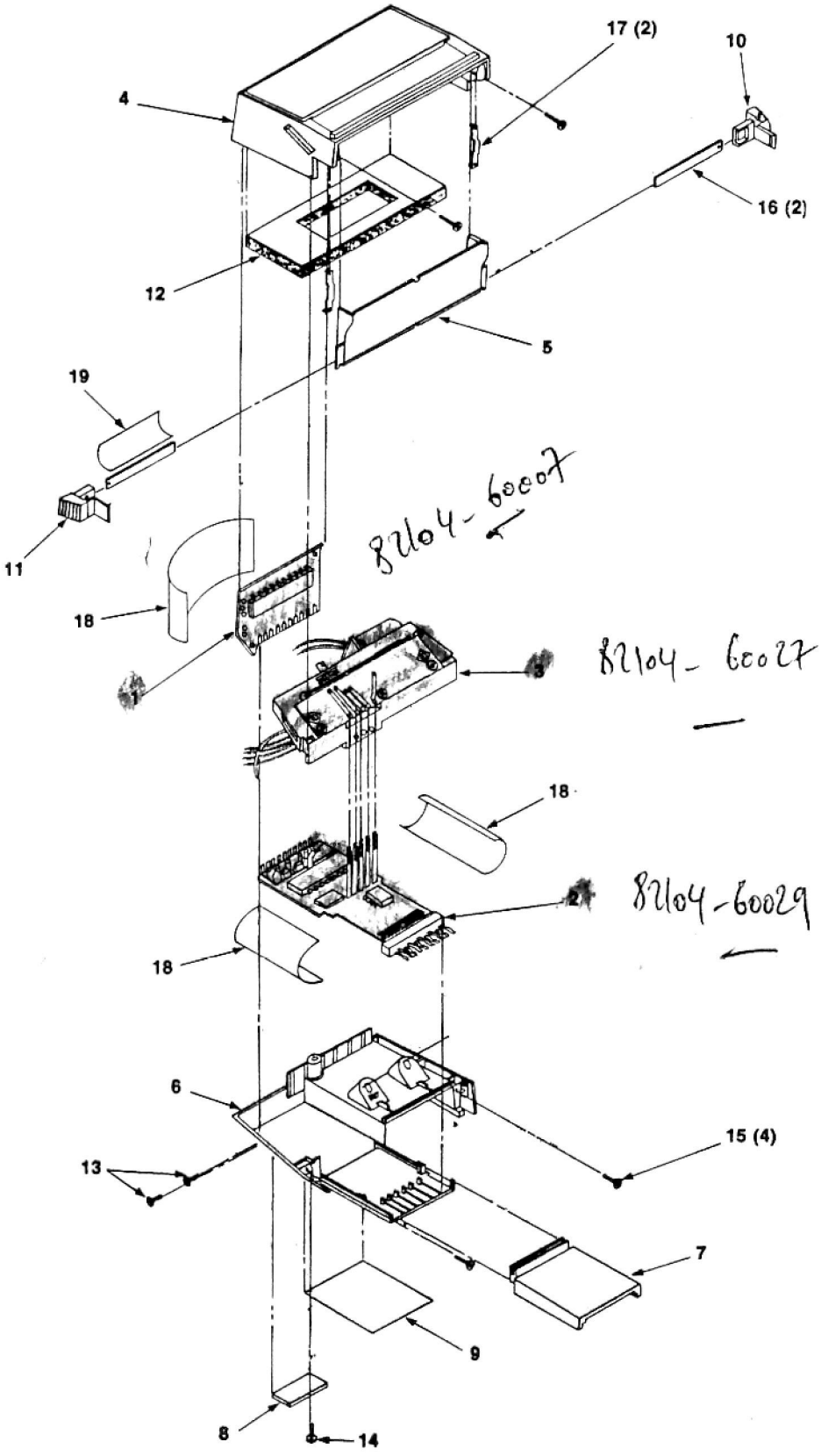


Figure 5-1. HP 82104A Exploded View

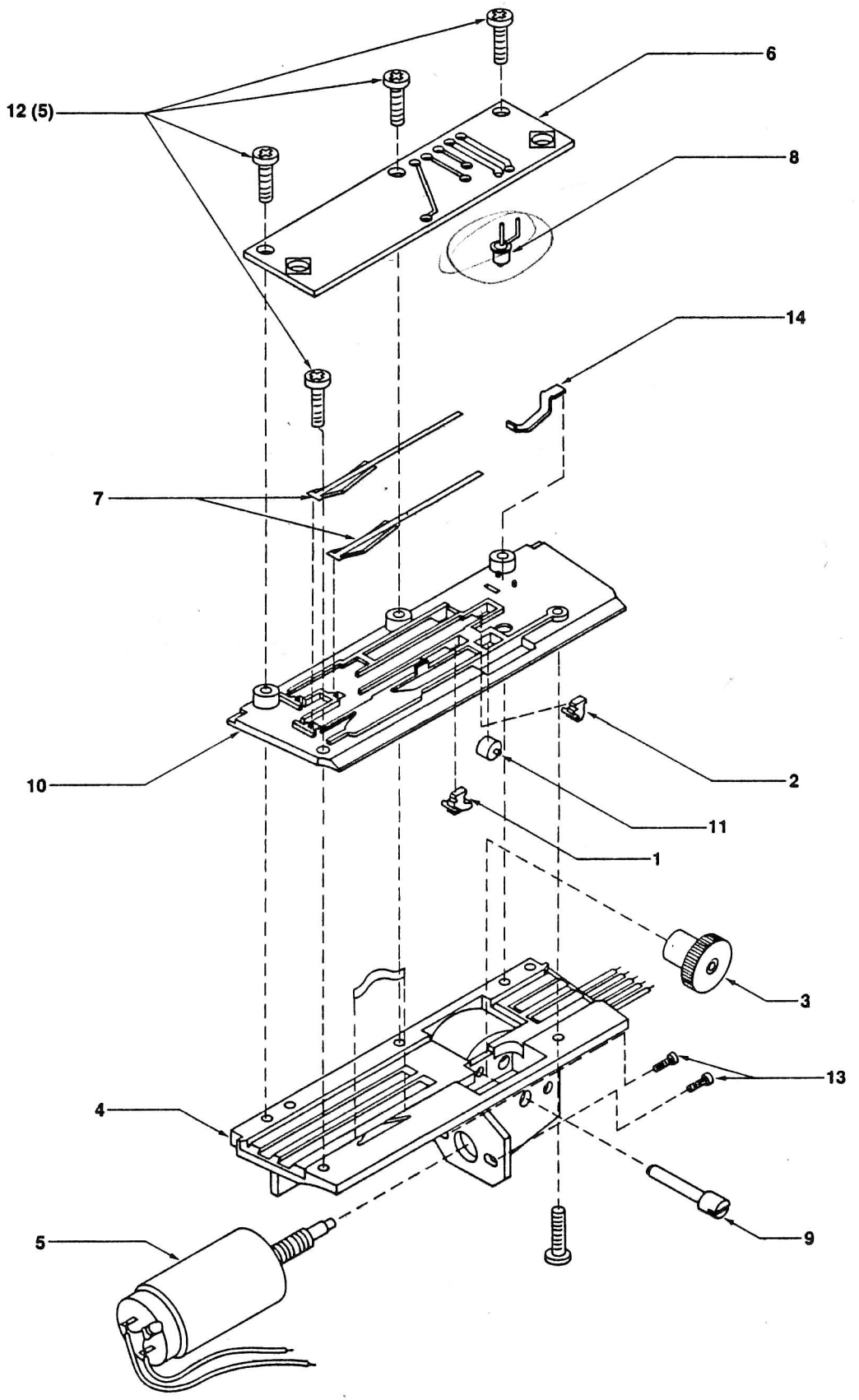


Figure 5-2. Reader Assembly Exploded View