HEWLETT PACKARD

HP 82161A

Digital Cassette Drive

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 82161A Digital Cassette Drive.

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

- A description of the cassette drive (section I).
- An explanation of how it works (section II).
- Information for disassembly and reassembly (section III).
- Steps for troubleshooting and testing the cassette drive (section IV).
- Information for testing electrical accessories (section V).
- A list of replaceable parts (section VI).
- Reference diagrams (section VII).

1-4. DESCRIPTION

1-5. The HP 82161A Digital Cassette Drive is a mass storage peripheral device that connects to HP-IL (Hewlett-Packard Interface Loop). The cassette drive stores and retrieves information on Hewlett-Packard Mini Data Cassettes.

1-6. The drive mechanism uses two motors that are geared directly to the tape drive spindles. The data is recorded on both tracks in the same direction. Thus the unit only controls the tape speed in one direction.

1-7. Service procedures for the cassette drive require an HP-41CV, an HP 82160A HP-IL Module, a formatted test cassette, a stall cassette, a skew tape, the diagnostic program DRVTST (on HP-41 magnetic cards), and an HP 82143A Printer (optional).

Table 1-1. Specifications

Physical Properties

- Width: 16.8 centimeters (6.61 inches).
- Depth: 13.2 centimeters (5.20 inches).
- Height: 6.2 centimeters (2.44 inches).
- Weight: 710 grams (1.57 pounds) with battery.

Data Format

- Number of tracks: 2.
- Density: 335 bits per centimeter (850 bits per inch).
- Format: 256 bytes per record (8 bits per byte).
- Formatted capacity: 512 records (131,072 bytes).
- Encoding method: bi-phase-level phase encoding.

Drive Mechanism

- Type: two-motor, hub drive.
- Read/write speed: 23 centimeters (9 inches) per second.
- Search/rewind speed: 76 centimeters (30 inches) per second.

Interface

- Type: HP-IL (Hewlett-Packard Interface Loop).
- Default address on power up: undefined.
- Default address after Auto Address Unconfigure: 2.

Power Requirements

- Primary source: HP 82033A Battery Pack.
- Recharging time for pack: 14 to 16 hours (drive turned on or off).
- Usage: ON 1.5 watts maximum (motor off).
  STANDBY (on) 1.7 watts maximum (motor off).
  STANDBY (off) 0 watts.

Temperature Limits

- Operating: 10 to 40 degrees C (50 to 104 degrees F).
- Charging: 15 to 40 degrees C (59 to 104 degrees F).
- Storage: -40 to 75 degrees C (-40 to 167 degrees F).

Table 1-1. Specifications (Continued)

Digital Cassette

- Type: Hewlett-Packard Mini Data Cassette.
- Tape length: 24 meters (80 feet).
- Temperature limits: 10 to 45 degrees C (50 to 113 degrees F).
- Humidity limits: 20 to 80 percent relative humidity.

1-8. IDENTIFICATION

1-9. The serial number of the cassette drive is used for identification and determination of warranty status. It is located on the bottom case. Its format is described below.

```
                  A
 Y Y W W   B   X X X X X
 --- ---   Q   ---------
  |   |    S       |
  |   |   ---      |
  |   |     |      +------ Sequence number.
  |   |     |
  |   |     +------------- Location manufactured:
  |   |
  |   |                      A = USA
  |   |                      B = Brazil
  |   |                      Q = United Kingdom
  |   |                      S = Singapore
  |   |
  |   +------------------- Week manufactured.
  |
  +----------------------- Year manufactured
                           (years since 1960).
```

SECTION
II

Theory of Operation

2-1. FUNCTIONAL DESCRIPTION

2-2. The HP 82161A Digital Cassette Drive (see figure 2-1) consists of nine primary electrical circuits:

- The processor circuit.
- The interface circuit.
- RAM (random-access memory).
- The read/write circuit.
- The motor drive circuit.
- The motor stall circuit.
- The end-of-tape circuit.
- The battery/standby circuit.
- The motor supply circuit.
- The 5-volt power supply.
- The indicator circuit.

2-3. These circuits are contained on the logic PCA (printed-circuit assembly) and the drive PCA. CMOS (complementary metal-oxide-semiconductor) circuitry is used in the HP-IL IC (integrated circuit), the one-shot flip-flop, the dual-D flip-flop, and the exclusive-OR gates. The processor IC and the RAM IC use NMOS (N-channel metal-oxide-semiconductor) technology. Other circuits use conventional bipolar components.

2-4. The cassette tape is monitored by the end-of-tape circuit and a cassette-present switch, is driven by two motors, and is read from and written to by a two-channel magnetic head.

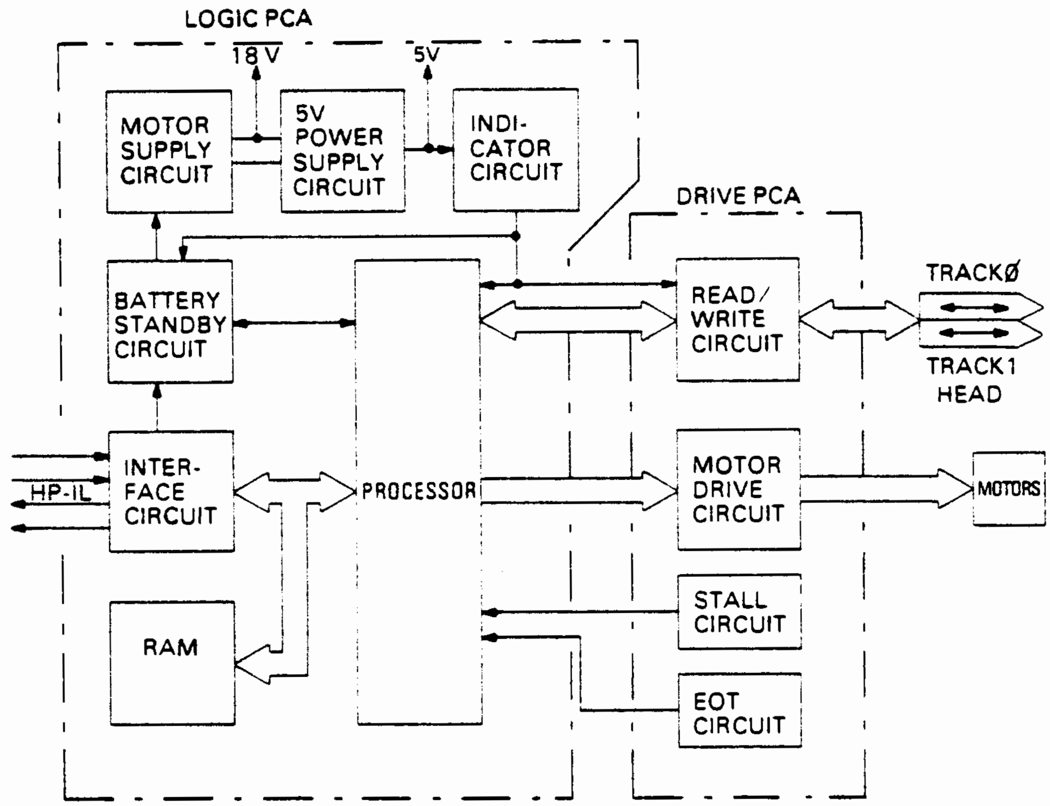

Figure 2-1. Cassette Drive Block Diagram

2-5. The cassette drive interfaces with the controller using HP-IL. This interface transfers information in one direction along a pair of wires, connecting the output transformer of one device to the input transformer of the next device. The information is passed from the wires to the internal circuitry by the coupling transformer.

-6. Processor Circuit

-7. The processor circuit consists of processor A1U3, REWIND switch A1S2, nd the cassette-present switch A2S1. (For an explanation of the eference designators, refer to paragraph 4-3.)

2-8. The processor controls the operation of the cassette drive in esponse to instructions received from HP-IL (and relayed to the processor rom the interface circuit). The processor contains all of the icroprogramming required to perform its functions. Crystal Y1 provides he 4-MHz clock frequency for circuit timing. Signal names are listed in able 2-1.

2-9. The processor interacts with the interface circuit using eight i-directional lines (A1 through A8) for the transfer of data, three utput lines (B0 through B2) to specify registers, two output lines ($\overline{\text{IWR}}$ nd $\overline{\text{IRD}}$) to specify data transmission to and from the interface circuit, espectively, and one output line ($\overline{\text{ISEL}}$) to select the HP-IL IC (U4) in the nterface circuit.

2-10. The processor interacts with RAM using four bi-directional lines B0 through B3) for the transfer of data, 10 output lines (A0 through A9) o specify registers, one output line ($\overline{\text{RWR}}$) to specify data transmission o ($\overline{\text{RWR}}$ low) and from ($\overline{\text{RWR}}$ high) RAM, and one output line ($\overline{\text{RSEL}}$) to select the RAM IC.

2-11. The processor interacts with the read/write circuit using one output ine (DOUT) for transfer of data to the read/write circuit, one input line DIN) for transfer of data from the read/write circuit, one input line (DRDY) o indicate that one bit of data is available on the DIN line, one output ine (TRK) to specify the track on the tape, and one output line ($\overline{\text{REC}}$) to specify data transmission to ($\overline{\text{REC}}$ low) and from ($\overline{\text{REC}}$ high) the read/write ircuit. The processor encodes and decodes the serial data sent to and eceived from the read/write circuit.

2-12. The processor interacts with the motor drive circuit using five output lines (M0 through M4) to control the operation of the motors.

2-13. The $\overline{\text{STAL}}$ input line informs the processor that excessive current is being drawn by the motor drive circuit. The $\overline{\text{EOT}}$ input line indicates that the tape is positioned at clear leader or at the index hole on the recording surface. The $\overline{\text{RST}}$ input line causes the processor to be reset. The processor sets the $\overline{\text{PWDN}}$ output line low when an HP-IL message specifies this operation.

Table 2-1. Signal Names

SIGNAL	DESCRIPTION
A0	RAM: Selects the pair of registers that form the eight-bit byte. HP-IL IC: Unused.
A1-A8	RAM: Selects address. HP-IL IC: Data transfer lines.
A9	RAM: Selects Buffer 0 or Buffer 1. HP-IL IC: Unused.
B0-B3	RAM: Data transfer lines. HP-IL IC: Register address.
BSY	Busy
CASP	Cassette Present
DIN	Data IN--from read circuit bit by bit.
DIO	Data IN/OUT (Sense Amp)
DOUT	Data OUT--to record circuit bit by bit.
DRDY	Data Ready
EOT	End-of-Tape
GND	Ground
ISEL	Interface (HP-IL) Select
IRD	Interface (HP-IL) Read
IWR	Interface (HP-IL) Write
LC1/2	HP-IL Timing
M0-M4	Motor Control
MGND	Motor Ground
PWDN	Power Down
REC	Record Data
REW	Rewind
RSEL	RAM Select
RST	Reset
RWR	RAM Write
RXD0/1	HP-IL Recieve
STAL	Stall
TRK	Track
TXD0/1	HP-IL Transmit
XTL1/2	System Timing

2-14. The REWIND switch pulls the $\overline{REW}$ line low to the processor, which causes the tape to be rewound. If the busy light is on the processor will ignore the $\overline{REW}$ line. The cassette-present switch (on the drive PCA) is closed when a cassette is present in the transport and the door is closed. This switch pulls the CASP line low to the processor.

2-15. Interface Circuit

2-16. The interface circuit consists of the HP-IL IC (U4), two input transformers, one output transformer, and discrete components. This circuit provides a floating, balanced pair of input and pair of output lines with proper loading, EMI (electromagnetic interference) reduction, and impedance matching. Each message consists of bits encoded in a three-level format, as shown in figure 2-2. The high and low pulses on the loop side are +1.5V and -1.5V nominal across the pair of wires. Pulses are typically 1 microsecond wide, with at least 2 microseconds delay between bits.

2-17. The HP-IL IC provides most of the interfacing logic and ensures proper interaction with the interface loop. This IC contains eight internal registers that hold operating information, including HP-IL messages received from the interface loop or from the processor.

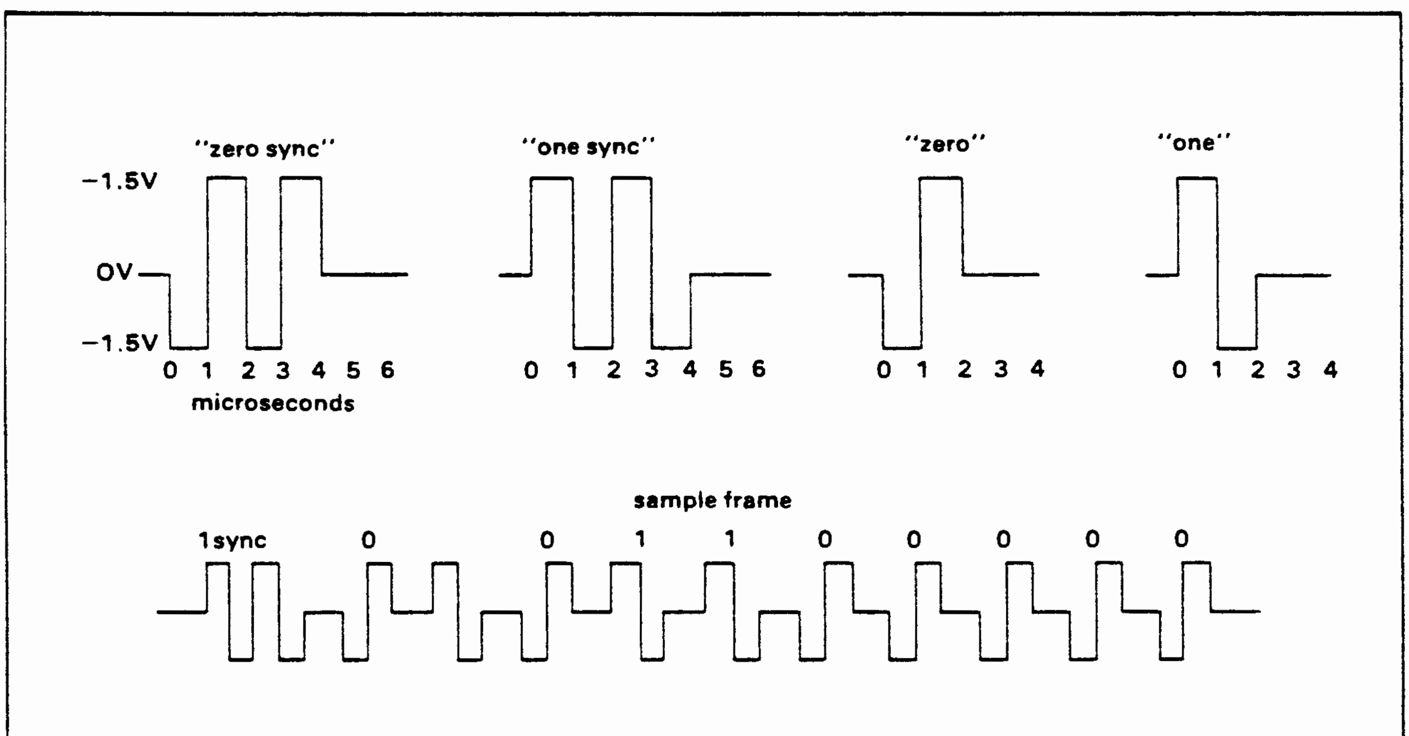

Figure 2-2. HP-IL Bit Encoding

2-18. Eight data lines (A1 through A8) connect the HP-IL IC to the processor. The B0, B1, and B2 input lines determine which internal register is connected to the data lines. Active low input signals on ISEL and IWR cause the HP-IL IC to accept data from the data lines; low input signals on ISEL and IRD cause data to be sent on the data lines.

2-19. The processor periodically examines the HP-IL IC to see if there is any activity on the loop that requires the processor's attention.

2-20. External components C10 and L1 control the 2-MHz clock used for timing the asynchronous HP-IL signals.

2-21. RAM

2-22. The RAM IC contains 1024 four-bit registers. The processor uses the registers in pairs, effectively yielding 512 eight-bit registers. Half of the registers are used as Buffer 0; the other half are used as Buffer 1. Buffer 0 holds information being transferred between the interface loop and the tape. Buffer 1 normally holds information being sent to or received from the interface loop and does not involve the tape.

2-23. Ten input lines (A0 through A9) select the internal register that is connected to the four data lines (B0 through B3). The two states of input line A0 specify the pair of registers that are used by the processor to form an eight-bit byte. A1 through A8 selects the adress of the byte in RAM. A9 selects Buffer 0 or Buffer 1. Active low input signals on RSEL and RWR cause RAM to accept data from B0 through B3; a low input signal on RSEL and a high signal on RWR cause RAM to send data on B0 through B3.

2-24. The Read/Write Circuit

2-25. Information is recorded on the tape using the bi-phase-level method. This means that each bit cell has a flux change at its midcell--the direction determines whether the bit is a "0" or "1". A flux change occurs at the edge of a bit cell if needed by the following cell. (See figure 2-3.) This type of coding is self-clocking since midcell transitions always occur.

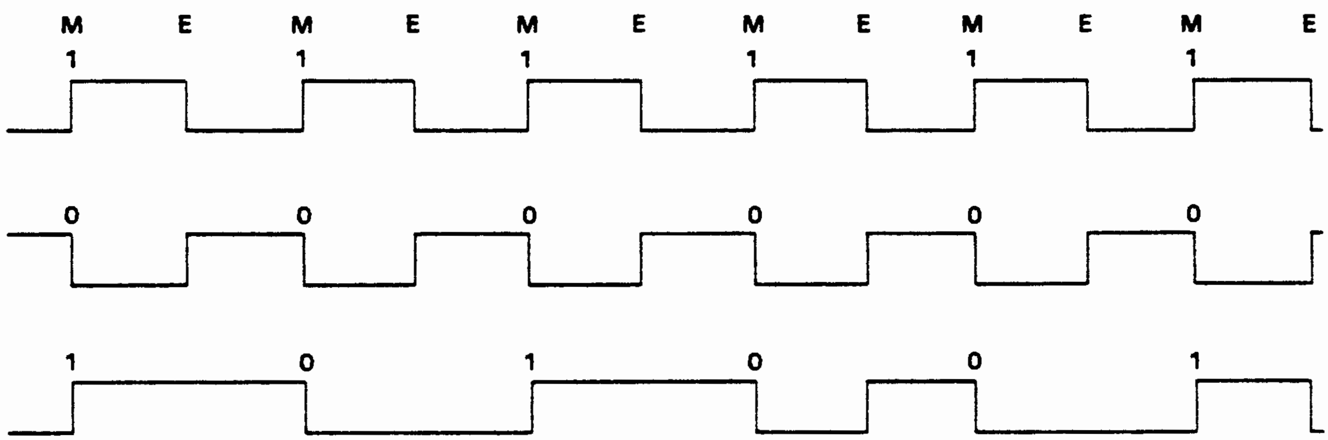

Figure 2-3. Bi-Phase-Level Tape Encoding

2-26. The write circuit (see figure 2-4) consists of sense amplifier A2U6. This circuit provides the interface between the processor and the tape head for the signal processing required when recording to the tape.

2-27. While writing information onto the tape, the REC input to the sense amplifier must be high. The TRK input to U6 determines which track will be used: TRK is low for track 0; TRK is high for track 1. Both tracks are recorded in the same direction, thus there is no need to turn the tape over. When the end of track 0 is reached, the tape automatically rewinds and track 1 is recorded. Signal transitions received on the DIO line are converted to currents with the appropriate directions for the tape head by the sense amplifier.

2-28. The read circuit (see figure 2-4) consists of the sense amplifier U6, the one-shot multivibrator U4B, the D-type flip-flop U5A, the D-type flip-flop U5B, and the exclusive-OR gates U3A, U3B, and U3D. This circuit provides the interface between the tape head and the processor for the signal decoding required when reading from the tape.

2-29. While reading information from the tape, the REC input to the sense amplifier must be low. The TRK input determines which track will be used. The output signal from U6 on the DIO line contains logic transitions that represent the flux changes on the tape--those at the cell edge and midcell positions of each bit cell. The desired information is represented by the direction of the midcell transitions.

2-30. The DIO signal (see figure 2-5) is input into U3D and U3A. The other input of U3D is tied high, so the output of U3D is inverted from DIO. The capacitor C12 on the output of U3D causes the input to U3A to rise slowly and decay slowly to the high and low states (figure 2-5). Thus, when DIO changes from high to low, C12 holds the second input to U3A low long enough to change the output on U3A to low. As C12 charges, the second input to U3A raises, and the output of U3A then switches high. When DIO next goes high, the output of U3D goes low and C12 begins to discharge, but the input to U3A is held high long enough for the output of U3A to go low. As C12 discharges, the second input to U3A goes low and the output of U3A goes high (see figure 2-5).

2-31. The first low pulse from the output of U3A fires the one-shot multivibrator U4B. Capacitor C14 and resistor R22 prevent the output $\overline{Q}$ of the one-shot from going high again until the cell edge has passed. Holding $\overline{Q}$ low prevents the one-shot from firing when a cell edge occurs. The output $\overline{Q}$ of the one-shot goes low when input A goes low and the output goes high again when the one-shot resets (figure 2-5). Input B must be high for the one-shot to fire again. This input is delayed from going high by C13 and R29 (figure 2-5). This prevents the one-shot from firing too quickly after resetting and allows DIN and DRDY to be properly latched into flip-flops U5A and U5B (described in paragraph 2-32). When the next midcell transition occurs, the prior cell edge transition (if any) will have been ignored and the one-shot will be enabled to fire again.

2-32. When $\overline{Q}$ of the one-shot goes high again, it triggers the D-type flip-flop U5A, which sets the output Q of U5A to the current state of DIO. The output Q of U5A sets the DIN line to the processor. When $\overline{Q}$ of the one-shot goes high it also changes the output of U3B from low to high. Capacitor C13 begins to charge delaying the triggering of U5B. The output $\overline{Q}$ of U5B is also the DRDY signal to the processor. When DRDY changes state the processor reads DIN. The delay created by C13 allows DIN to be properly set prior to the processor reading DIN. C13 also delays the B input to the one-shot from going high again until DIN and DRDY have been properly set.

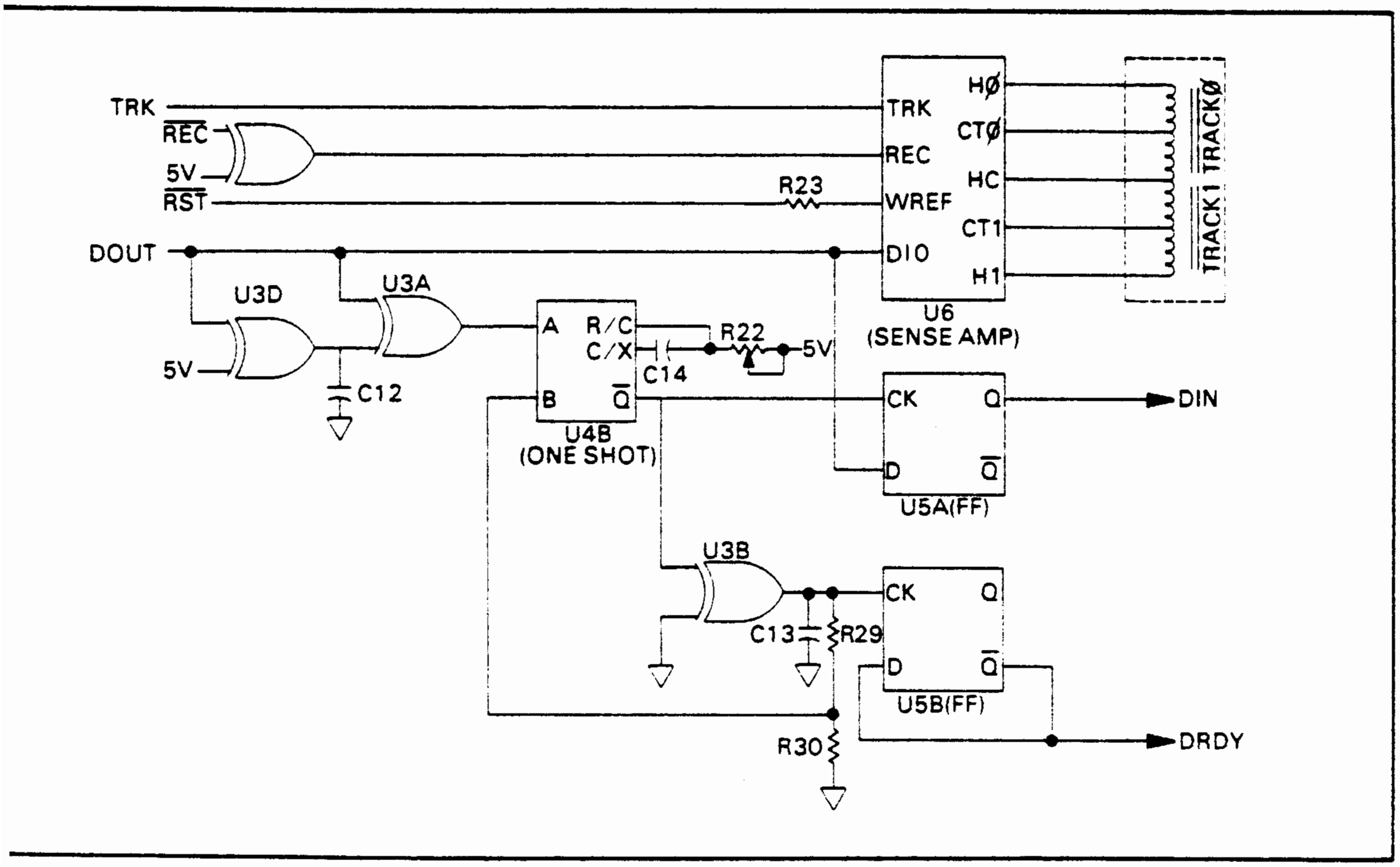

Figure 2-4. Read/Write Circuit

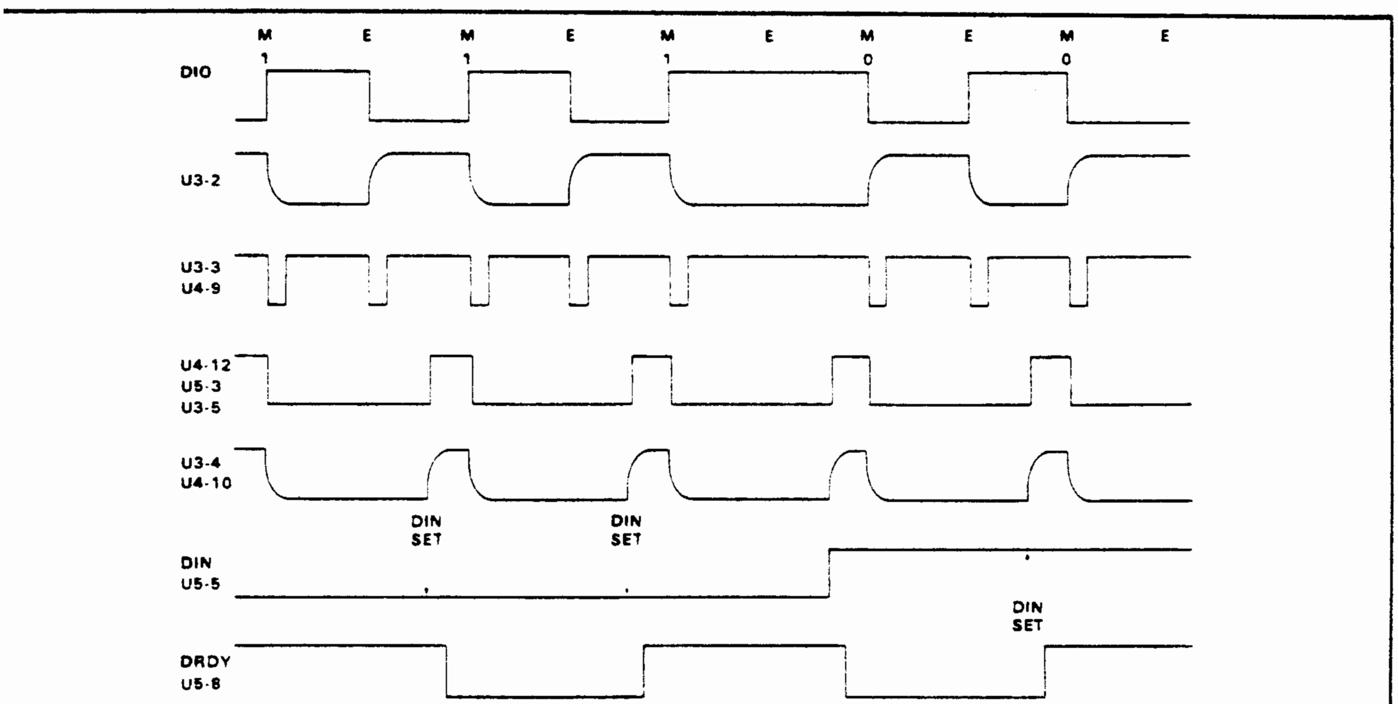

Figure 2-5. Write Circuit Timing

2-33. The timing of the one-shot is established at the beginning of each record by a sync byte consisting of alternating "1"s and "0"s. A string of alternating "1"s and "0"s contain no cell edge transitions (figure 2-6). This pattern gives the one-shot pure midcell transitions so the firing will be properly keyed to only midcell transitions through the rest of the record.

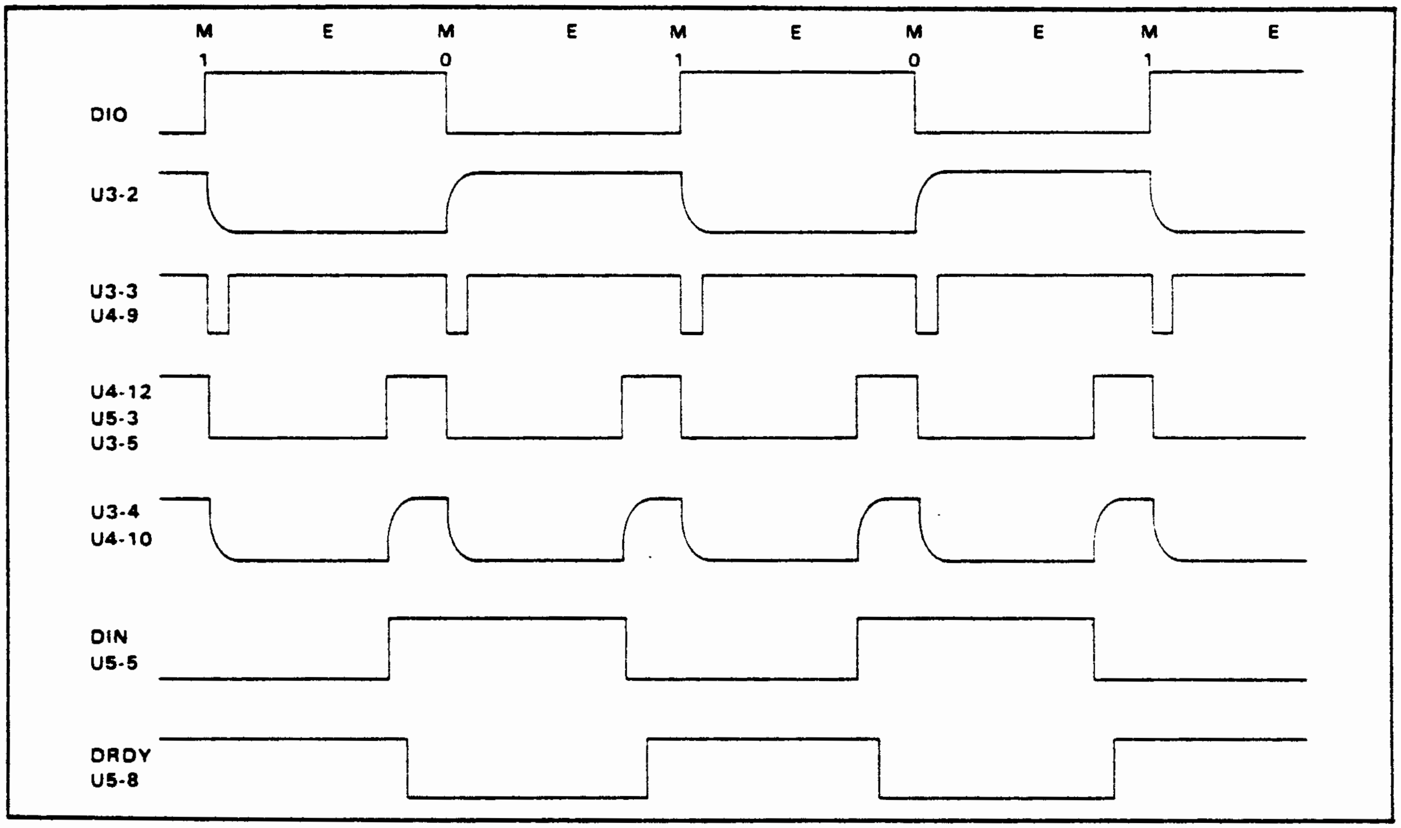

Figure 2-6. One-Shot Timing

2-34. Motor Drive Circuit

2-35. The motor drive circuit (see figure 2-7), which controls the two tape drive motors, consists of five open-collector comparators in U1 and U2, two differential amplifiers in U7, and other related circuitry. The circuit provides precise speed control during recording and reading operations, full-speed forward and reverse movement, and braking.

2-36. Five motor-control lines (M0 through M4) from the processor determine the operation of the drive. Possible operations are listed in table 2-2. Signal levels are compared to a 2.6V reference voltage generated by regulator U9.

Table 2-2. Drive Operations

OPERATION	MOTOR-CONTROL LINES M0	M1	M2	M3	M4
Inactive	high	high	high	high	high
Record/Read	high	high	low	high	high
Fast Forward	low	high	low	high	high
Fast Reverse	high	low	high	high	low
Forward Brake	low	low	high	low	high
Reverse Brake	low	high	high	low	high

2-37. The motor control circuit consists of a summing op-amp U7A, the two drive motors, the feedback-control op-amp U7B, and related support circuitry. The motors produce a back EMF (electromotive force, or voltage) whenever the motor is being driven or is free spinning (like when the tape is pulling the trailing motor). Resistor R17 is adjusted so that the ratio of R17 and R27 matches the ratio of the resistance of motor B1 and the resistance of inductor L1. (L1 is acting as a resistor in this circuit.) This ratio matching effectively subtracts out the driving I-R drop across motor B1, leaving only the sum of the back EMFs as the output from op-amp U7A. Feedback op-amp U7B takes the output from U7A and adjusts the current into B1 through transistor Q3 such that the sum of the two back EMFs is held constant. Holding the sum of the back EMFs constant is the same as holding the sum of the velocities of the motors constant. Thus as the tape stacks up on the drive motor's (B1) spool, the trailing motor (B2) begins to rotate faster. The faster rotation of B2 increases its back EMF, which is fed through the feedback loop and slows down motor B1. Thus the tape speed at the tape head is held constant.

2-38. Peripherial driver A2U8 and comparators A2U1 and A2U2 are open-collector type. The two states of the output are set such that in the high state the outputs are open and in the low state the outputs are grounded.

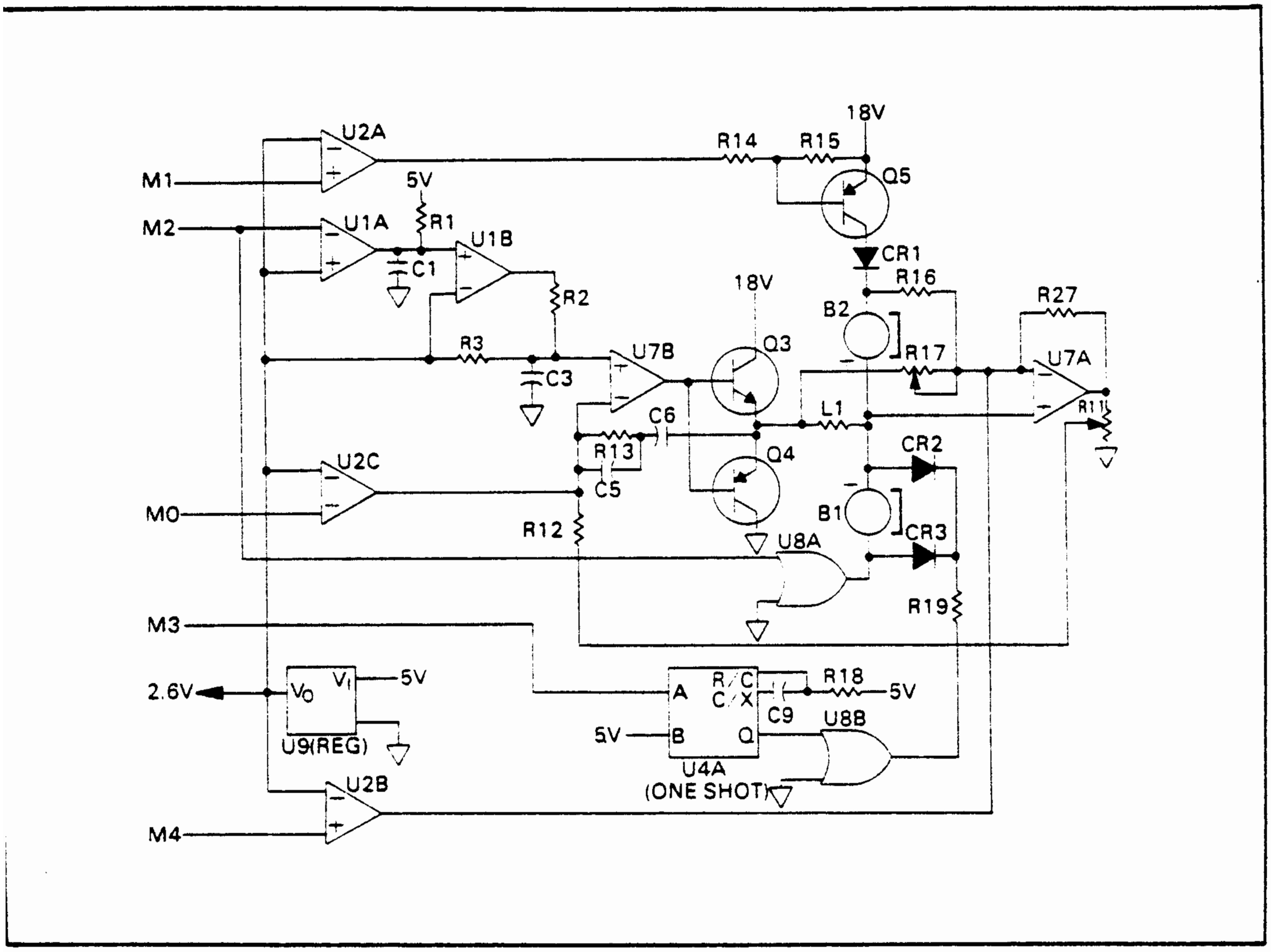

Figure 2-7. Motor Drive Circuit

2-39. The read/write mode is the controlled forward speed, during which all read and record operations occur. In read/write mode line M0 is high, which opens the output of U2C and and allows the feedback network to U7B to operate. Line M1 is high which opens the output on U2A and turns off transistor Q5. Line M3 is high so the one-shot U4A does not fire and U8B cannot provide a ground path for motor B1. Line M4 is high and U2B is open at the output. Line M2 is low which provides a ground path for motor B1 through U8A. Line M2 also inputs to U1A which opens the output of U7A allowing C1 to begin charging through R1. As C1 charges it eventually exceeds the threshold of U1B. The output of U1B goes from ground to open and capacitor C3 slowly charges to the 2.6V reference. The charging of C3 allows the motors to smoothly increase in speed until the feedback network comes into balance to control the speed of the motors. This 2.6V reference and the feedback loop provide the two inputs for controlling the speed of the motors.

2-40. Before a read/write operation occurs the motors are in the inactive state and the output of U1B is grounded. The voltage drop across resistor R2 provides a 0.3V input into U7B. When M2 initially goes low and capacitors C1 and C3 are charging, this 0.3V is the only input into U7B. U7B turns off Q4 and turns on Q3, which begins turning motor B1. As the slack is taken out of the tape, motor B2 begins to turn and the summing op-amp U7A begins feeding back into U7B. By the time capacitor C3 fully charges the system has been brought into balance.

2-41. For fast forward motion all the motor control lines are the same as in the read/write mode execpt M0, which is now low. A low M0 grounds the output of U2C, which grounds the negative input to U7B and the negative feedback loop. The 2.6V reference on the positive input of U7B causes the output of U7B to turn Q3 on hard. With Q3 on hard, motor B1 runs forward at its top speed.

2-42. For fast reverse M0 is high, which allows the feedback circuit to operate. M2 is high, which grounds the outputs of U1A and U1B, so only 0.3V is on the positive input to U7B. M3 is high, so the one-shot does not fire. M4 goes low, which grounds the output of U2B and grounds negative input to U7A. U7A then feeds a positive voltage into the negative input of U7B, which causes a negative output on U7B. The negative output on U7B turns off Q3 and turns on Q4. Q4 provides the ground path for motor B2. M1 goes low, which grounds the output of U2A and turns on transistor Q5. Q5 provides the current to motor B2, which then runs full speed reverse.

2-43. Forward brake is done by braking the trailing motor B2, which prevents the tape from stacking up in the cassette. The braking is accomplished by setting M2 high, which puts 0.3V on the input to U7B (by grounding the output of U1B) and opens the output on U8A, which opens the ground path of motor B1. M4 is high, which opens the output of U2B. M0 is low, which grounds the output of U2C and grounds the negative feedback loop to U7B. The output of U7B goes positive turning on Q3 and turning off Q4. M1 goes low, turning on Q5, which provides +18V to the negative lead of motor B2. M3 goes low and fires the one-shot, which grounds the output of U8B. The output of U8B provides the ground path for motor B2. With both transistors Q3 and Q5 on, the motor B2 is effectively floating and the input and output leads are effectively shorted together. Shorting the leads of the motor allows the back EMF to quickly drain the energy of the motor through the motor's internal resistance. As the back EMF drops, the 18 volts from Q3 keeps the motor from reversing by balancing the 18 volts from Q5. After a short time the R/C input to the one-shot allows $\overline{Q}$ to go high again, thus shutting off the ground path for motor B2. This way the processor does not need to time the braking action.

-44. Reverse braking is accomplished by braking the trailing motor B1. n reverse brake M1 is high, which turns off Q5. M2 goes high, which opens he ground path of motor B1 through U8A, and sets the reference voltage into he positive input on U7B to 0.3V. M4 goes high, which sets the output of J2B open. M0 goes low, grounding the negative input to U7B. M3 also goes ow, firing the one-shot, which sets the output of U8B to ground. The 0.3V n the positive input to U7B causes the output of U7B to turn off Q4 and turn n Q3. Q3 clamps the input to motor B1 at 18V. As the back EMF builds and xceeds 18V at the negative side of B1, the current flows through diode CR3 o ground. As the back EMF falls to the +18V input from Q3, the current rom Q3 goes through diode CR2 preventing B1 from rotating in the forward lirection. After a short time the R/C input to the one-shot allows $\overline{Q}$ to go high again and thus shuts off the ground path from motor B1 and ransistor Q3.

-45. In motor inactive state, all motor control lines, M0 through M4, are high, thus providing no ground paths and no voltage sources to either motor.

-46. Motor Stall Circuit

-47. The motor stall circuit (see figure 2-8) senses current on the 18V supply line and sets signal $\overline{\text{STAL}}$ to the appropriate state. The circuit ses two identical transistors (Q1 and Q2) to provide equal base-to-emitter oltage drops. With these voltage drops equal, the voltage across resistor R5 is the same as that across the sensing resistor R4. Therefore the current hrough R5 (and R7) is proportional to the supply current through R4. When he voltage at the centertap of R7 exceeds the 2.6V reference voltage, the output of comparator U1C goes open allowing C2 to charge. If the supply current remains high long enough for the voltage across C2 to exceed 2.6V, he $\overline{\text{STAL}}$ output of comparator U1D goes low. When the processor senses a low on the $\overline{\text{STAL}}$ line it sets all motor control lines high turning off the motor circuit and sets the status bits indicating a stall.

2-48. End-Of-Tape Circuit

2-49. The end-of-tape circuit (see figure 2-9) enables the cassette drive to detect either end of the tape by sensing the small hole or the clear leader. The circuit's main components are LED (light-emitting diode) DS1, phototransistor Q1, and comparator U2D. (Q1 is mounted on the head-frame assembly.) Whenever the 5V supply is present, DS1 is turned on, creating a voltage of about 3.7V at the positive input to U2D. When the tape prevents light from reaching Q1, Q1 is off and the negative input to U2D is low, causing a high signal on $\overline{\text{EOT}}$. When the hole in the tape allows light to reach Q1, Q1 turns on, causing a high voltage at the negative input to U2D and a low $\overline{\text{EOT}}$ signal.

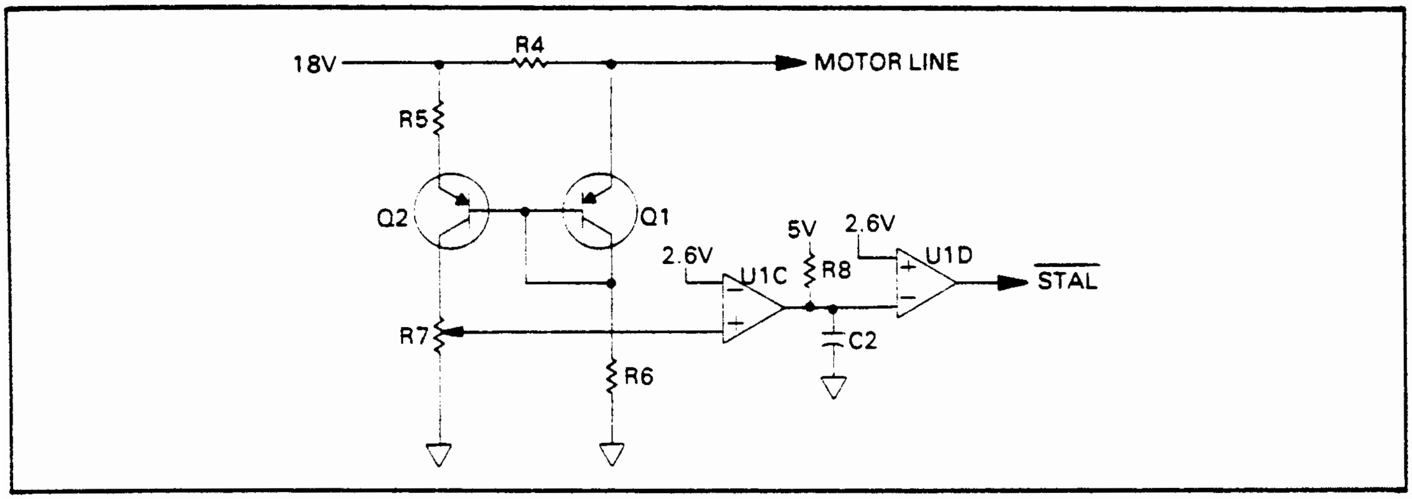

Figure 2-8. Motor Stall Circuit

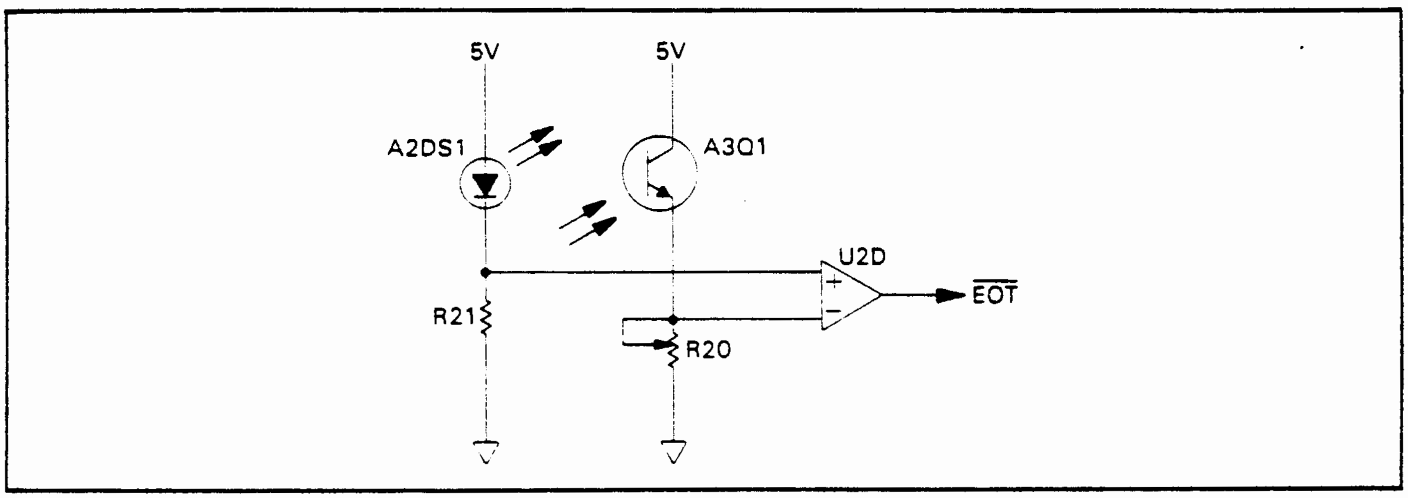

Figure 2-9. End-Of-Tape Circuit

2-50. Battery/Standby Circuit

2-51. The battery/standby circuit (see figure 2-10) enables the nickel-cadmium battery pack in the cassette drive to be charged using ac power, allows the processor to turn off the cassette drive, and allows any HP-IL signal to turn on the cassette drive. The transformer in the recharger drops the line voltage to 11.6 Vac under no load conditions. The diode bridge rectifies the alternating current. Resistor R1 limits the charging current when switch S1 is in the OFF or STANDBY position. R1 is shunted when the switch is ON, providing more current to operate the cassette drive and charge the battery pack.

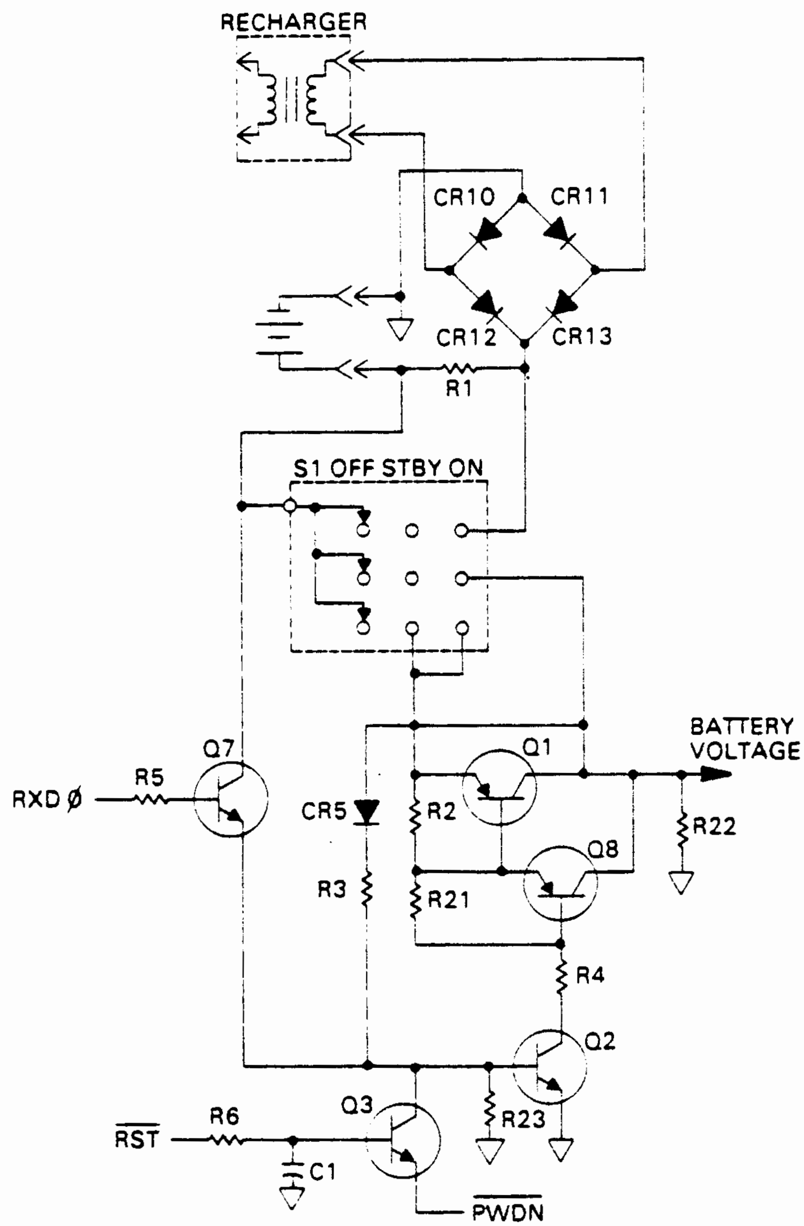

Figure 2-10. Battery/Standby Circuit

2-52. When switch S1 is OFF, the battery pack can charge. No other circuits receive power. When S1 is ON, it connects battery power directly to circuits in the cassette drive.

:-53. When switch S1 is switched from OFF to STANDBY, transistors Q7 and Q2 .re off, preventing transistors Q8 and Q1 from supplying power to other ircuits and keeping the cassette drive inactive. When an HP-IL signal is 'eceived, the signal turns on transistors Q7 and Q2 briefly. When Q2 turns n, it turns on Q8 and Q1, and the voltage at their collectors feeds back hrough CR5 and latches Q2 on. The $\overline{\text{RST}}$ line is held low until after the rocessor sets $\overline{\text{PWDN}}$ high, preventing Q3 from turning on and interrupting his circuit.

?-54. When switch S1 is switched from ON to STANDBY, CR5 keeps Q2 turned on, :eeping Q8 and Q1 turned on. If the processor sets $\overline{\text{PRDN}}$ low ($\overline{\text{RST}}$ is ıormally high), Q3 turns on and turns off Q2. This turns off Q8 and Q1, and 'emoves power from all circuits.

?-55. Motor Supply Circuit

?-56. The motor supply circuit (figure 2-11) provides a +18V supply for the irive motors and for the 5-volt power supply. In addition, it provides a ;V reference voltage.

?-57. The battery/standby circuit provides nominally 5V to regulator PS1. :ts output powers the 5V reference U1. The voltage divider formed by R7 and ?8 generates the control voltage (approximately 2.7V), which regulates the 18V generated by PS1. Capacitor C4 stores power for peak loads. Diodes CR6 ınd CR7 provide a control voltage during turn-on, but are normally reverse-biased. Diode CR8 prevents a reverse voltage across U1 during turn-on.

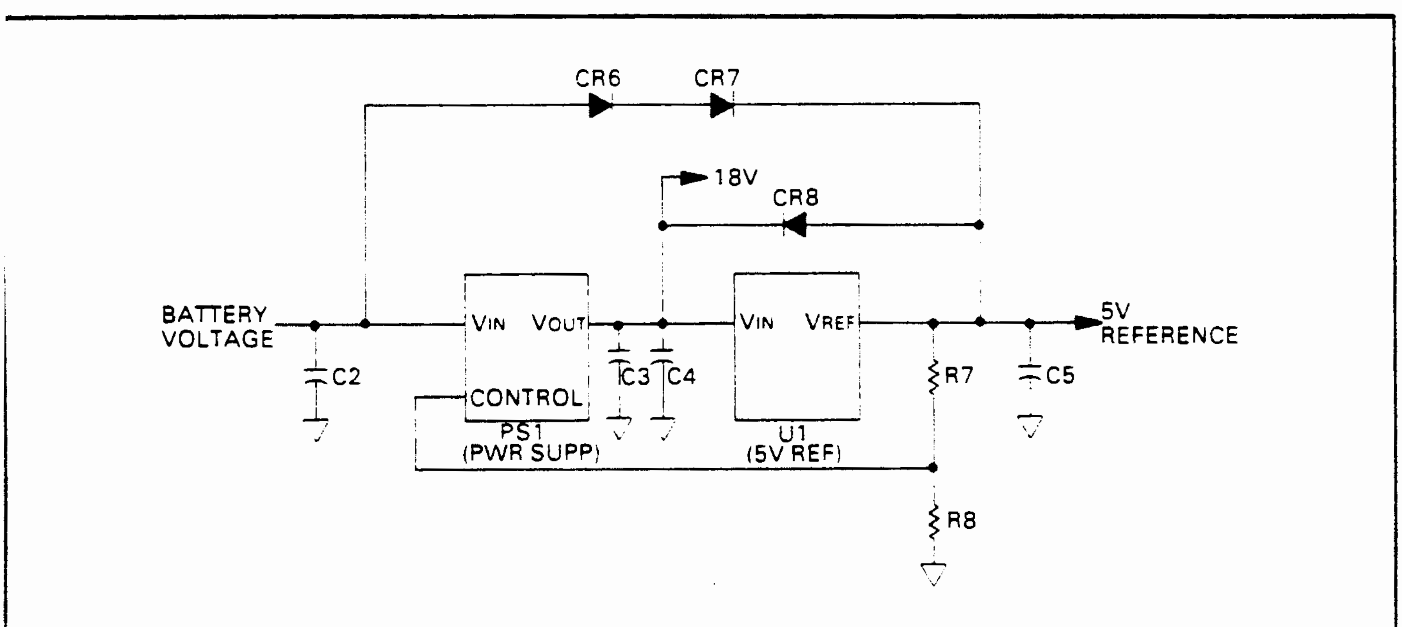

Figure 2-11. Motor Supply Circuit

2-58. 5-Volt Power Supply

2-59. The 5-volt power supply (see figure 2-12) provides +5 Vdc to the circuit. It uses the 5V reference and power from the motor supply circuit.

2-60. With transistor Q4 turned off and the 5V output voltage lower than the 5V reference voltage (causing the output from comparator U2A to be open), transistor Q5 is turned off and capacitor C6 is charged through T1B and R11. When C6 becomes sufficiently charged, Q4 saturates, placing approximately 10V across T1A. This produces approximately 3.4V across T1B, causing current to flow through CR10 and R9 and causing C6 to charge in the reverse direction. At the same time, the current through T1A to C7 and the load increases linearly until the 5V output exceeds the reference voltage, causing the output of U2A to go low, turning Q5 on and Q4 off. The energy stored in T1A causes a voltage reversal that maintains the current flow, drawing current through CR9 and supplying it to C7 and the load. A corresponding voltage reversal at T1B forces Q5 into temporary reverse saturation until C6 discharges sufficiently. C6 then continues charging through R11. When the 5V output eventually falls below the reference voltage, the output of U2A goes high, turning Q5 off. When the energy stored in T1 is dissipated, the reverse voltage on T1A and T1B vanish, letting the voltage on C6 turn on Q4. This cycle repeats as required to regulate the 5V output.

2-61. Transformer T1 and capacitor C7 are the primary energy-storing components in this circuit. Typically, Q4 is on and T1 stores energy during approximately 30 percent of the cycle.

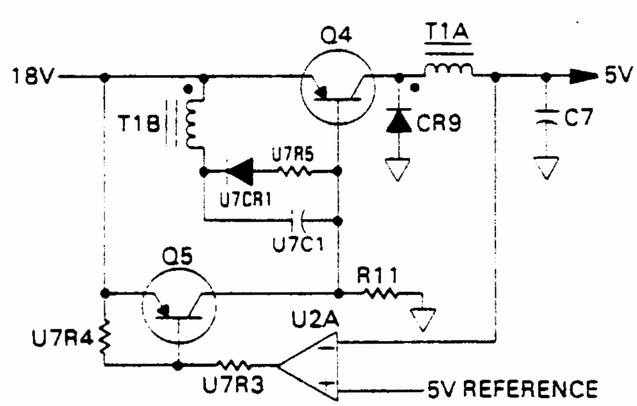

Figure 2-12. 5-Volt Power Supply

-62. Indicator Circuit

-63. The indicator circuit (see figure 2-13) senses and responds to various onditions of the battery voltage and 5V supply voltage. It turns on the AT light whenever the battery voltage falls below 4.6V, but the cassette rive is still operable. However, if the 5V power supply falls below .75V, the POWER light is turned off and the cassette drive is disabled. he indicator circuit also controls the BUSY light.

-64. When battery power is supplied to the motor supply circuit, the 5V eference voltage is immediately established, causing the output from 2C to be high. In this condition, the POWER light DS3 is off and transistor 6 is off, setting $\overline{RST}$ low. (A low $\overline{RST}$ resets the processor and sense mplifier and disables the $\overline{PWDN}$ input to the standby circuit.) When the V power supply voltage reaches the reference voltage, the output from U2C oes low, turning on DS3 and Q6. This sets $\overline{RST}$ high. It also reduces the ositive input to U2C to 4.75V, so that the output does not change unless the V power supply voltage drops below this lower threshold (due to either a ead battery or power turn-off.)

-65. When the 5V power supply has been established, the negative input to omparator U2B is 4.6V. If the battery voltage falls below this level, the 2B output goes low, turning on the BAT light DS2.

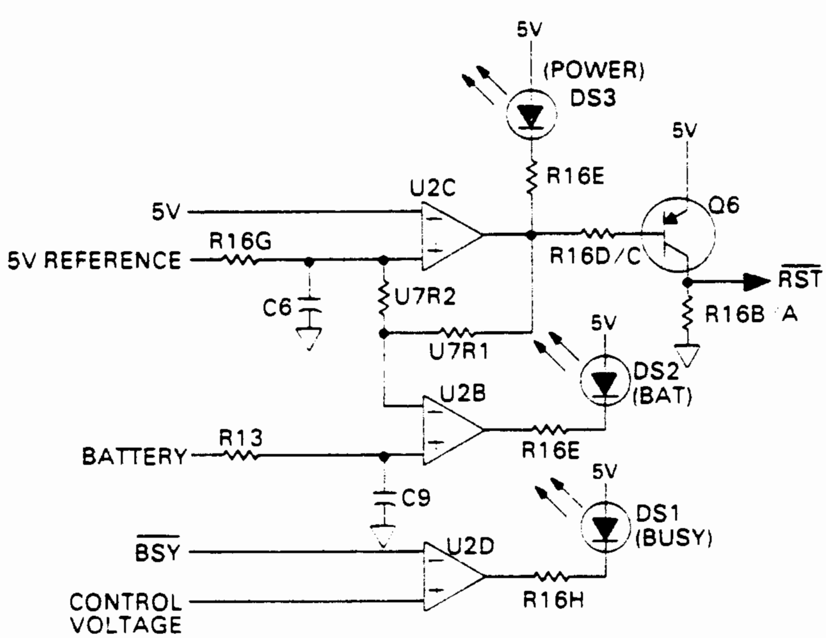

Figure 4-13. Indicator Circuit

2-66. Whenever the motor supply circuit is on, the control voltage from that circuit (approximately 2.7V) is present at the negative input to comparator U2D. When the processor sets the $\overline{BSY}$ line low, the output from U2D goes low, turning on the BUSY light DS1. The light is off when the $\overline{BSY}$ line is high.

2-67. When the processor is addressed or is active with the motor drive, the the processor will pull the $\overline{BSY}$ line low. A low $\overline{BSY}$ line causes the output of the open collector comparator U2D to go to ground, which turns on light DS1.

2-68. SYSTEM OPERATION

2-69. The following paragraphs describe the interaction of the circuits in the cassette drive.

2-70. When the cassette drive is inactive on HP-IL, the interface circuit monitors the HP-IL messages and automatically transmits them to the next device. The processor repeatedly checks information in the HP-IL IC to determine if it needs to take any action.

2-71. In the read operation, the tape is positioned by the drive motors under the control of the processor. The processor selects the track and through the read/write circuit, reads the data from a record on the tape. The processor positions the tape by counting and keeping track of the records as they pass by the head. (A record consists of 256 data bytes.)

2-72. When data is to be recorded onto the tape, the processor selects the HP-IL register, reads the data as it is received (one byte at a time), and stores the data byte in RAM. When the data is ready to be recorded (all bytes have been received or RAM is full), the processor retrieves the data from RAM, encodes it as a series of pulses, and sends it to the read/write circuit, which writes it onto the tape (moving under control of the processor). The interface circuit temporarily delays passing the last HP-IL message until the recording operation is completed. Additional data can then be processed in the same way.

2-73. When data is to be read from the tape, the processor enables the read/write circuit to read data, and then accepts the serial bits from the read/write circuit and stores the data in RAM. When the data is ready to be transmitted on HP-IL (all bytes have been read or RAM is full), the processor retrieves the data one byte at a time and sends it to the interface circuit, which transmits it on HP-IL. Remaining data is read and sent in the same way.

SECTION
III

Disassembly and Reassembly

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ie following procedures describe the steps necessary to disassemble and assemble the HP 82161A Digital Cassette Drive in order to replace or repair mponents that are faulty:

- Separating the Case (procedure 3-1).
- Removing the Transport Assembly (procedure 3-2).
- Replacing Door and Head-Frame Parts (procedure 3-3).
- Replacing a Drive Motor or Spline Parts (procedure 3-4).
- Replacing Drive PCA Parts (procedure 3-5).
- Replacing the Logic PCA, Switch, LED (procedure 3-6).
- Installing the Transport Assembly (procedure 3-7).
- Assembling the Case (procedure 3-8).

.sassembly and reassembly tools are listed in table 3-1. For additional .d, see the exploded views, figures 6-1 and 6-2.

Table 3-1. Recommended Tools

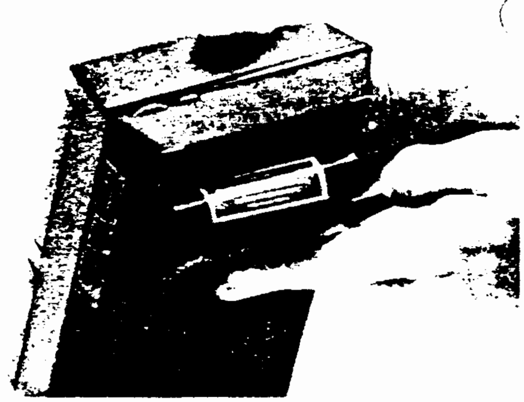
HP PART/MODEL NUMBER	DESCRIPTION
8710-1394	Bit, Torx T6, hex
8690-0227	Desoldering Tool, antistatic
8690-0253	Desoldering Tool Tip, antistatic
8710-1404	Handle, hex-bit
8710-0549	Pliers, needlenose
8710-0899	Screwdriver, Posidriv, #1
8730-0008	Screwdriver, small flat-blade
8690-0129	Soldering tool
8690-0132	Soldering tool stand
9300-0797	Static control table mat assembly
8710-0026	Tweezers
8700-0003	X-acto knife
8700-0006	X-acto knife blade

CAUTION

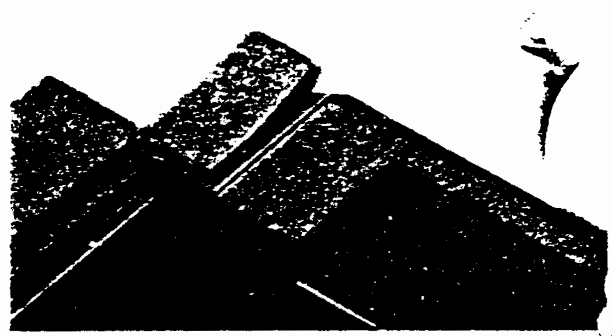
Be sure that you take adequate precautions regarding electrostatic protection. Work at a bench setup that is electrostatically protected. Otherwise, components may be damaged.

3-1. SEPARATING THE CASE

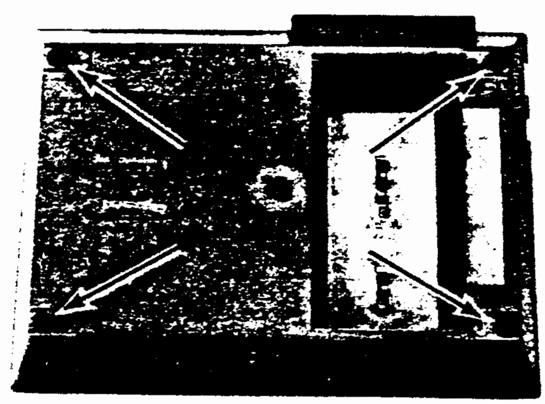
a. Remove the battery door and battery pack by sliding back the latches and then tipping the case.



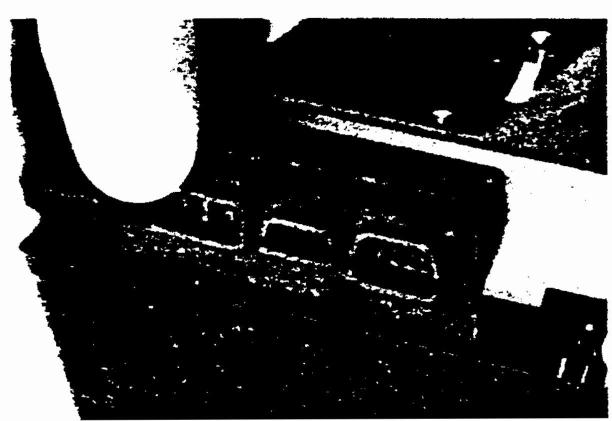
b. Remove and discard the four rubber feet from the bottom case. Peel them off using a pointed knife.



c. Remove the four screws from the bottom case. (The hole near the middle of the case is not used.)



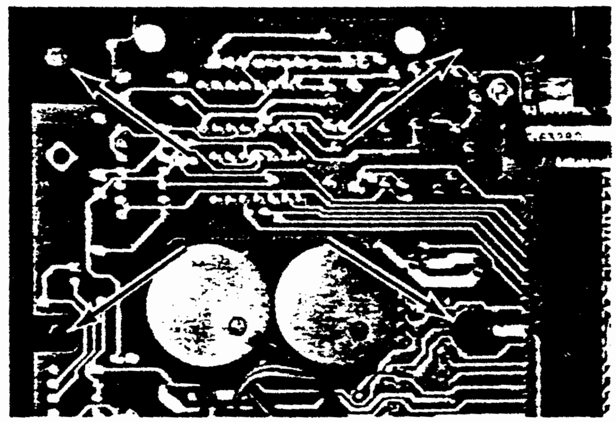
d. Lift off the bottom case, sliding out the I/O plate from the top case and invert the bottom case to the right. If necessary, separate the case completely by unplugging the two battery wires from the logic PCA (printed-circuit assembly).



. REMOVING THE TRANSPORT ASSEMBLY

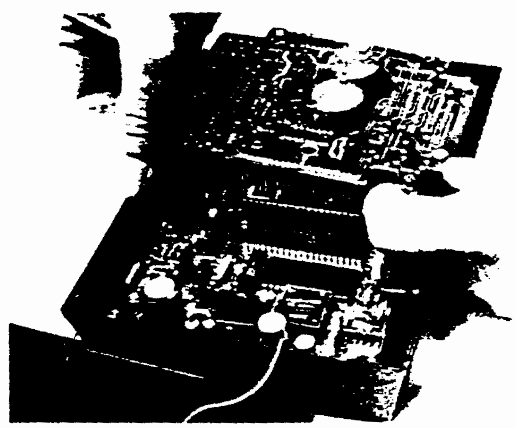
er separating the case (procedure 3-1):

Remove the four screws holding the transport assembly to the top case. These screws are located below the drive PCA.



Open the cassette door by pressing the OPEN key. (You must hold the transport assembly in place while you press the key.)

. Gently separate the contacts on the drive PCA from the connector on the logic PCA. Do this by rocking and lifting the drive PCA.



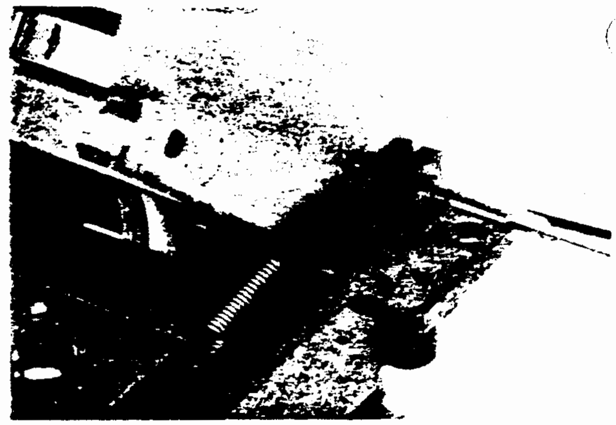
3-3. REPLACING DOOR AND HEAD-FRAME PARTS

After separating the case and removing the transport assembly (procedures 3-1 and 3-2):

a. If the head-frame assembly must be completely detached, unsolder the eight head wires from the PCA. Otherwise, these wires can remain attached.

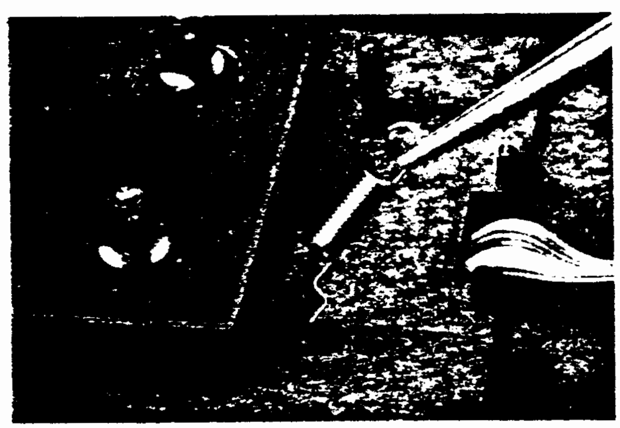
b. Open the cassette door by pressing down on the latch bar.

c. Remove the hinge pin by pulling it out with a pliers.

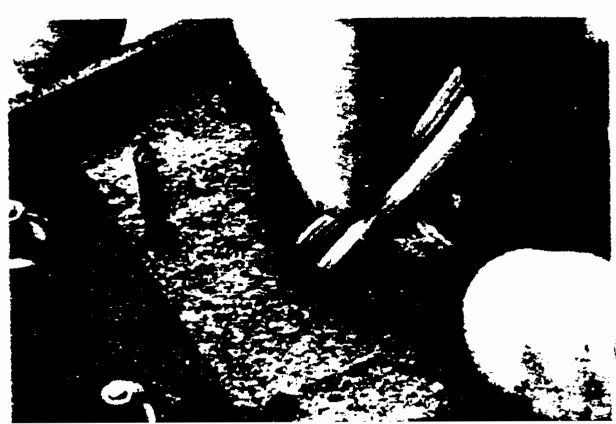


d. Remove the door assembly by swinging it forward and spreading the sides of the door where they hinge onto the head-frame assembly.

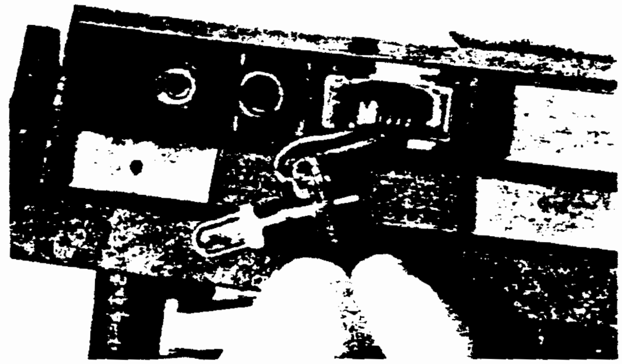
e. To replace or remove the head-frame assembly, unhook the door spring from the door and lift the assembly from the main frame.

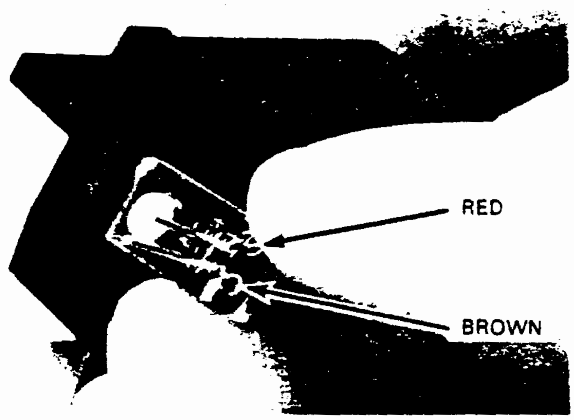


f. To install the head-frame assembly in the main frame, first slide the head wires through the hole in the main frame and hook the door spring to the head-frame assembly and the main frame.



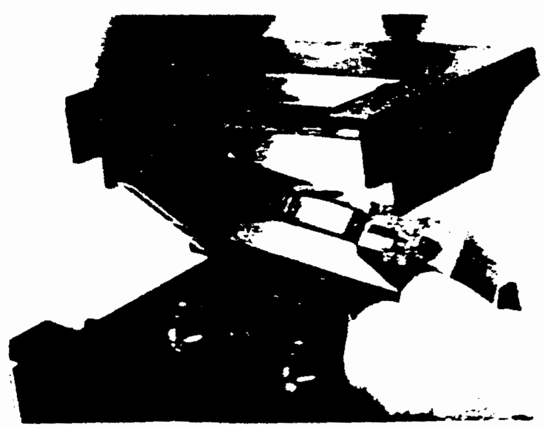
To replace the phototransistor, latch the head-frame into the main frame, remove the screw from the phototransistor PC board at the rear of the head-frame assembly, and swing out the PC board. Unsolder the phototransistor and install a new one (but don't solder it yet so it can properly seat). The lead by the flat side of the phototransistor goes in the hole with the square solder pad. Swing the PC board into position and install the screw and washer (next photo). Hold the phototransistor in its opening in the head-frame and solder its leads. Press on the latch bar and pull the head frame up.*





. Install the door assembly by inserting one door pin into one side of the door and pulling the door into place.

. Align the holes at the back of the door, head-frame, and main frame and insert the hinge pin.



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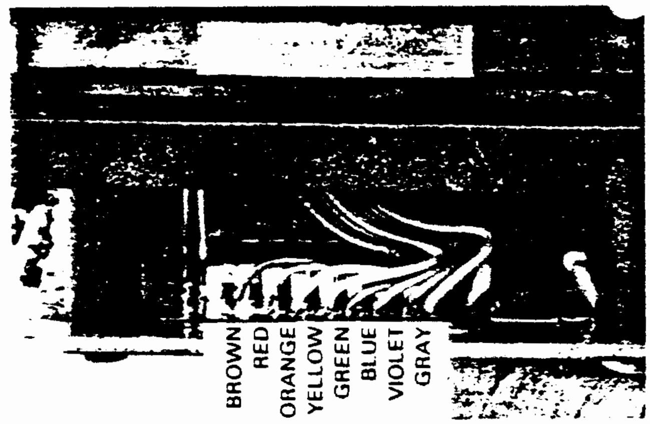
* On some early units, the position of the phototransistor and LED associated with the End-Of-Tape circuit are interchanged. On these units, the PC board in the rear of the head frame contains the LED. Additionally, the brown wire connects to the trace with the square solder pad (the brown and red wires are reversed).

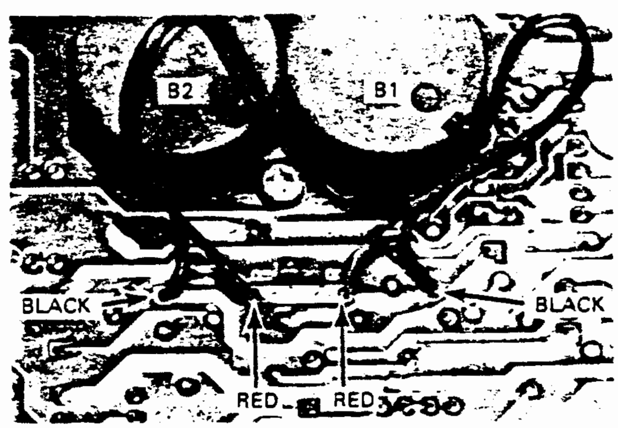
j. If necessary, solder the eight head wires to the drive PCA.



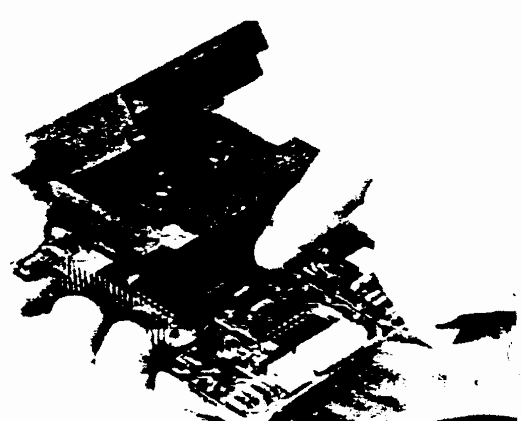
3-4. REPLACING A DRIVE MOTOR OR SPLINE PARTS

After separating the case and removing the transport assembly (procedures 3-1 and 3-2):

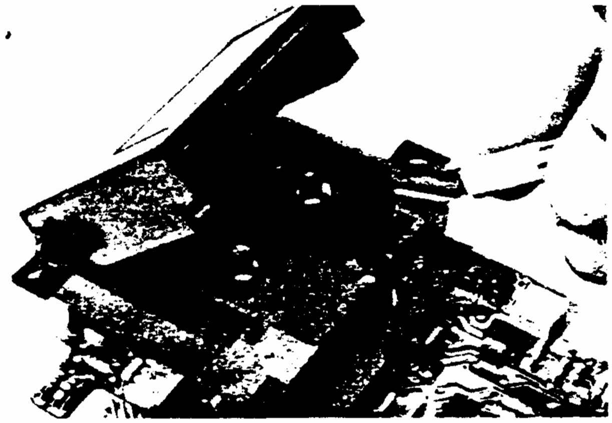
a. If necessary, unsolder the two appropriate motor wires from the drive PCA.



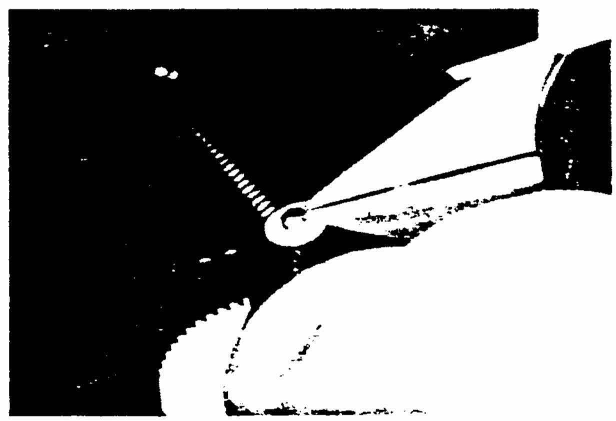
b. Open the cassette door by pressing down on the latch bar.



c. Pry the drive cover off the main frame using a sharp knife.

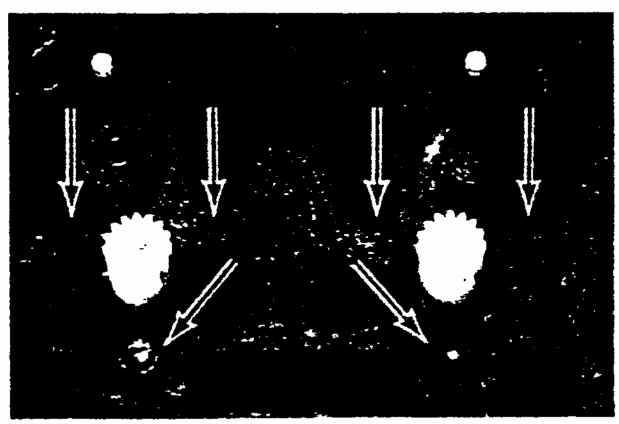


> CAUTION
> During the following steps, be careful not to bend or loosen the spline shafts.

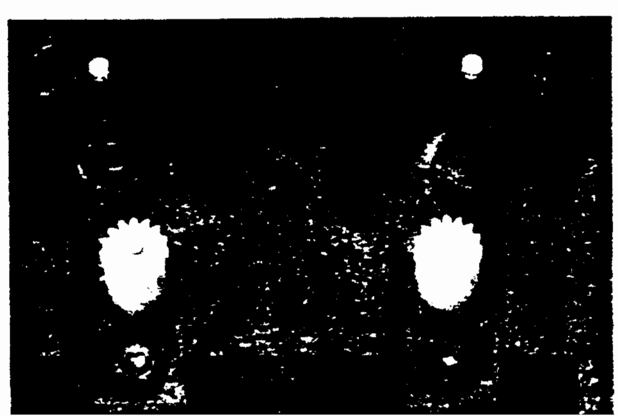


d. Remove the spline, snubber, gear, and spring by pushing down on the spline and removing the mylar washers from the shaft.

e. If necessary, remove the motor by unscrewing its three torx mounting screws.



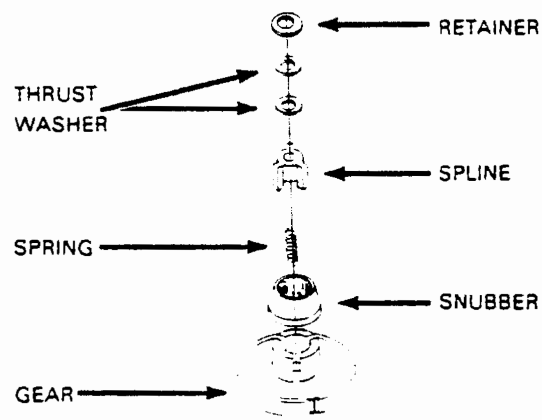
f. Install the motor by inserting its gear through the hole in the main frame and installing the three torx mounting screws.



CAUTION

Be sure the legs of the snubber are not folded or bent when the spline in installed.

g. Install the spring, gear, snubber and spline onto the shaft.

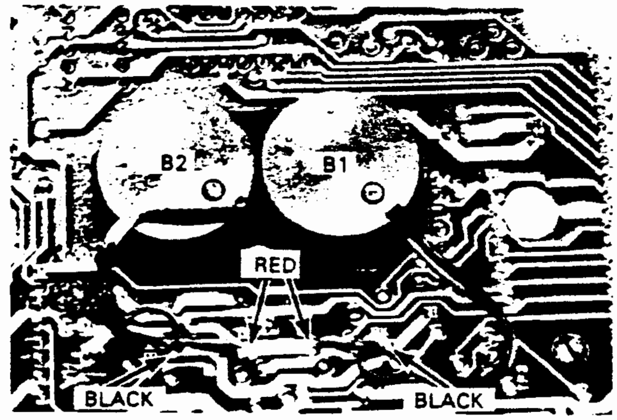


h. Push down on the spline and install the two nyletron washers and the mylar retainer washer onto the shaft.

i. Install a new cover on the main frame. The front edge is notched for proper orientation. Be sure it seats between the raised edges of the frame.

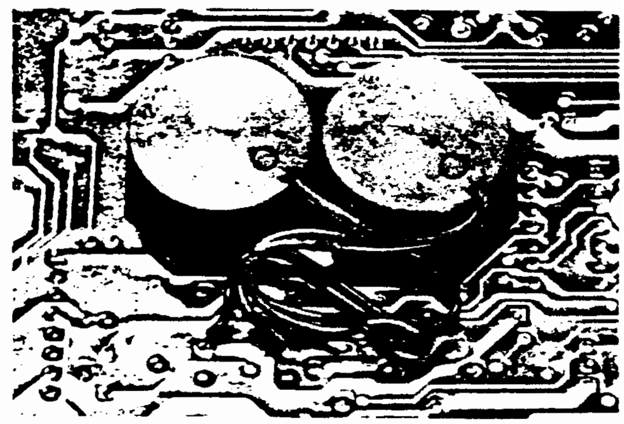
j. Close the cassette door.

k. Resolder the motor wires to the drive PCA as shown.



> CAUTION
>
> Be sure the wires are positioned as shown; otherwise, the wires might be damaged when the unit is assembled.

l. Position the motor wires as shown.

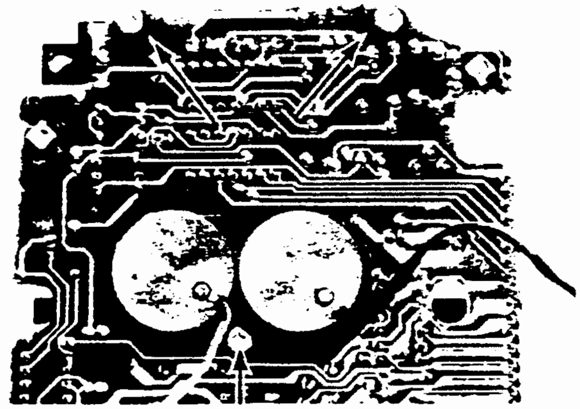


3-5. REPLACING DRIVE PCA PARTS

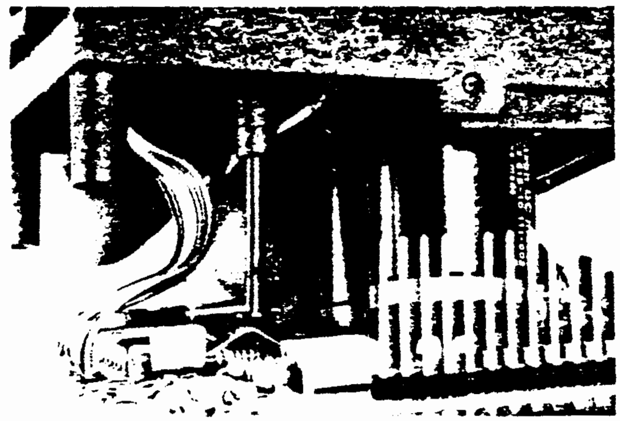
After separating the case and removing the transport assembly (procedures 3-1 and 3-2):

a. If necessary, unsolder the four motor wires from the PCA.

b. Remove the three screws holding the PCA to the main frame.

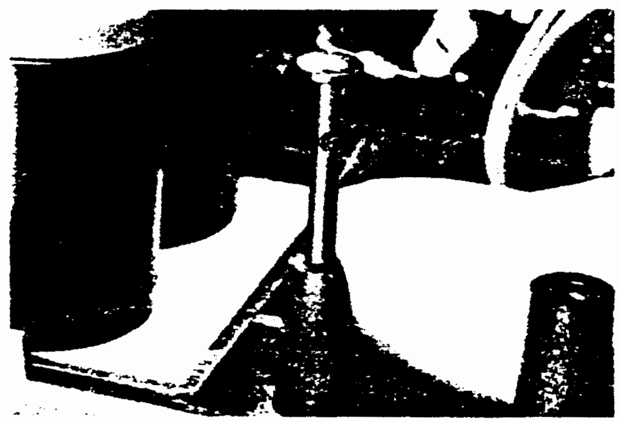


c. Tilt back the PCA. Avoid pulling on the head wires. Note that the cassette present pin is not retained in the main frame.

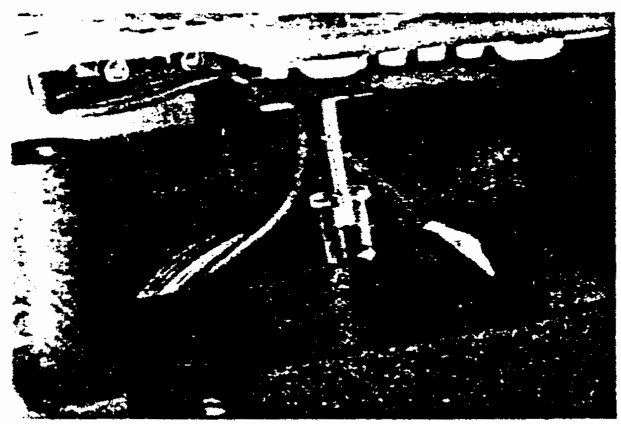


d. If necessary, replace the LED, but do not solder it in place. The lead by the flat on the side of the LED goes in the hole with the square solder pad.*

e. To reassemble the transport assembly, insert the plastic cassette present pin into the guide in the main frame.

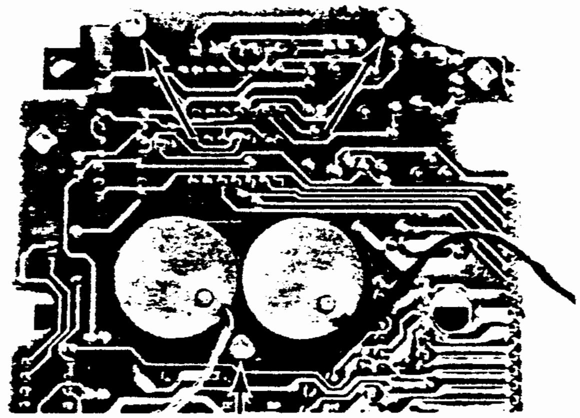


f. Place the drive PCA onto the main frame. Be sure the LED fits into its hole in the frame.

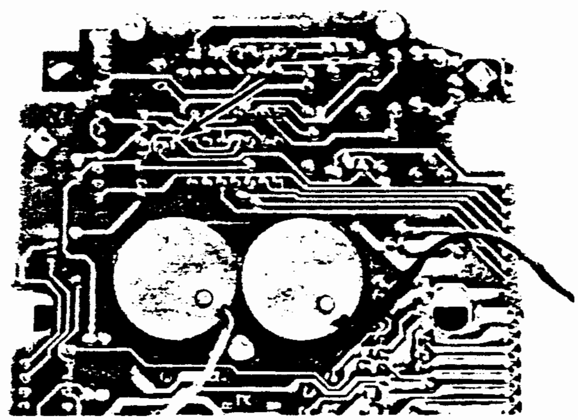


* On some early units, the positions of the LED and the phototransistor associated with the End-Of-Tape circuit are interchanged. On these units, the phototransistor is on the drive PCA. If it needs to be replaced, insert the lead by the flat side in the hole with the square solder pad. Do not solder the leads until step h.

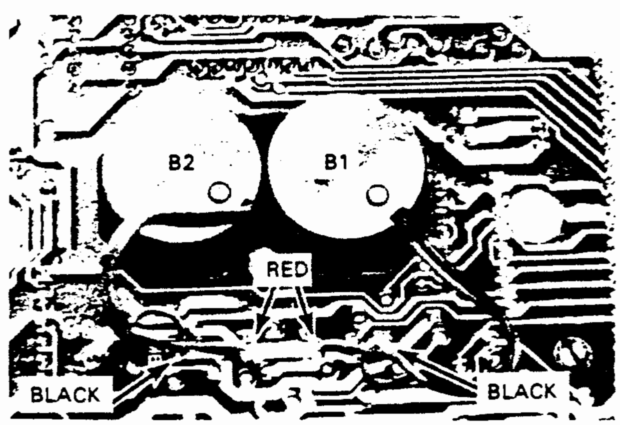
g. Install the three screws that hold the PCA to the main frame.



h. If necessary, solder the LED to the PCA, being sure that the LED is completely seated into the hole in the main frame.

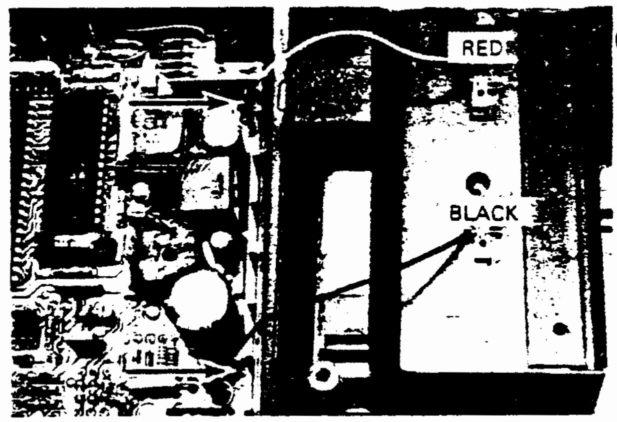


i. Resolder the motor wires to the PCA as shown.

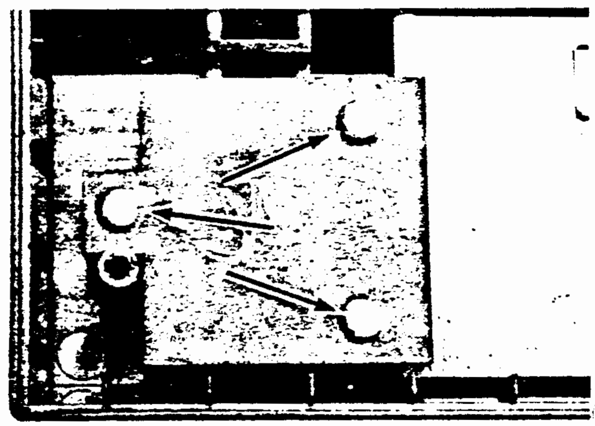


3-6. REPLACING THE LOGIC PCA, SWITCH, AND LED

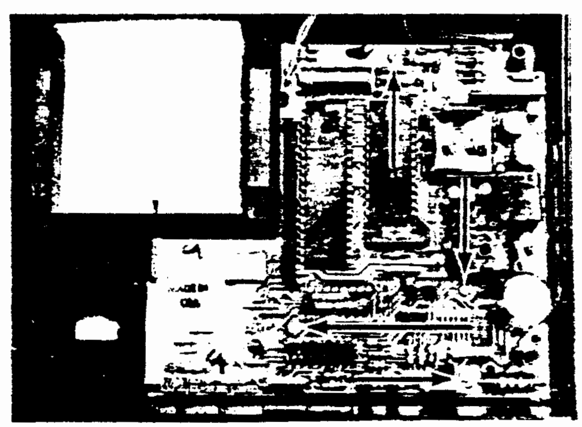
After separating the case and removing the transport assembly (procedures 3-1 and 3-2):



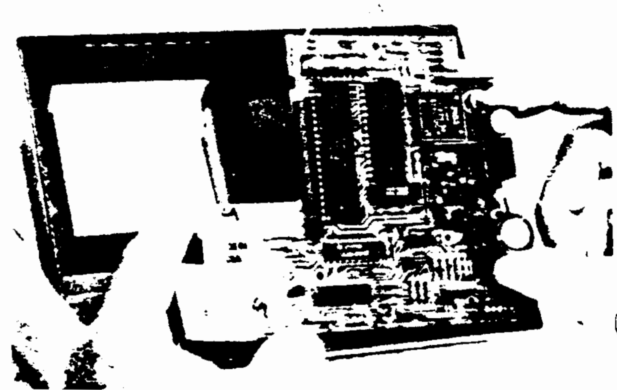
a. Unplug the two battery wires from the logic PCA.



b. Remove the key retainer by unscrewing the three screws and lifting it off. Remove the key.

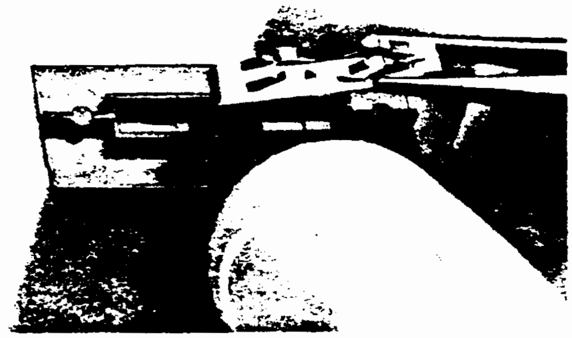


c. Unscrew the four screws holding the logic PCA to the top case.



d. Lift out the logic PCA. The rubber spacer and slide switch parts may stick to the PCA.

e. If necessary, replace and lubricate slide-switch parts. Install the flat side of the contact into the recess in the switch lever. Use a small amount of conductive silicon lubricant on the printed-circuit pads.

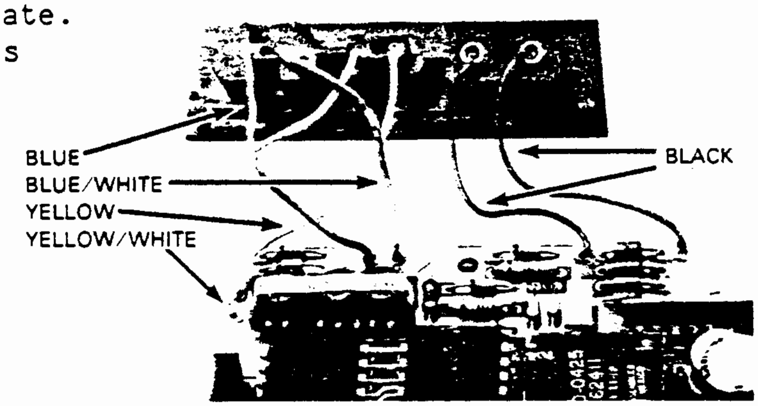


> CAUTION
> Maintain extreme cleanliness when replacing a snap-disc; otherwise, the switch may malfunction. Clean the printed-circuit pads with alcohol and handle the snap-disc with a clean tweezers, not your fingers.

f. If necessary, replace key-switch parts. The snap-disc on the reverse side of the PCA should be centered on the printed-circuit ring and held in place with mylar tape.

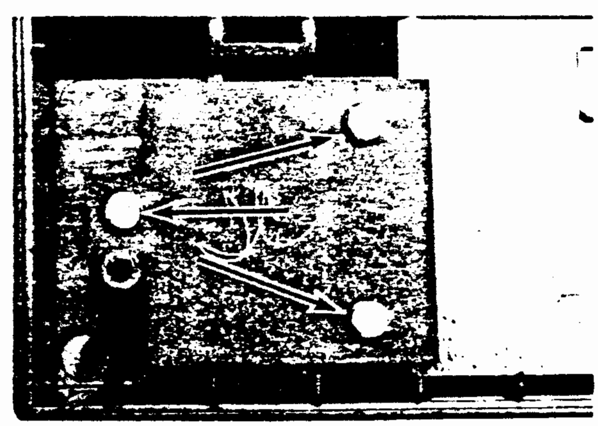
g. If necessary, replace an LED. Install it flush on the PC board and solder it in place. The lead by the flat side of the LED goes in hole with the square solder pad.

h. If necessary, replace the I/O plate. Be sure the wires are soldered as shown.

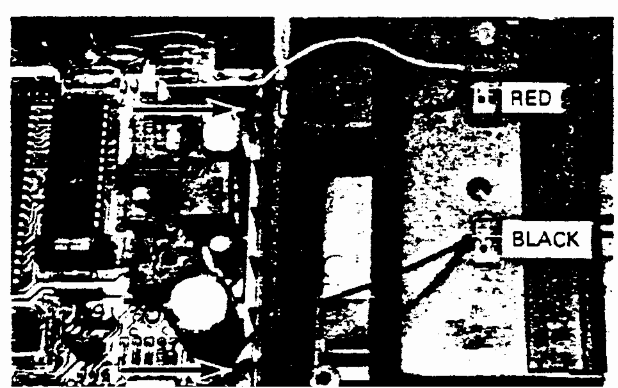


i. Install the logic PCA using the four screws. Be sure the rubber spacer is properly located around the last LED and protrudes through the cutout at the end of the PCA.

j. Install the key retainer using the three screws.



k. Connect the battery wires to the PCA as shown.

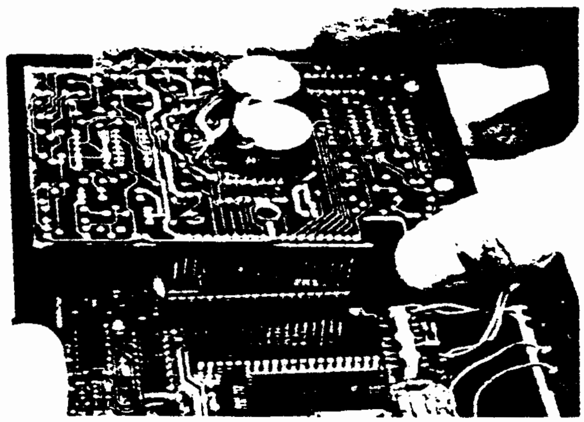


-7. INSTALLING THE TRANSPORT ASSEMBLY

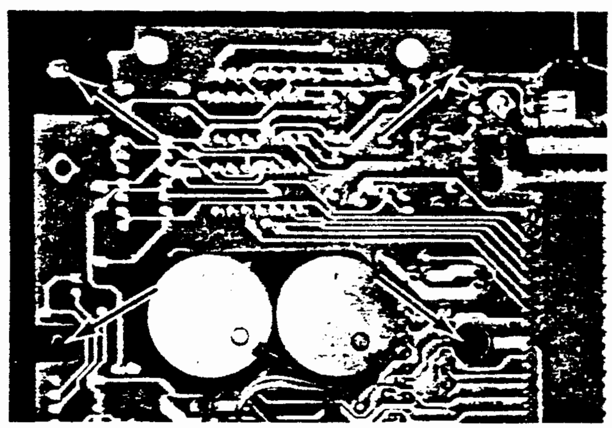
. Open the cassette door on the transport assembly by pressing the latch bar.

. Align and insert the contacts on the drive PCA into the connector on the logic PCA. Press down gently to ensure good contact.

. Close the cassette door.

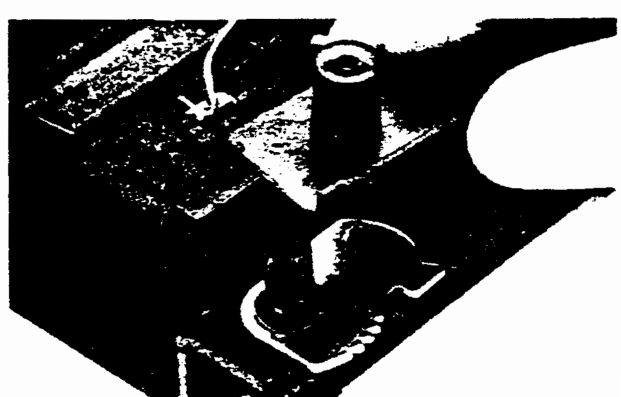


. Install the four screws that hold the frame assembly to the top case.



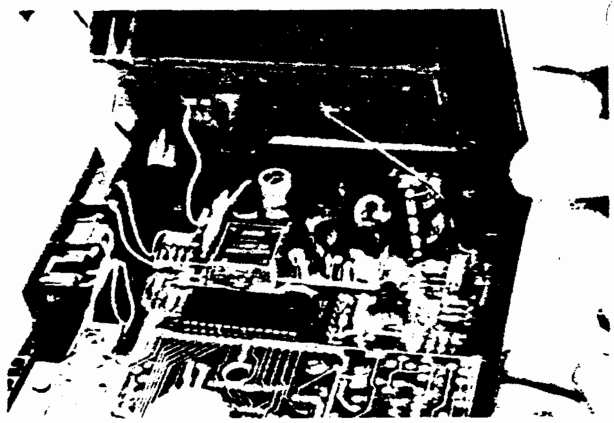
-8. ASSEMBLING THE CASE

. If security latch needs to be replaced, place the metal plate on the plastic peg with the spring washer on top. Then set the plastic retainer in place.

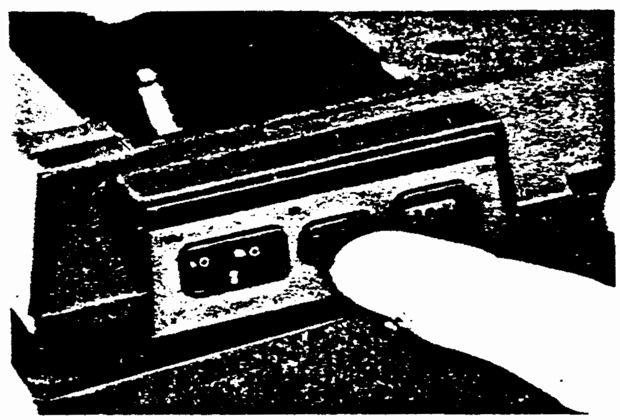


> CAUTION
> Be sure to position the wires as shown or they may be damaged or cut as the unit is assembled.

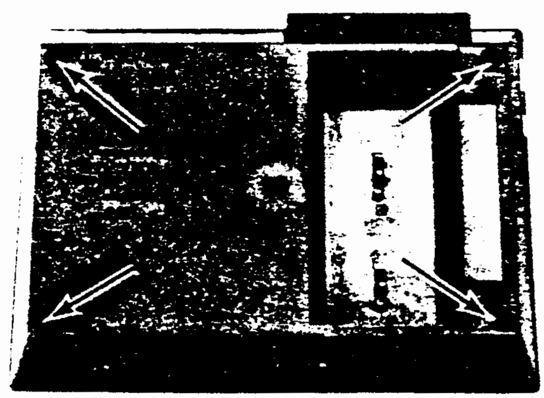
b. Position the wires as shown.



c. Place the bottom case onto the top case, locating the I/O plate in the grooves in the top case.

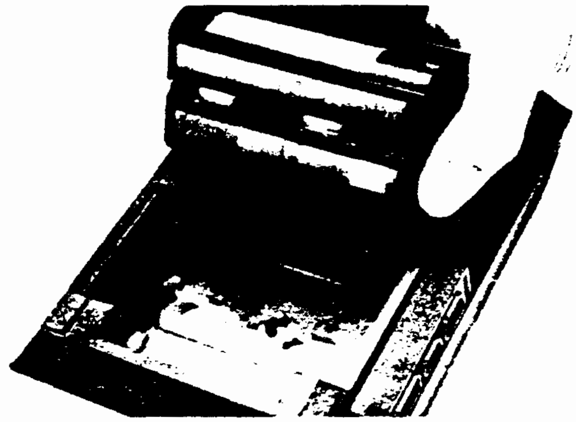


d. Install the four screws through the bottom case. The hole at the center of the case is not used.



e. Attach four new rubber feet in the recesses in the bottom case.

. Install the battery pack and battery door. The contacts on the battery pack should face and line up with the contact springs. Secure the door by sliding the latches outward.



SECTION
IV

Troubleshooting and Testing

4-1. INTRODUCTION

4-2. This section contains the procedures you should follow to isolate the cause of a problem in an HP 82161A Digital Cassette Drive. It also gives the procedure to verify that a unit is good. Tools that facilitate service are listed in table 4-1.

> **CAUTION**
>
> Ensure that adequate precautions are taken regarding electroststic protection. Work at a bench setup that is electrostatically protected. Otherwise, components may be damaged.

Table 4-1. Recommended Tools

HP PART/MODEL NUMBER	DESCRIPTION
82161-60905	Cassette, EOT tape
82161-60909	Cassette, formatted
82161-60906	Cassette, skew tape
82161-60910	Connector cable
0960-0062*	Continuity tester
82161-60908	Diagnostic program
82161-60907	Diagnostic ROM
82161-69901	HP 82160A HP-IL Module
HP 3469B*	Multimeter
HP 180C/1801A/1820C*	Oscilloscope
HP 10004*	Oscilloscope probe
HP 41CV*	Test Calculator

*Or equivalent.

4-3. The reference designators used in this manual have the following form:

```
A x Y x - z
| | | |   |
| | | |   +-- The pin designator found on the
| | | |       schematic.  This could be a number
| | | |       for an IC pin or an E, B, or C for
| | | |       the Emitter, Base, or Collector on
| | | |       a transistor.  The corresponding
| | | |       number or letter is shown on the
| | | |       schematic.
| | | |
| | | +------ The number of the discrete component
| | |         as shown on the schematic.
| | |
| | +-------- The discrete component designator.
| |           For example: U is for ICs, Q is for
| |           transistors, and R is for resistors.
| |
| +---------- The number of the assembly.
|
+------------ Means assembly.
```

For example A2U3-4 is printed circuit assembly 2 (drive PCA), IC 3, and pin 4; A1Q3-E is printed circuit assembly 1 (logic PCA), transistor 3, and E designates the emitter lead.

4-4. The test and repair section is devided into two parts. The first part is the test procedure, which should be completely stepped through each time a unit comes in for repair. This part should help you determine where the problems are and what table to refer to for troubleshooting the problems. If you branch to a table from the test procedure, you should return to and repeat the step in the test procedure and then continue stepping through the rest of the test procedure. Additionally, this first procedure should be completely stepped through after a unit is repaired to be sure the unit is operating properly.

4-5. The second part is the repair procedures, which enable you to repair any specific problem that is found by the test procedure. In some instances one table will refer you to another table. In all instances you should go back to the point from which you branched, to be sure the problem has been solved. For example, if you are in table 4-4, Improper Turn On, at step 1 and from there you refer to table 4-11, 5V Power Supply Circuit, return to and complete table 4-4 after you have completed table 4-11.

4-6. The repair tables list actions that you should take depending on the measurement you get. If no listed action corresponds to the measurement you get, you should simply proceed to the next step.

4-7. In the following procedures you will find lists of parts to be replaced. You should replace the parts one at a time in the order listed. Each time you replace a part you should repeat the measurement to see if the problem has been solved. When the problem is solved there is no need to replace any additional parts listed unless otherwise indicated. Before replacing any IC, be sure to check the power and ground connections. If the power input is bad, refer to either table 4-11, 5V Power Supply Circuit, or table 4-12, Motor Supply Circuit, after you have checked the traces.

4-8. INITIAL PREPARATION

4-9. Perform the following steps before attempting to troubleshoot the cassette drive:

a. Visually inspect the unit for physical damage. Replace any components that are visibly damaged.

b. Determine the customer's concern, if possible. Frequently the customer includes with the unit a message describing the problem.

- If the problem relates to the rechargeable battery pack or recharger, test them according to the procedures in section V.

- For other problems with the unit, perform the test and repair procedure (paragraph 4-10).

4-10. TEST PROCEDURE

4-11. Disassemble the unit into its two major assemblies, as shown in

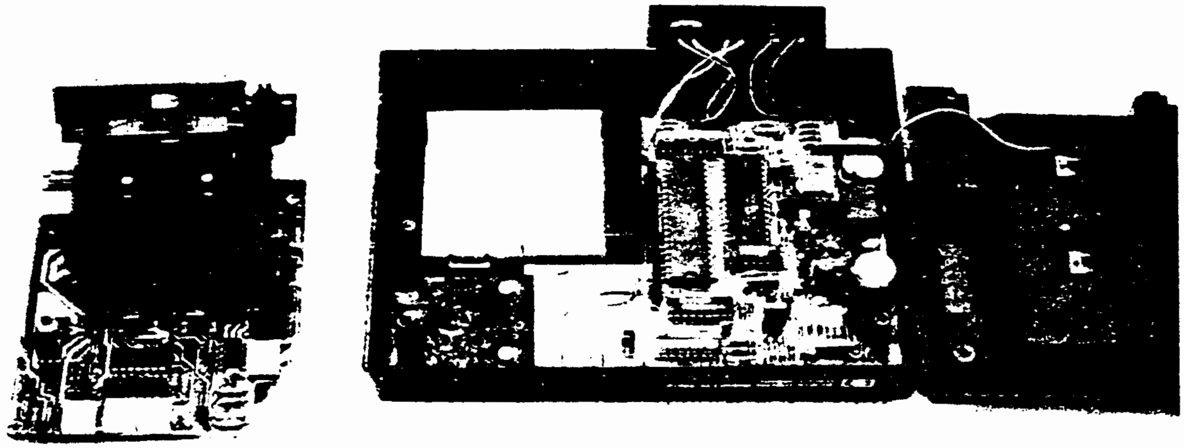


Figure 4-1. Major Assemblies

4-12. Connect the connector cable, 82161-60910, onto the connector pins on the transport assembly and insert the connector cable pins into the socket on the logic PCA as shown in figure 4-2. The connector cable comes with two different connector pin groups. One group has all the pins intact and is used initially as well as thoughout most of the tests. The other connector pin group has pins 3, 4, 5, 6, and 7 removed and is used in troubleshooting the read/write circuit. (See figure 4-3.)

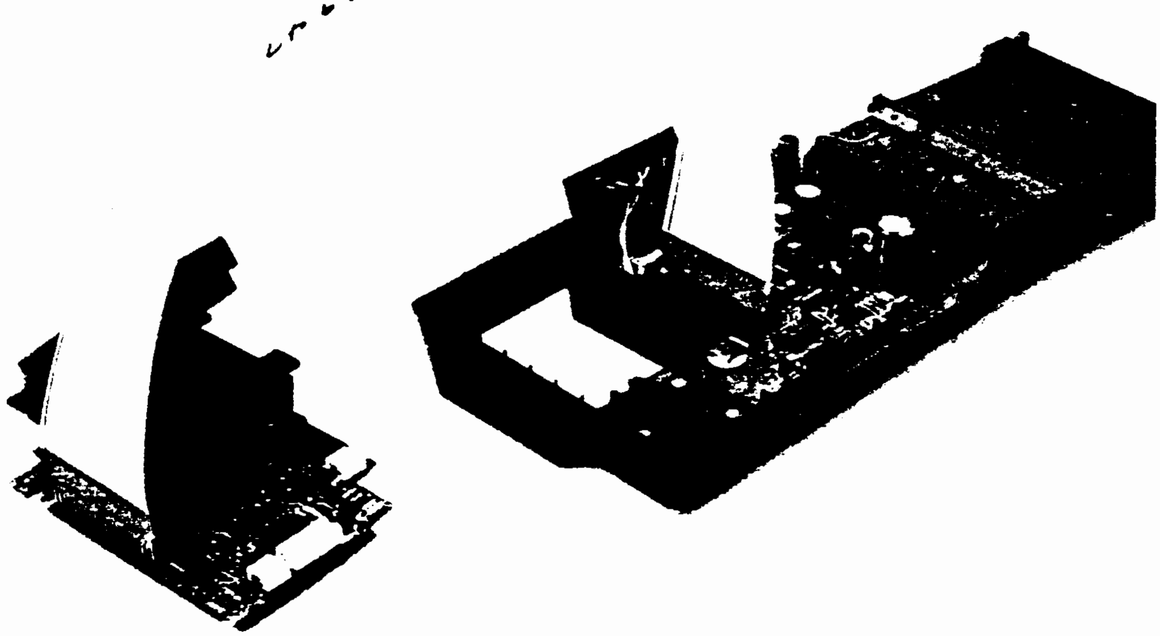


Figure 4-2. Assemblies and Connector Cable

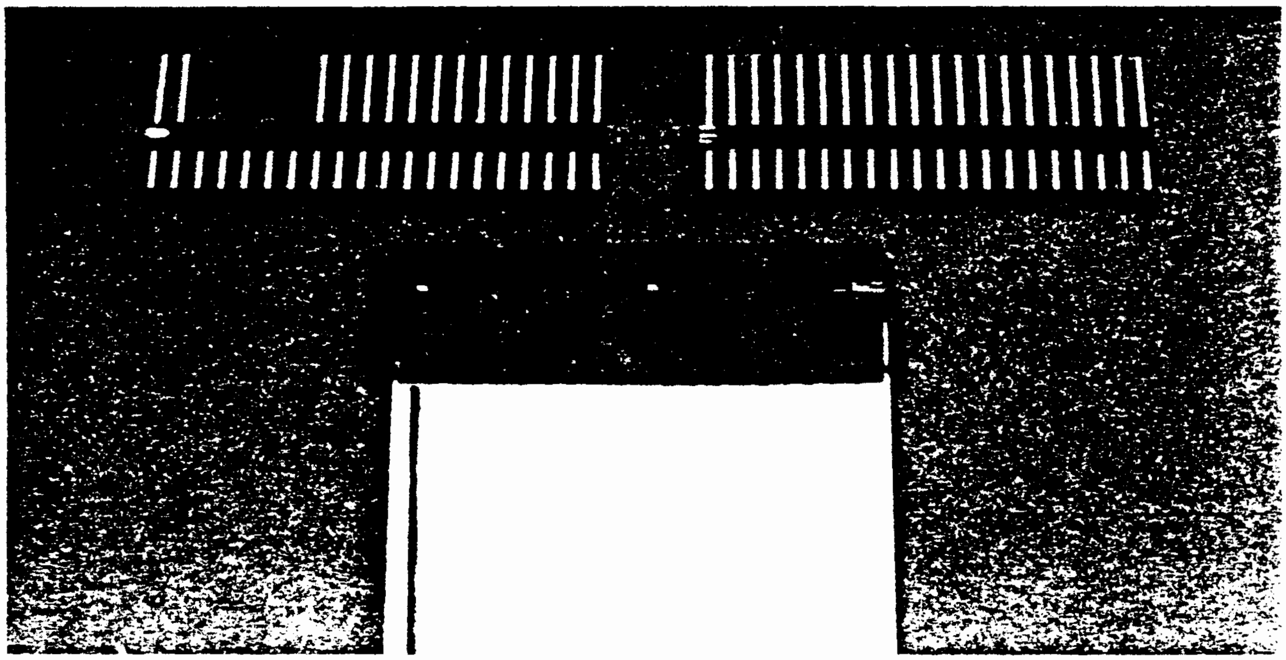


Figure 4-3. Connector Cable

4-13. Perform the following steps to determine the causes of improper operation of the cassette drive. For reference information concerning component locations and part numbers, use figures 7-1 through 7-6 and tables 6-1 through 6-4.

a. Turn OFF-STANDBY-ON switch to the ON position while the cassette drive is disconnected from the interface loop (and no cassette installed).

   - If the POWER light turns on and the BAT light stays off, the unit is operating properly. Proceed with step b.

   - If any other response occurs, determine and repair the cause using the procedure in table 4-4, Improper Turn On. Then repeat this step.

b. Observe the POWER light as you switch the unit from ON to STANDBY, then to OFF and to STANDBY. Finally turn the unit ON.

   - If the POWER light stays on when switched from ON to STANDBY, and if the POWER light stays off when switched from OFF to STANDBY, then the circuit is operating properly. Proceed with step c.

   - If the POWER light operates in any other manner, check the standby

c. Insert a cassette that is positioned somewhere on the recording surface (not on the clear leader or at the index hole) and close the cassette door. Observe how the tape is moved by the drive.

- If the tape rewinds normally, then moves forward slowly, and stops with the index hole positioned as shown in figure 4-4, the unit is operating properly. Remove the cassette and examine the position of the index hole. The hole should be approximately 3 mm (1/8 in.) past the hole in the cassette. Proceed with step d.

- If any other response occurs, be sure the cassette is good. Then repair the cause using the procedure in table 4-6, Improper Tape Positioning.

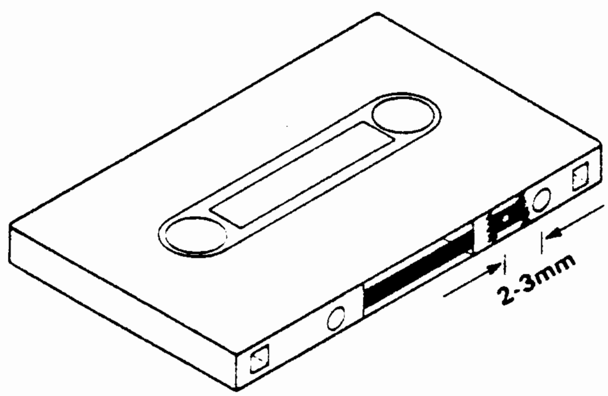


Figure 4-4. Index Hole Position

d. Insert a cassette and observe the BUSY light.

- If the light goes on while the tape is moving and goes off when the tape stops, the light is operating properly. Proceed with step e.

- If any other response occurs repair the unit using the procedure in table 4-7, BUSY Light Circuit.

e. Press the [REWIND] key.

- If the tape rewinds to clear leader and stops, the unit is operating properly. Proceed with step f.

- If any other response occurs, do the following in order and check to see if the problem has been solved after you perform each step: measure the continuity across snap disc A1S2 while pressing the [REWIND] key. If continuity is good replace processor A1U3. If contiuity is bad, check traces, then clean or replace snap disc A1S2.

f. Perform the following adjustments in the order specified. If any of the adjustments cannot be made successfully, go to the beginning of that table and troubleshoot the circuit until the problem is solved and the adjustment can be successfully made. Then return here and continue from where you left off.

1. Adjust the motor drive circuit. Perform steps F16 through F25 in table 4-15, Motor Drive Circuit.

2. Adjust the stall circuit. Perform steps 6 through 8 in table 4-8, Stall Circuit.

3. Adjust the end-of-tape (EOT) circuit. Perform steps 4 through 9 in the table 4-13, End-Of-Tape Circuit.

4. Adjust the read/write circuit. Perform steps 1, 2, 6, 7, and 15 in table 4-14, Read/Write Circuit.

g. Insert the stall tape. The stall tape is made by covering the EOT hole on the front left side of the cassette with a piece of opaque tape, as shown in figure 4-5. The piece of opaque tape prevents the EOT circuit from working.

- If the tape rewinds to the end of the clear leader, locks up, and the motors shut off within about 0.5 seconds, the unit is working properly. Proceed with step h.

- If any other response occurs repair the unit using the procedures in table 4-8, Stall Circuit.

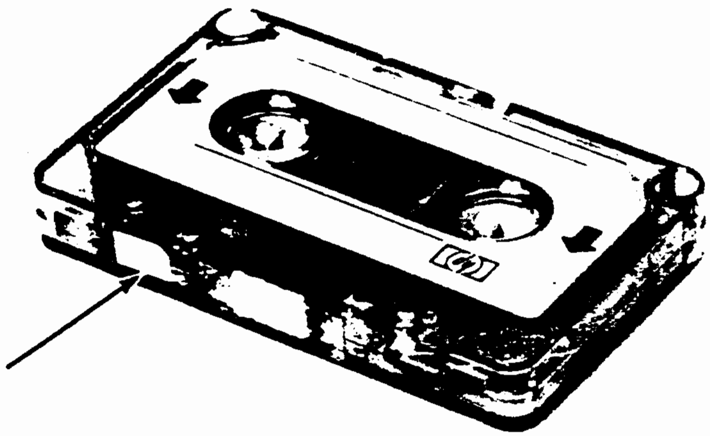


Figure 4-5. Stall Tape

. Turn OFF-STANDBY-ON switch to the off position and connect the cassette drive to the test calculator system, which consists of an HP-41CV calculator (or an HP-41C calculator and an HP 82170A Quad-Memory Module), an HP 82160A HP-IL Module, an 82161-60907 Diagnostic ROM, and an HP 82143A Printer (optional). (See figure 4-6.)

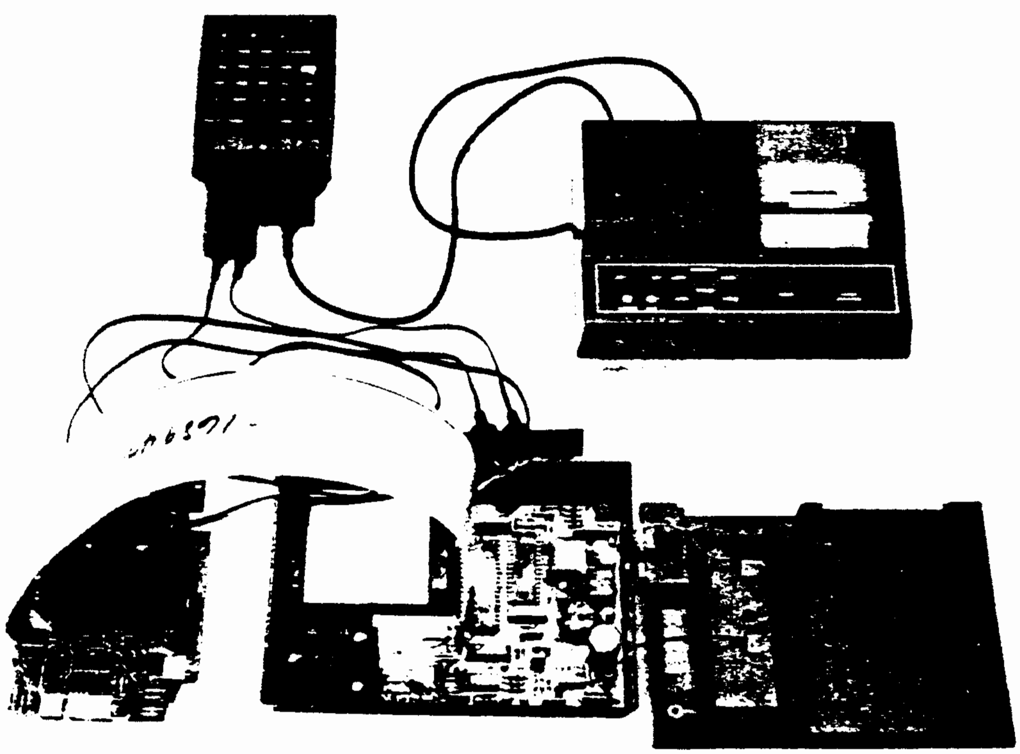


Figure 4-6. Test System

i. Turn the OFF-STANDBY-ON switch on the cassette drive to the ON position and then to the standby position. Turn the printer and the calculator on. Set the printer to MAN mode. Be sure you set the printer switch to DISABLE on the HP-IL Module.

j. Insert a formatted test cassette into the drive. An unformatted tape will cause a status error 18, stall error.

k. If necessary load the diagnostic program DRVTST from the the magnetic cards into the test calculator.

l. Execute the diagnostic program DRVTST. A listing of the program can be found at the end of this section in table 4-17.

m. Note the messages displayed and printed. As the program runs, you will see the flags 0 through 4 turned on at different points in the program. A tone is sounded each time one flag is turned off and the next flag is turned on.

- If you see the messages LOOP INTACT and PASSED, the unit is OK. When the unit passes the four tone "beep" will sound. Proceed with step m.

- Any other response indicates improper operation. Refer to table 4-2, Program Error Messages, for the action required for any error message displayed. Five identical tones will sound if the unit does not pass.

n. If you made any repairs or adjustments, repeat this entire test procedure to verify proper operation.

Table 4-2. Program Error Messages

MESSAGE	ACTION
AAD (Auto Address) ERROR	Replace in order A1U4 (HP-IL IC) and A1U3 (processor).
AAU (Auto Address Unconfigure) ERROR	Replace in order A1U4 (HP-IL IC) and A1U3 (processor).
CPU ERROR	Replace in order A1U4 (HP-IL IC), A1U5 (RAM), and A1U3 (processor).
DDT3 (Device Dependent Talker 3: Send Position) ERROR	Replace A1U3 (processor). (Position should be track 1, record 10, and byte 50.)
HP-IL ERROR	Refer to table 4-16, HP-IL Circuit.
LOOP DEAD	Check your HP-41CV, your HP 82160A HP-IL Module, and all interconnects. Then refer to table 4-16, HP-IL Circuit.
LPD (Loop Power Down) ERROR	Check OFF-STANDBY-ON switch; it should be in the STANDBY position. If switch is in the STANDBY position refer to table 4-9, Improper Power Down.
LPU (Loop Power Up) ERROR	Refer to table 4-10, Improper Power Up.
MCL (Master Clear) ERROR	Replace your HP-IL module.

Table 4-2. Program Error Messages (Continued)

MESSAGE	ACTION
NOT NEW TAPE	Replace A1U3 (processor). (The processor did not detect a new tape.)
P-W (Partial Write) ERROR	Frist refer to table 4-14, Read/Write Circuit, then if you still have this error, replace in order A1U3 (processor) and A1U4 (HP-IL IC).
RAM ERROR	Replace in order A1U5 (RAM), A1U4 (HP-IL IC), and A1U3 (processor).
R/W (Read Write) ERROR	Refer to table 4-14, Read/Write Circuit.
STATUS n ERROR (n is the error number)	Refer to table 4-3, Status Errors.

Table 4-3. Status Errors

NUMBER	CONDITION	DEFINITION	ACTION
0-15	Idle condition	No error and not executing a previuous command.	None.
16		Not used.	
17	End Of Tape Error	Unexpectedly reached end of tape.	Refer to table 4-13, End-Of-Tape Circuit, then refer to table 4-15, Motor Drive Circuit.
18	Stall Error	Tape has stalled.	Make sure the tape is properly formatted. Then in the following order refer to table 4-13, End-Of-Tape Circuit, table 4-15, Motor Drive Circuit, and table 4-8, Stall Circuit.
19	End/Stall Error	End-of-Tape and Stall conditions.	In the following order refer to table 4-13, End-Of-Tape Circuit, table 4-15, Motor Drive Circuit, and table 4-8, Stall Circuit.
20	No Tape Error	No tape installed in drive.	Check cassette present switch A2S1, clean and replace if necessary.
21	Device Error	No tape installed and stall.	Refer to table 4-8, Stall Circuit.
22	Device Error	No tape installed and End-Of-Tape.	Refer to table 4-13, End-Of-Tape Circuit.

Table 4-3. Status Errors (Continued)

NUMBER	CONDITION	DEFINITION	ACTION
23	New Tape Error	A new tape has been inserted but not positioned.	Replace A1U3 (processor).
24	Time out Error	No data detected on tape.	Check tape to be sure it is good, then in the following order refer to table 4-14, Read/Write Circuit, and replace A1U3 (processor).
25	Record Number Error	Retrieved record number not as expected.	Be sure tape is good, then in the following order refer to table 4-14, Read/Write Circuit, and replace A1U3 (processor).
26	Checksum Error	Computed checksum differs from expected.	Be sure tape is good, then in the following order refer to table 4-14, Read/Write Circuit, and replace A1U3 (processor).
27		Not used.	
28	Size Error	Specified Track number greater than 1.	Check diagnostic program for program misload or errror.
29-31		Not used.	
32-63	Busy Condition	Device is executing a previous command. This is not an error.	

4-14. REPAIR PROCEDURES

4-16. In the following tables, test points for discrete components are indicated as "right", "left", "front", or "rear" according to the conventions labeled in figures 7-1 through 7-6. Both PCAs shown are with the component side up. For example, right refers to a lead that is toward the right side of the board, and rear refers to a lead that is toward the back of the board. These references are given for components such as resistors, capacitors, and jumper wires, or where the designated lead cannot be specified in any clearer way.

Table 4-4. Improper Turn-On

Use these procedures to correct an improper response when the cassette drive is turned ON. Be sure the battery pack is good before starting. Begin troubleshooting the unit at the appropriate symptom listed below.

STEP	SPECIFICATION	ACTION
A. SYMPTOM: POWER light does not turn on.		
1. Measure 5V supply at the left side of jumper A1W1.	4.9V to 5.1V	If out of range refer to table 4-11, 5V Power Supply Circuit.
2. Measure A1U2-8.	4.9V to 5.1V	If out of range check traces.
3. Measure anode A1DS3 (5V supply) at the round solder pad.	4.9V to 5.1V	If out of range check traces.
4. Measure A1U2-9.	4.7V to 4.8V	
5. Measure A1U2-14.	0V to 0.5V	

Table 4-4. Improper Turn-On (Continued)

STEP	SPECIFICATION	ACTION
6. Measure A1DS3 cathode at the square solder pad.	less than 3.2V	If A1U2-9 and A1U2-14 are in range and DS3 cathode is above range, replace A1R16. If A1U2-9 is 4.9 to 5.1V and A1U2-14 is above range, replace A1U2, then A1U7. If A1U2-9, A1U2-14, and A1DS3 cathode are below range, replace A1DS3.
B. SYMPTOM: BATTERY light is on and POWER light is on.		
1. Measure A1U2-7.	greater than 4.6V	If less than 4.6V, check traces to battery, clean switch A1S1 (OFF-STANDBY-ON), then replace in order A1C9 and A1R13.
2. Measure A1U1-1 (5V reference) at the square solder pad.	4.9V to 5.1V	If A1U1-1 is out of range refer to table 4-11, 5V Power Supply Circuit.
3. Measure A1U2-6	4.4V to 4.6V	If A1U2-6 is out of range, check traces, then replace in order A1U7, A1R16, and A1C6.
4. Measure A1U2-1	greater than 3V	If A1U2-1 is below range, replace A1U2.

Table 4-4. Improper Turn-On (Continued)

STEP	SPECIFICATION	ACTION
C. SYMPTOM: BATTERY light is on and POWER light is off.		
1. Measure A1U1-1 (5V reference) at the square solder pad.	4.9V to 5.1V	If greater than range refer to table 4-11, 5V Power Supply. In this situation the most likely problem is that A1U1 is regulating above range or A1CR8 is shorted. If below range, perform both of the following: replace A1U2 and refer to table 4-11, 5V Power Supply Circuit. If within range, first refer to symptom A above where switch A1S1 is ON and the power light is off. Then refer to symptom B above where switch A1S1 is ON and both the battery light and power light are on.

Table 4-5. Standby Circuit

Use this procedure to repair the standby circuit when it is not operating properly. The standby circuit controls the POWER light and power supplies when the unit is switched to STANDBY.

STEP	SPECIFICATION	ACTION
1. Switch unit from ON to STANDBY.	POWER light on.	If POWER light is on, go to step 8.
2. Measure A1Q1-E by measuring the lead on the right side of A1R2.	4V to 7V	If out of range, check or clean switch A1S1, then replace A1R1.
3. Temporaraily connect A1Q2-C to ground and disconnect it before you go to step 4.	POWER light should turn on.	If POWER light does not turn on, replace in order A1Q1, A1Q8, A1R4, and A1R21.
4. Switch unit to ON.		
5. Measure A1Q2-B.	0.5V to 1V	
6. Measure A1Q3-E.	3V to 5V	If A1Q2-B is out of range and if A1Q3-E is below range, replace A1U3 (processor). If A1Q3-E is in range, and A1Q2-B is out of range, replace in order A1CR5, A1R3, and A1R23.
7. Measure A1Q2-C.	0V to 0.5V	If out of range, replace A1Q2.

Table 4-5. Standby Circuit (Continued)

STEP	SPECIFICATION	ACTION
8. Switch unit from OFF to STANDBY.	POWER light off	If POWER light is off, the circuit is good and there no need to proceed further in this table.
9. Switch unit to OFF.		
10. Measure A1Q2-B.	0V	If out of range, replace A1Q7.
11. Switch unit to STANDBY.		
12. Ground A1Q2-B.		If POWER light turns off, replace A1Q3.
13. Measure A1Q2-C.	greater than 4.5V	If below range, replace A1Q2. If within range, replace in order A1R2, A1R21, A1Q1 and A1Q8.
14. Disconnect ground from A1Q2-B.		

Table 4-6. Improper Tape Positioning (Continued)

STEP	SPECIFICATION	ACTION
2. Disconnect the connector cable and ground connector pin A1J9-1.		
3. Measure connector pins A1J9-11 through A1J9-15. Note: At this point processor should be indicating rewind.	During rewind, pins 12, 13: 0V to 0.5V pins 11, 14, 15: 3V to 5V	If pins measure different than indicated in specification, replace A1U3 (processor).
4. Disconnect A1J9-1, ground connector pin A1J9-9, then ground A1J9-1 again. Note: This should cause the processor to indicate slow forward.		
5. Measure connector pins A1J9-11 through A1J9-15.	During slow forward, pin 15: 0V to 0.5V pins 11-14: 3V to 5V	If pins measure different than indicated in specification, replace A1U3 (processor).
6. Disconnect ground from connector pins A1J9-1 and A1J9-9.		

Table 4-6. Improper Tape Positioning (Continued)

STEP	SPECIFICATION	ACTION
7. Reconnect connector cable.		If it was not neccessary to replace the A1U3 (processor) in steps D3 to D5 above, refer to table 4-15, Motor Drive Circuit.
E. SYMPTOM: Tape goes fast forward.		
1. Disconnect connector cable.		
2. Measure connector pins A1J9-11 through A1J9-15.	During fast forward, pins 11, 15: 0V to 0.5V pins 12-14: 3V to 5V	If the pins measure as indicated in specification, replace A1U3 (processor). If the pins measure different than indicated in specification, refer to table 4-15, Motor Drive Circuit.
3. Reconnect connector cable.		

Table 4-7. BUSY Light Circuit

Use this procedure to repair the BUSY light circuit when it is not operating properly. The BUSY light should be on whenever the motors are operating or the processor is performing an HP-IL operation.

STEP	SPECIFICATION	ACTION
1. Measure A1DS1 Anode (5V Supply) at the round solder pad.	4.9V to 5.1V	If out of range, refer to table 4-11, 5V Power Supply Circuit.
2. Measure A1U2-10.	2.6V to 2.9V	If out of range, refer to table 4-12, Motor Supply Circuit.
3. Connect A1U2-11 to ground.	BUSY light (A1DS1) on	If BUSY light is on, check traces to A1U3-26, then replace A1U3.
4. Measure A1U2-13.	0V to 0.5V	If A1U2-13 is out of range, replace A1U2. If A1U2-13 is in range, replace in order A1DS1 and A1R16.
5. Remove ground connection at A1U2-11.		

Table 4-8. Stall Circuit

Use the procedure in this table to repair the stall circuit when it is not operating properly. The stall circuit should cause a low input to the processor on the STAL line whenever the motors stall. The processor should subsequently set all the motor lines high.

STEP	SPECIFICATION	ACTION
1. Insert stall tape. Note: Most measurements need to be measured before, during, and after the momentary stall condition.		
2. Monitor A1U3-13.	Goes from high to low to high.	If only high to low is observed and the stall does not occur (all moter lines high), replace A1U3.
3. Monitor A2U1-13	Goes from high to low to high.	If only high to low is observed, check traces from A2U1-13 to A1U3-13
4. Measure A2U1-11 and A2U1-8	2.5V to 2.7V	If out of range check A2U9 in steps 13 and 14 of this table, then return here. If A2U9 is good, then check traces.
5. Remove the stall tape.		
6. Temporarily install a 138-ohm, 5W resistor between ground and A2Q1-E (the square solder pad).		Note: This provides a current halfway between stall and run currents.

Table 4-8. Stall Circuit (Continued)

STEP	SPECIFICATION	ACTION
7. Monitor A2U1-14 and adjust A2R7.	Toggles between 0.5V and 5V when adjusting A2R7 to either side of the threshold.	Adjust A2R7 so that A2U1-14 just toggles low. If A2U1-14 does not toggle, try to adjust A2R7 using steps 8 through 12. After finishing step 12, come back to this step and adjust A2R7 after reconnecting the 138-ohm resistor.
8. Remove the 138-ohm resistor.		
9. Insert stall tape.		
10. Measure A2U1-9.	Less than 2.6V before and after tape stalls. Greater than 2.6V during stall.	If A2R7 cannot be adjusted within range, replace in order until operational A2R7, A2Q1, A2Q2, A2R5, and A2R6.
11. Measure A2R8 at the rear lead.	4.9V to 5.1V	If out of range, refer to table 4-11, 5V Power Supply Circuit.
12. Measure A2U1-10 and A2U1-14.	Goes from 0-0.5V to 4.9-5.1V to 0-0.5V.	If does not go to 5V, replace in order A2R8, A2C2, and A2U1. If does not go to ground (0V to 0.5V), replace in order A2C2 and A2U1.
13. Measure A2U9-I (5V Supply).	4.9V to 5.1V	If out of range refer to table 4-11, 5V Power Supply Circuit.
14. Measure A2U9-O.	2.5V to 2.7V	If out of range, replace in order A2U9 and A2C4.

Table 4-9. Improper Power Down

Use the procedure in this table to repair a unit when the diagnostic program is unable to power down the unit.

STEP	SPECIFICATION	ACTION
1. Turn switch A1S1 ON, then to STANDBY.		
2. Temporarily connect A1Q3-E (square solder pad) to ground. Remove the ground connection.	POWER light should turn off.	If unit turns off, replace A1U3.
3. Measure A1Q6-E.	4.9V to 5.1V	If out of range, refer to table 4-11, 5V Power Supply Circuit.
4. Measure A1Q6-B.	4.1V to 4.4V	If out of range, replace in order A1R16 and A1Q6.
5. Measure A1Q6-C.	4.7V to 4.9V	If out of range replace in order A1Q3, A1R6, A1R16, and A1C1.

Table 4-10. Improper Power Up

Use the procedure in this table to repair a unit when the diagnostic program is unable to power up the unit. Be sure a good battery has been installed.

STEP	SPECIFICATION	ACTION
1. Measure A1Q7-C.	4.5V to 6.5V	If out of range, check traces to battery.
2. Using an oscilloscope, monitor A1Q7-B as an HP-IL message is sent on the loop.	pulses that reach 1.2V to 1.7V	If out of range, replace A1R5, then refer to table 4-16, HP-IL Circuit. If within range, replace A1R5, A1Q7.

Table 4-11. 5V Power Supply Circuit

Use this procedure to repair the 5V power supply circuit when it is not operating properly. The 5V power supply circuit provides power to many of the ICs and is a logic input for many of the ICs.

STEP	SPECIFICATION	ACTION
1. Turn the power switch to ON.		
2. Measure A1U2-4 and A1U2-8.	4.9V to 5.1V	If within range, 5V power supply is good. If pin 4 is within range and pin 8 outside, check A1W1.
3. Temporarily unsolder the left lead of jumper A1W1.		
4. Measure A1U2-4.	4.9V to 5.1V	If within range, check for excessive current load. Separate the logic PCA from the drive PCA and reconnect jumper W1. If the 5V supply comes back to proper range, then the excessive load is on the drive PCA, otherwise it is on the logic PCA. Disconnect jumper W1 again.
5. Measure A1U7-7.	16V to 19V	If out of range, check traces then refer to table 4-12, Motor Supply Circuit.
6. Measure A1U2-5 (reference voltage).	4.9V to 5.1V	If out of range, check traces then replace in order A1CR8, A1U1, and A1C5.

Table 4-11. 5V Power Supply Circuit (Continued)

STEP	SPECIFICATION	ACTION
7. Measure A1U2-2.		If 5V supply is above range and A1U2-2 is below 5V, replace in order A1Q5, A1Q4, and A1U7. If 5V supply is above range and A1U2-2 is above 15V, replace A1U2. If 5V supply is below range and A1U2-2 is below 5V, replace A1U2. If 5V supply is below range and A1U2-2 is above 15V, replace in order A1Q4, A1Q5, A1R11, A1CR9, A1T1, A1C7, and A1C8.
8. Reinstall jumper A1W1.		

Table 4-12. Motor Supply Circuit

Use this procedure to repair the motor supply circuit when it is not operating properly. The motor supply circuit provides the power to drive the motors and provides power to many of the ICs.

STEP	SPECIFICATION	ACTION
1. Turn the power switch to ON.		
2. Measure A1PS1-5 and A1U1-3. (18V supply). This trace can be reached at the right lead of A1C4.	17V to 19V	If within range, motor supply is good.
3. Measure A1PS1-4 (battery voltage at motor supply). This trace can be reached at the left lead of A1C2.	4.5V to 6.5V	If below range, check battery, traces, and switch A1S1. Then replace in order A1C2 and A1R22.
4. Measure A1U1-1 (5V reference).	4.9V to 5.1V	
5. Measure A1PS1-2. This trace can be reached at the rear lead of A1R7 and A1R8.	2.65V to 2.84V	If A1U1-1, A1PS1-2, and A1U1-4 are within range, replace A1PS1. If A1U1-1 is within range and A1PS1-2 is out of range, replace A1R7 and A1R8. If 18V supply below 8V and A1U1-1 is low, replace in order A1CR6, A1CR7, A1PS1, and A1C5. If A1U1-3 (18V supply) is out of range and A1U1-1 (reference) is out of range replace in order A1CR8, A1R7, A1R8, A1U1, and A1C5.

Table 4-13. End-Of-Tape (EOT) Circuit

Use this procedure to repair the EOT circuit when it is not operating properly. The EOT circuit detects clear leader or the hole on the tape, and initiates a low input on the EOT line to the processor.

Some early units have the positions of A2DS1 and A3Q1 interchanged. If A2R20 is a fixed resistor, you have one of these early units. (See figures 7-2, 7-3, 7-5, and 7-6.) If you have one of these early units, use the procedure in section B of this table. Otherwise use the procedure in section A of this table.

STEP	SPECIFICATION	ACTION
A. LATE-STYLE EOT REPAIR PROCEDURE		
1. Measure A2DS1 anode at the round solder pad.*	4.9V to 5.1V	If out of range, refer to table 4-11, 5V Power Supply Circuit.
2. Measure A2U2-11. This trace can be reached at the right lead (square solder pad) of A2DS1.	3V to 4V	If out of range replace in order A2DS1 and A2R21.
3. Physically check the alignment of A2DS1 and A3Q1.	Shoulder should be tight and square.	Adjust as needed.
4. Insert EOT tape so the index hole will be in front of phototransistor A3Q1.		
5. Adjust A2R20 while measuring A2U2-10. The trace to A2U2-10 can be reached at A2J5-1.	4.60V	Adjust A2R20 until A2U2-10 is 4.60V. If it will not adjust to 4.65V replace in order A3Q1, A2DS1, and A2R20.

Table 4-13. End-Of-Tape (EOT) Circuit (Continued)

STEP	SPECIFICATION	ACTION
6. Measure A2U2-13.	0V to 0.5V	If out of range replace A2U2.
7. Remove the EOT tape and reinstall it so the index hole is not in front of the A3Q1 (phototransistor).		
8. Measure A2U2-10.	less than 0.2V	If A2U2-10 is greater than 0.2V, replace A3Q1.
9. Measure A2U2-10 while adjusting A2R20.	0.25V	Adjust A2R20 so that A2U2-10 is 0.25V. (If A2R20 will not adjust up to 0.25V, adjust it as high as it will go.) If A2R20 will not adjust at all, replace in order A3Q1 and A2R20.
8. Measure A2U2-13.	3V to 5V	If below range, replace in order A2U2 and A1U3.

* A2DS1 and A3Q1 are reversed on some early units. Refer to section B, Early Style EOT Repair Procedure.

Table 4-13. End-Of-Tape (EOT) Circuit (Continued)

STEP	SPECIFICATION	ACTION
B. EARLY-STYLE EOT REPAIR PROCEDURE On some early units the positions of A2DS1 and A3Q1 are interchanged. However, the part numbers are not changed. In the following procedure, LED and phototransistor will be used as the reference designators. Whenever the LED is needs to be replaced, use the part number for A2DS1. Whenever the phototransistor needs to be replaced, use the part number for A3Q1. Additionally, A2R20 is one of four fixed resistors. The position of the red and brown wires are also reversed on the EOT PC board (A3) on these early units. See the note on the schematic, figure 7-4. The loading diagrams of the early and late style drive PCAs are in figures 7-2, 7-3, 7-5, and 7-6. Also, refer to paragraph 6-7.		
1. Measure the collector lead of the phototransistor at the square solder pad.	4.9V to 5.1V	If out of range, refer to table 4-11, 5V Power Supply Circuit.
2. Measure A2U2-11. This trace can be reached at A2J5-1.	3V to 4V	If out of range replace in order A2DS1 and A2R21.
3. Physically check the alignment of the LED and phototransistor.	Shoulder should be tight and square.	Adjust as needed.
4. Insert EOT tape so the index hole is not in front of the LED.		
5. Measure A2U2-10.	0.25V	If out of range, replace A2R20 with the 26.1K resistor.

Table 4-13. End-Of-Tape (EOT) Circuit (Continued)

STEP	SPECIFICATION	ACTION
6. Measure A2U2-10.	A2U2-10 needs to be as close to 0.25V as possible without going above 0.25V.	If below range, replace A2R20 with increasing values of A2R20* until range is good. If it will not come up to range, replace in order the LED, the phototransistor, and A2R21. If above range, replace A2R20 with decreasing values of A2R20* until range is good. If it will not decrease to range, replace in order the LED, the phototransistor, and A2R21.
7. Measure A2U2-13.	3V to 5V	If below range, replace in order A2U2 and A1U3.
8. Remove the EOT tape and reinstall it so the index hole is in front of the LED.		
8. Measure A2U2-13.	0V to 0.5V	If out of range, replace A2U2.

* The suggested resistor values are 17.8K, 23.7K, 26.1K, and 34.8K. Refer to table 6-4 for part numbers.

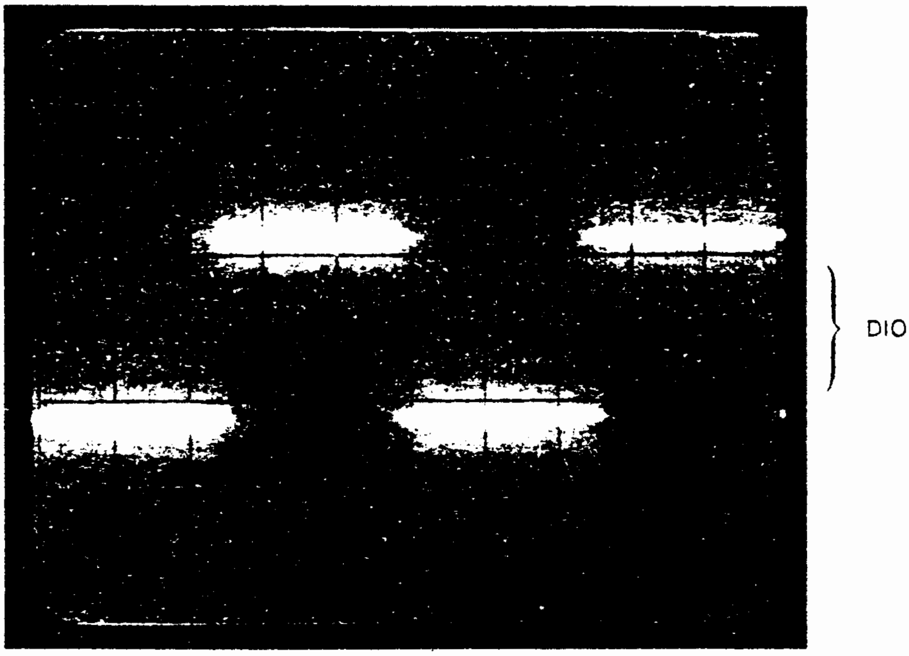
Table 4-14. Read/Write Circuit

Use this procedure to rapair the read/write circuit when the diagnostic program indicates a read/write error.

STEP	SPECIFICATION	ACTION
1. Remove the pin connector from the cable connector and install the pin connector with pins 3,4,5, 6, and 7 removed.		
2. Ground connector pin A2J6-3 on the drive PCA.		
3. Measure A2U3-8.	0V to 0.5V	If out of range, check traces.
4. Measure A2U3-9.	4.9V to 5.1V	If out of range, check traces, connector, and 5V refer to table 4-11, 5V Power Supply Circuit.
5. Measure A2U3-10.	4.5V to 5.1V	If below range, replace A2U3.
6. Set up a TTL-compatible square-wave generator.	4 KHz at 5V	
7. Connect the generator to connector pin 4 on the drive PCA. This will simulate a DIO signal.		Check A2U6-4 for a good signal from the generator. If the signal is not good check traces.

Table 4-14. Read/Write Circuit (Continued)

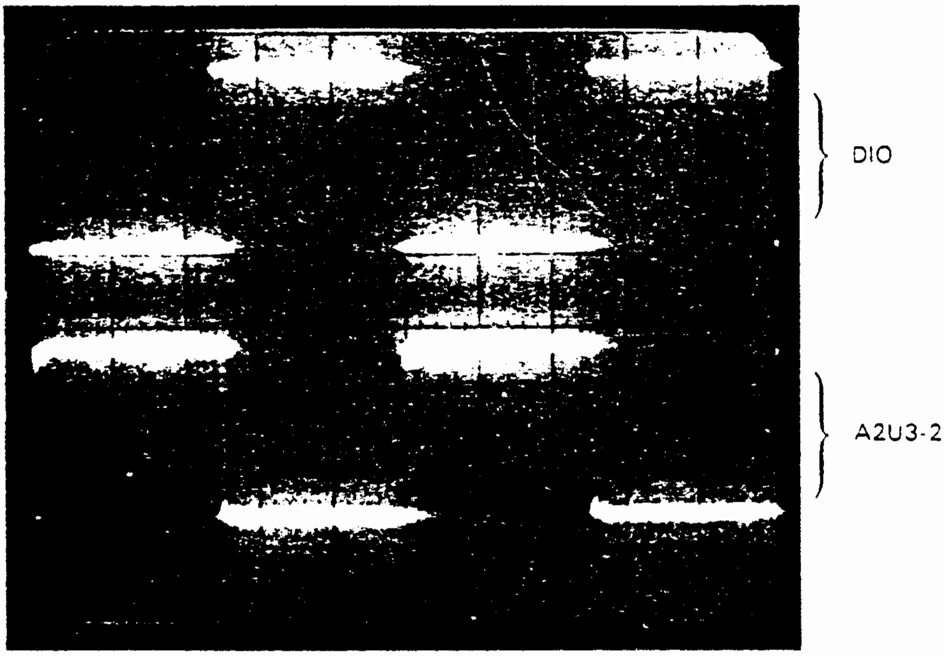
STEP	SPECIFICATION	ACTION
In steps 8 through 19 check the waveform patterns at the specified points with an oscilloscope. The following figures will show only two traces at a time. See figure 2-5 for the relative timing of all the patterns.		
8. Measure DIO at A2U3-1, A2U3-13, and A2U5-2.	DIO signal in photo below	If out of range check setting on square wave generator and traces.



Vertical: 2 V/div. Horizontal: 0.1 ms/Div

Table 4-14. Read/Write Circuit (Continued)

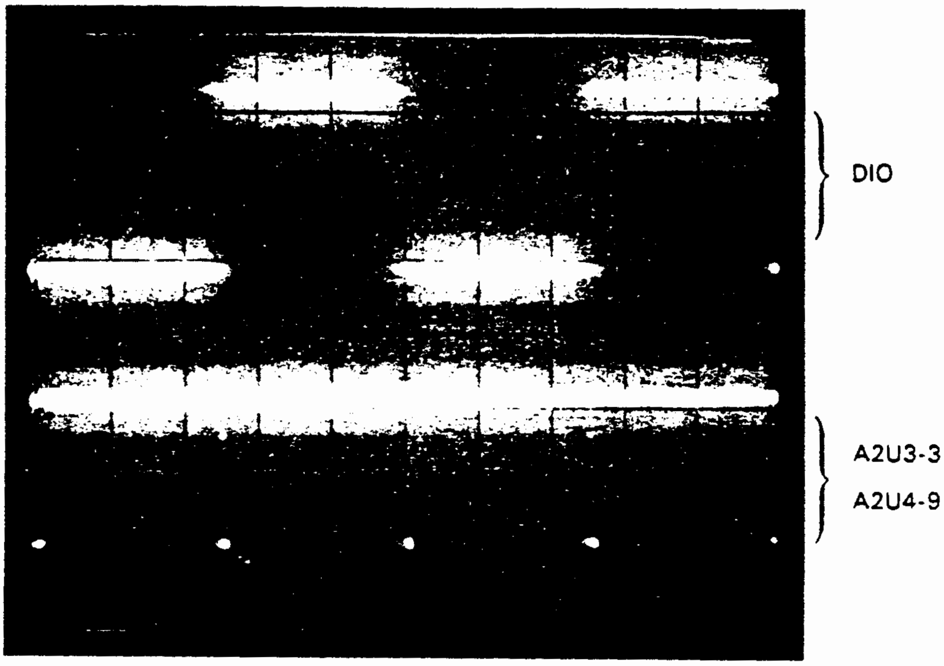
STEP	SPECIFICATION	ACTION
9. Monitor A2U3-2 and A2U3-11.	A2U3-11 signal in photo below.	If A2U3-11 is not toggling, replace A2U3. If the charging and discharging curves are out of range, replace A2C12. If A2U3-2 is out of range, check traces.



Vertical: 2 V/div. Horizontal: 0.1 ms/div.

Table 4-14. Read/Write Circuit (Continued)

STEP	SPECIFICATION	ACTION
10. Monitor A2U3-3 and A2U4-9.	A2U3-3 signal in photo below.	If A2U3-3 and A2U4-9 is not toggling as shown in photo below, replace A2U3.

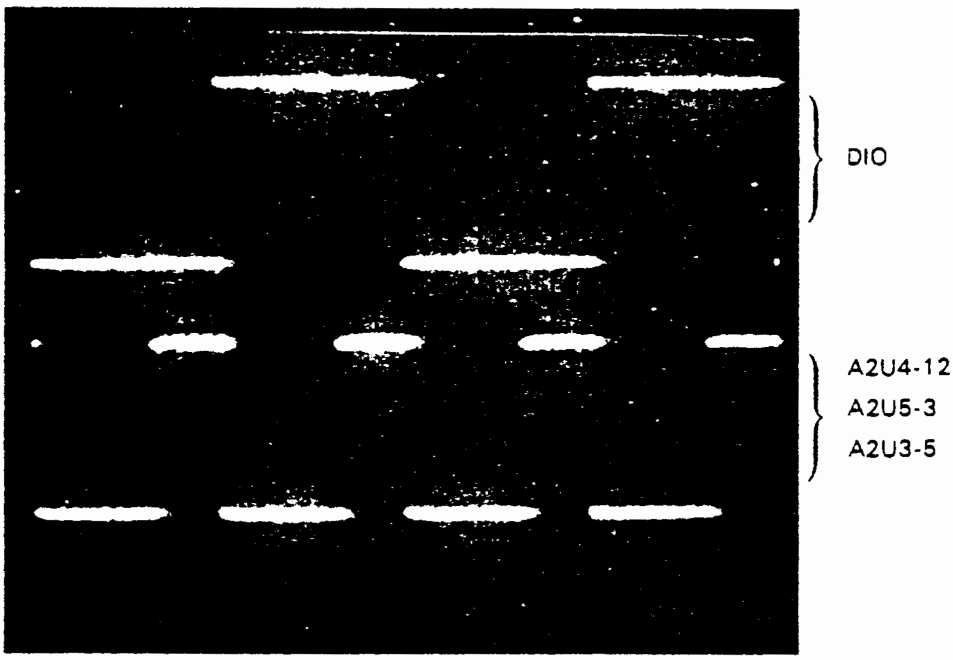


Vertical: 2 V/div. Horizontal: 0.1 ms/div.

STEP	SPECIFICATION	ACTION
11. Measure A2U4-11.	4.9V to 5.1V	If out of range, check traces, connector, and refer to table 4-11, 5V Power Supply Circuit.
12. Measure A2U3-6.	0V (ground)	If out of range, check traces.
13. Measure 5V input to A2R22. This trace can be reached at A2U8-8 or at the rear solder pad of A2R22 on the bottom of the board.	4.9V to 5.1V	If out of range, check traces, connector, and table 4-11, 5V Power Supply Circuit.

Table 4-14. Read/Write Circuit (Continued)

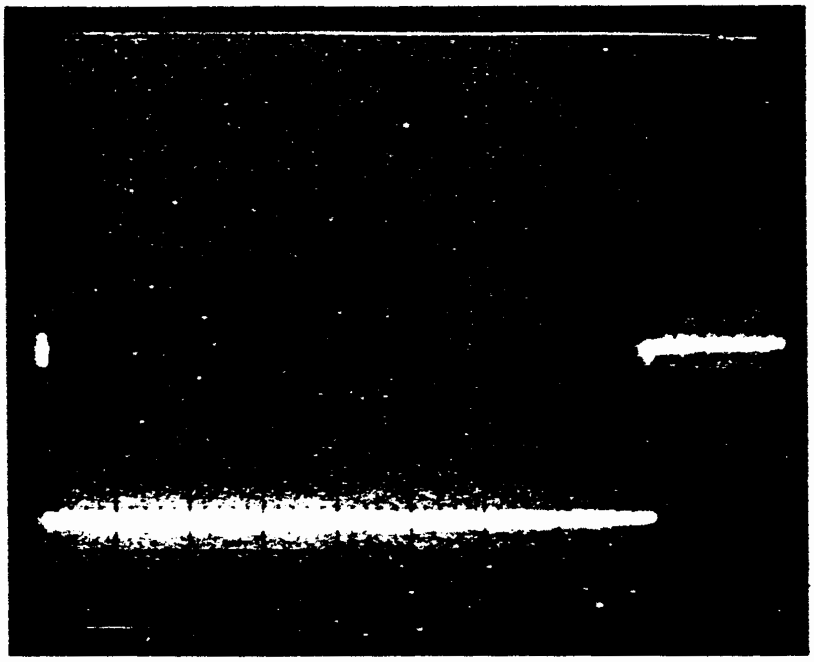
STEP	SPECIFICATION	ACTION
14. Monitor A2U4-12, A2U5-3, and A2U3-5.	A2U4-12 signal in photo below.	If A2U4-12 is not toggling as shown in photo below, replace in order A2U4, A2R22, A2C14, A2U3, A2R29, A2R30, and A2C13. If A2U5-3 and/or A2U3-5 is not toggling, check traces.



Vertical: 2 V/div. Horizontal: 0.1 ms/div

Table 4-14. Read/Write Circuit (Continued)

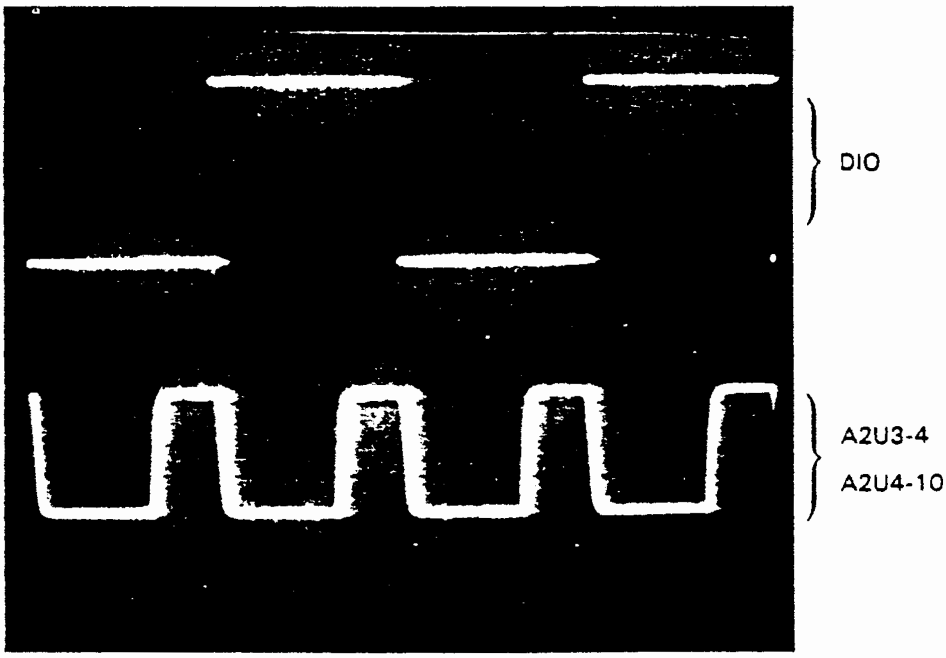
STEP	SPECIFICATION	ACTION
15. Adjust A2R22 while monitoring A2U4-12.	82 to 83 us low pulse as shown in photo below.	If A2R22 will not adjust to this pulse width, replace in order A2R22, A2U4, and A2C14.



Vertical: 2 V/div. Horizontal: 10 us/div.

Table 4-14. Read/Write Circuit (Continued)

STEP	SPECIFICATION	ACTION
16. Monitor A2U4-10.	A2U4-10 signal in photo below.	If A2U4-10 is not toggling, check traces, then replace in order A2U3, A2R29, A2R30 and A2C13. If charging and discharging curves appear to be too steep or too flat as compared to those in the photo below, then replace in order A2C13 and A2R29.

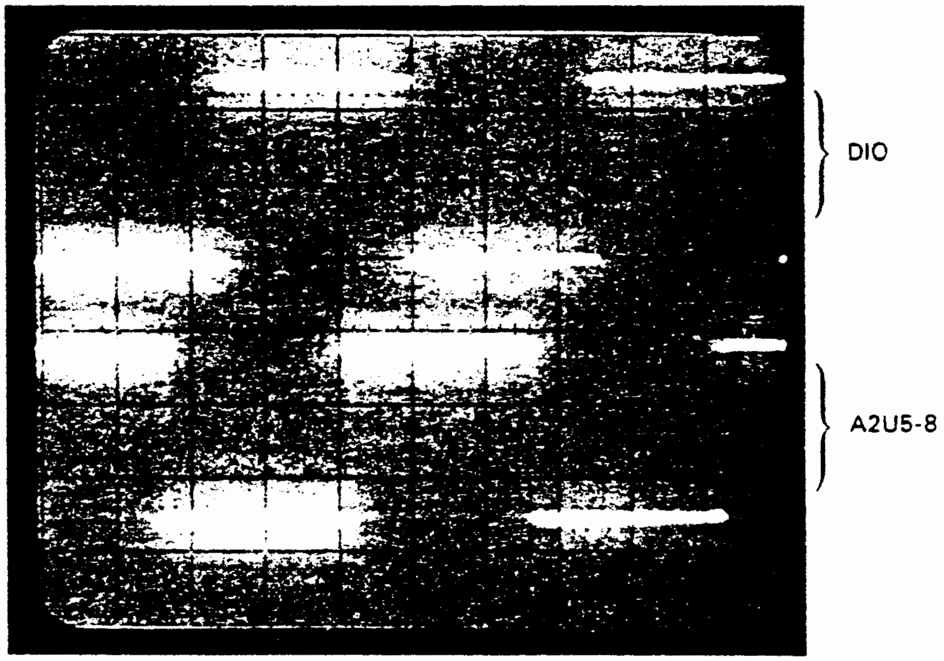


Vertical: 2 V/div. Horizontal: 0.1 ms/div.

STEP	SPECIFICATION	ACTION
17. Measure A2U5-1, A2U5-4, A2U5-10, A2U5-13.	4.9V to 5.1V	If out of range, check traces, connector, and refer to table 4-11, 5V Power Supply Circuit.

Table 4-14. Read/Write Circuit (Continued)

STEP	SPECIFICATION	ACTION
18. Monitor A2U5-8.	A2U5-8 signal in photo below.	If A2U5-8 is not toggling as shown in photo below, check traces from A2U5-8 to A2U5-12, then replace A2U5.



Vertical: 2 V/div Horizontal: 0.1 ms/div.

Table 4-14. Read/Write Circuit (Continued)

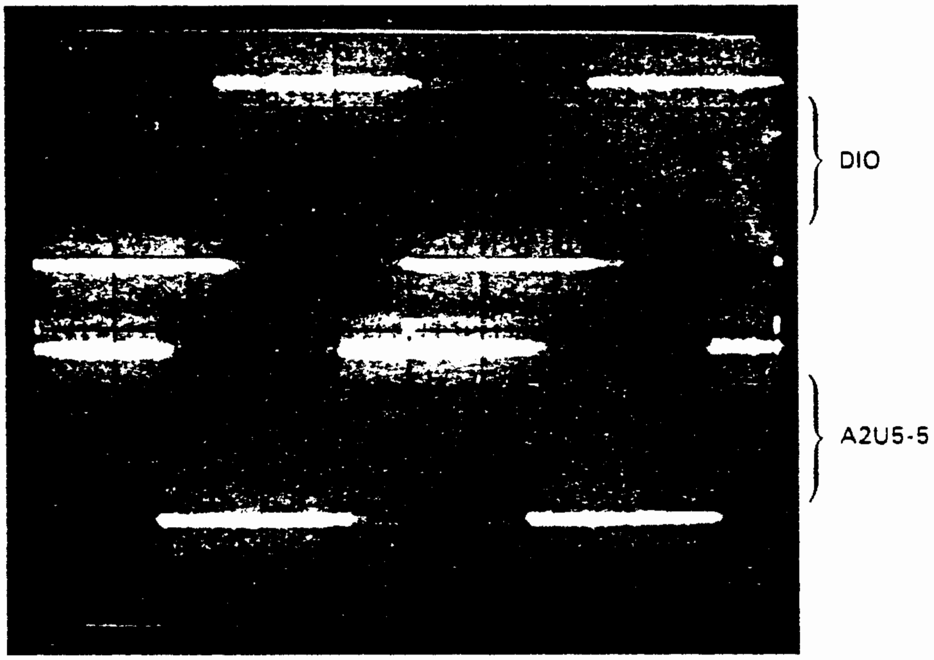
STEP	SPECIFICATION	ACTION
19. Monitor A2U5-5.	A2U5-5 signal in photo below.	If A2U5-5 is not toggling as shown, replace A2U5.
 Vertical: 2 V/div. Horizontal: 0.1 ms/div.		
20. Disconnect all the jumper wires, meters, and the oscilloscope. Reinstall the pin connector that has all of the pins intact and reconnect the connector cable.		

Table 4-14. Read/Write Circuit (Continued)

STEP	SPECIFICATION	ACTION
21. Measure the resistance between: A2J5-7 (VIO) and A2J5-5 (GRN).	between 5 and 40 ohms	If out of range, replace the head-frame assembly.
22. Measure the resistance between:		If any are out of range, replace the head-frame assembly.
A2J5-7 (VIO) and A2J5-3 (ORN)	two times the resistance measured in step 20 ±15%	
A2J5-7 (VIO) and A2J5-4 (YEL)	three times the resistance measured in step 20 ±15%	
A2J5-7 (VIO) and A2J5-6 (BLU)	four times the resistance measured in step 20 ±15%	
23. Measure the resistance between A2J5-8 (GRY) and each of the following: A2J5-7 (VIO) A2J5-6 (BLU) A2J5-5 (GRN) A2J5-4 (YEL) A2J5-3 (ORN)	greater than 100K ohm	If any are out of range, replace the head-frame assembly.

Table 4-15. Motor Drive Circuit

Use this procedure to repair the motor drive circuit when it is not operating properly. While troubleshooting this circuit you can ignore the motor movements unless the motors are doing something unexpected, are chattering, or are giving some other indication that they are bad. Be sure the unit is in the idle state before troubleshooting this circuit. Perform the steps in section A before branching to any other part of this table.

STEP	SPECIFICATION	ACTION
A. TROUBLESHOOTING: A2U9 and A1U3 (processor) idle state.		
1. Measure A2U9-I at the rear, round solder pad.	4.9V to 5.1V	If out of range, check traces, and the connector, then refer to table 4-11, 5V Power Supply Circuit.
2. Measure A2U9-C at the round solder pad on the right side.	0V (ground)	If out of range, check traces.
3. Measure A2U9-O at the square solder pad.	2.5V to 2.7V	If out of range, replace in order A2C4 and A2U9.
4. Measure connector pins A1J9-11 through A1J9-15.	3V to 5V	If out of range, check unit to be sure it is in the idle state, then replace A1U3.

The following guide lists motor drive symptoms and the corresponding table sections that should be used to repair a unit with those symptoms. Some symptoms are listed more than once.

- If the tape does not move in any forward speed or is in a constant stall state, check A2Q4, steps D5, D15-D19, then replace A2CR3 and A2C8.
- If the unit shows problems with fast forward, forward brake, or reverse brake continue with section B, troubleshooting M0.

Table 4-15. Motor Drive Circuit (Continued)

STEP	SPECIFICATION	ACTION
• If the unit shows problems with fast reverse, continue with section C, troubleshooting M4. • If the unit shows problems with fast reverse or forward brake, continue with section D, troubleshooting M1. • If the unit shows problems with forward brake or reverse brake, continue with section E, troubleshooting M3. • If the unit shows problems with Read/Write (slow, controlled forward), continue with section F, troubleshooting M2.		
B. TROUBLESHOOTING M0: connector pin A2J6-11		
1. Connect pin A2J9-11 to ground at connector pin A2J9-20.		
2. Measure A2U2-8.	2.5V to 2.7V	If out of range, check traces.
3. Measure A2U2-9.	0V to 0.5V	If out of range, check traces to connector pin 11.
4. Measure A2U2-14.	0V to 0.5V	If out of range, check traces to ground then replace A2U2.
5. Disconnect connector pin A2J6-11 from ground.		

Table 4-15. Motor Drive Circuit (Continued)

STEP	SPECIFICATION	ACTION
C. TROUBLESHOOTING M4: connector pin A2J6-13		
1. Connect connector pin A2J6-13 to ground at A2J6-20.		
2. Measure A2U2-6.	2.5V to 2.7V	If out of range, check traces.
3. Measure A2U2-7.	0V to 0.5V	If out of range, check traces to connector pin 13.
4. Measure A2U2-1.	0V to 0.5V	If out of range check ground traces then replace A2U2.
5. Disconnect ground from connector pin A2J6-13.		
D. TROUBLESHOOTING M1: connector pin A2J6-12		
1. Measure A2U2-4.	2.5V to 2.7V	If out of range, check traces.
2. Measure A2U2-5.	0V to 0.5V	If out of range, check traces to connector pin 12.
3. Measure A2U2-2.	16V to 19V	If out of range replace in order A2U2, A2R15, and A2R14.
4. Measure A2Q5-C.	less than 1V	If out of range replace in order A2Q5, A2R15, and A2R14.

Table 4-15. Motor Drive Circuit (Continued)

STEP	SPECIFICATION	ACTION
5. Connect connector pin A2J6-12 to ground at A2J6-20.		
6. Measure A2U2-2.	0V to 0.5V	If out of range, replace A2U2.
7. Measure connector pins A2J6-17 and A2J6-18.	17V to 19V	If out of range, refer to table 4-12, Motor Supply Circuit.
8. Measure A2Q5-E.	16.5V to 19V	If out of range, check traces then replace A2R4.
9. Measure A2Q5-B.	0.5V to 0.9V less than the measurement in step 8.	If out of range, replace in order A2R14, A2R15, and A2U2.
10. Measure A2Q5-C.	0.1V to 0.5V less than that measured in step 8 above.	If out of range, replace in order A2CR1 and A2Q5.
11. Measure cathode A2CR1 at the square solder pad.	0.7V-1.2V less than that measured in step 8 above.	If out of range, replace A2CR1.
12. Measure A2U2-1.	greater than 2V	If out of range, replace in order A2U2 and A2R16.
13. Measure A2U2-14.	greater than 2V	If out of range, replace A2U2.
14. Measure A2U8-5, A2U8-3.	greater than 2V	If either is out of range, replace A2U8.
15. Note the movement of motor A2B2.	turning slower than normal reverse	

Table 4-15. Motor Drive Circuit (Continued)

STEP	SPECIFICATION	ACTION
16. Connect connector pin A2J6-13 to ground at A2J6-20. This should turn on full reverse.	motor speed should increase to normal reverse speed	If motor speed did not increase when connector pin 13 was grounded, replace A2Q4.
17. Measure A2U2-1.	0V to 0.5V	If A2U2-1 is out of range, replace A2U2.
18. Measure A2Q4-E.	0.1V to 0.4V	If out of range, replace in order A2Q4, A2U7, A2R11, and A2R12.
19. Disconnect ground from connector pins 12 and 13.		
E. TROUBLESHOOTING M3: connector pin A2J6-14.		
1. Connect connector pin 14 to ground.		
2. Measure A2U4-2,3 and the right side of A2R18.	4.9V to 5.1V	If out of range, check traces, connector pin, and then refer to table 4-11, 5V Power Supply Circuit.
3. Measure A2U4-1.	0V to 0.5V	If out of range, check traces.
4. Monitor A2U4-4 with an oscilloscope.	Each time you ground connector pin 14, you should see a 0V to 0.5V low pulse for 100-300 ms.	If does not go low, replace A2U4. If goes low but the time is out of range, replace in order A2C9, A2R18, and A2U4.

Table 4-15. Motor Drive Circuit (Continued)

STEP	SPECIFICATION	ACTION
5. Monitor A2U8-6 with an oscilloscope.	Each time you ground connector pin 14, you should see a 0V to 0.5V low pulse for 100-300 ms.	If does not go low, check traces.
6. Measure A2U8-7.	0V to 0.5V	If out of range, check traces.
7. Monitor A2U8-5 with an oscilloscope.	Each time you ground connector pin 14, you should see a 0V to 0.5V low pulse for 100-300 ms.	If does not go low, replace A2U8.
8. Disconnect ground from connector pin 14.		
9. Measure A2U4-4.	4.9V to 5.1V	If low, replace A2U4.
10. Connect connector pin 12 to ground at pin 20.		
11. Measure A2U8-5.	greater than 2V	If out of range, replace in order A2CR2, A2R19, and A2U8.
12. Disconnect ground from connector pin 12.		
13. Measure A2R19. (A2CR2, A2CR3, and A2U8-5 should isolate this resistor.)	150 ohms	If out of range replace in order A2R19, A2CR2, and A2CR3.

Table 4-15. Motor Drive Circuit (Continued)

STEP	SPECIFICATION	ACTION
F. TROUBLESHOOTING M2: connector pin A2J6-15.		
1. Measure A2U1-4 and A2U8-1.	3V to 5V	If either or both are out of range, check traces to conector pin 15, then refer to section A in this table.
2. Measure A2U1-5, and A2U1-6.	2.5V to 2.7V	If either or both are out of range, check traces then refer to section A of this table.
3. Measure A2U8-2.	0V to 0.5V	If out of range, check traces.
4. Measure A2U1-2.	0V to 0.5V	If out of range, replace A2U1.
5. Measure A2U1-1.	0V to 0.5V	If out of range, replace A2U1.
6. Connect connector pin A2J6-15 to ground.		
7. Measure A2U1-4 and A2U8-1.	0V to 0.5V	If either or both are out of range, check traces to connector pin 15.
8. Measure A2U8-3.	0V to 0.5V	If out of range, replace A2U8.
9. Measure A2R1 at the rear lead.	4.9V to 5.1V	If out of range, check traces then refer table 4-11, 5V Power Supply Circuit.
10. Measure A2U1-2.	4.9V to 5.1V	If out of range replace in order A2R1, A2C1, and A2U1.

Table 4-15. Motor Drive Circuit (Continued)

STEP	SPECIFICATION	ACTION
11. Measure A2U1-7.	4.9V to 5.1V	If out of range, check traces.
12. Measure A2U1-1.	2.5V to 2.7V	If out of range replace in order A2U1, A2R2, and A2C3.
13. Measure A2U8-5.	greater than 2V	If out of range, replace A2U8, then refer to section E in this table.
14. Measure A2U2-14.	greater than 2V	If out of range, replace A2U2.
15. Disconnect ground from connector pin 15.		
16. Connect A2U7-7 to A2U8-3. (See photo.)		
17. Connect A2U7-9 to A2Q3-E. (See photo.)		
18. Monitor A2U7-14 with an oscilloscope. (See photo.)		
19. Connect connector pin A2J6-15 to ground at pin 20.		

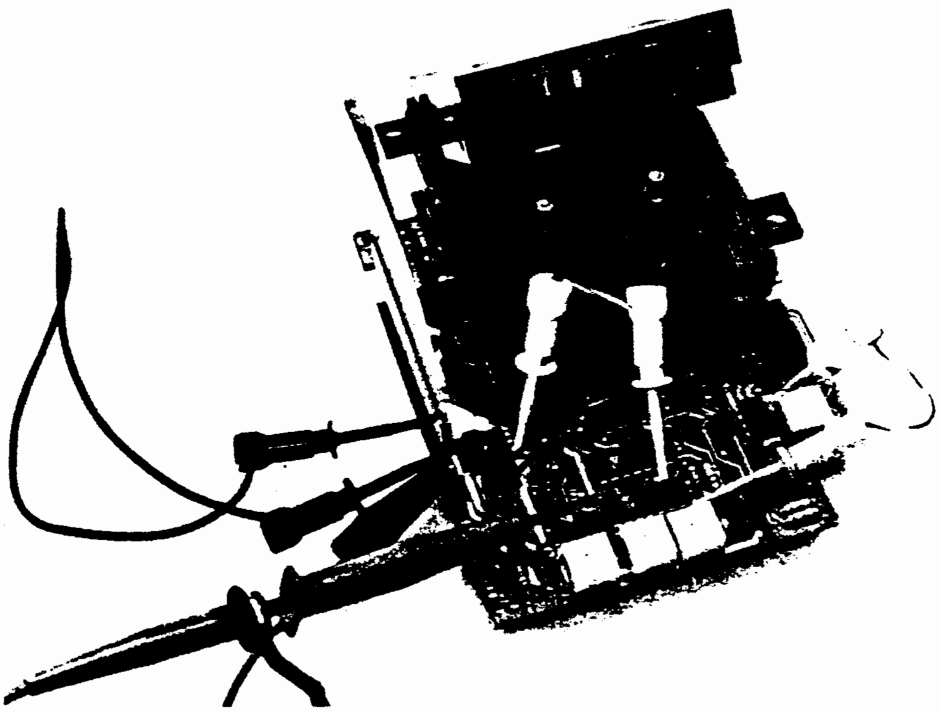
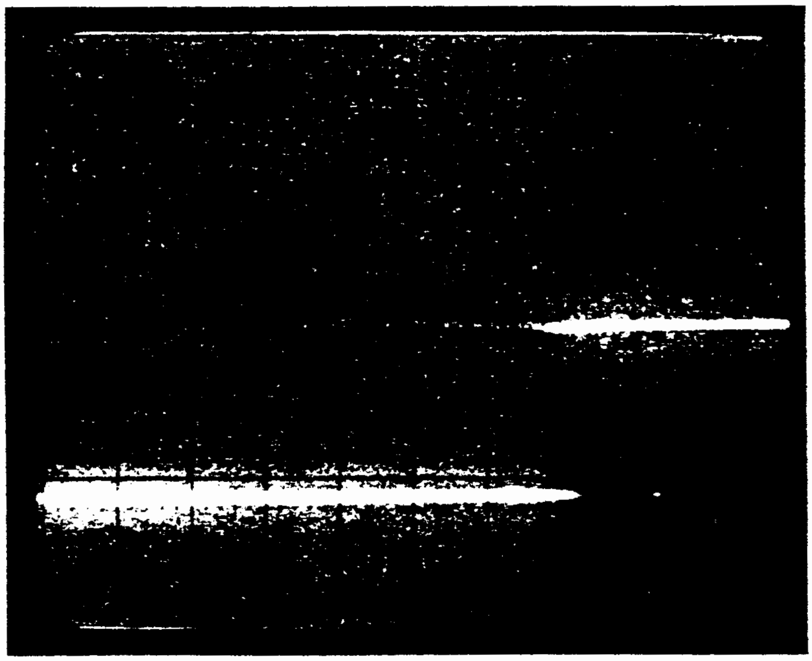


Table 4-15. Motor Drive Circuit (Continued)

STEP	SPECIFICATION	ACTION
20. Adjust A2R17: Hold the spline of motor B1 (the one that is turning) and adjust A2R17 until A2U7-14 just toggles. R17 should be adjusted so that U7-14 is right on the edge of the toggle state or just toggles. Let go of the motor and then hold it again. Repeat the procedure until you have the same adjustment on R17 twice in a row.		
21. Disconnect ground from connector pin 15 and jumper wires from A2U7-7, A2U8-3, A2U7-9, A2Q3-E, and A2U7-14.		
22. Insert the skew tape.		

Table 4-15. Motor Drive Circuit (Continued)

STEP	SPECIFICATION	ACTION
23. Monitor connector pin A2J6-6 (DRDY) with an oscilloscope.		
24. Connect connector pin A2J6-15 to ground at pin 20.		
25. Adjust A2R11 so that DRDY toggles at the given specification. Make the adjustment, then rewind the skew tape and readjust A2R11 during the first 10 seconds of the tape.	140 us, plus or minus 10 us of jitter. The jitter will be seen as an overlap at the toggling edge. Adjust the center of the overlap to 140 us. The overlap should be no more than 10 us on either side of the center point of 140 us. (See photo.)	If the motor speed will not adjust, or the jitter is out of range, check the motors, then replace in order A2U7, A2Q3, A2Q4, A2CR2, A2CR3, A2B1, A2B2, and the resistors and capacitors associated with the feedback circuit.



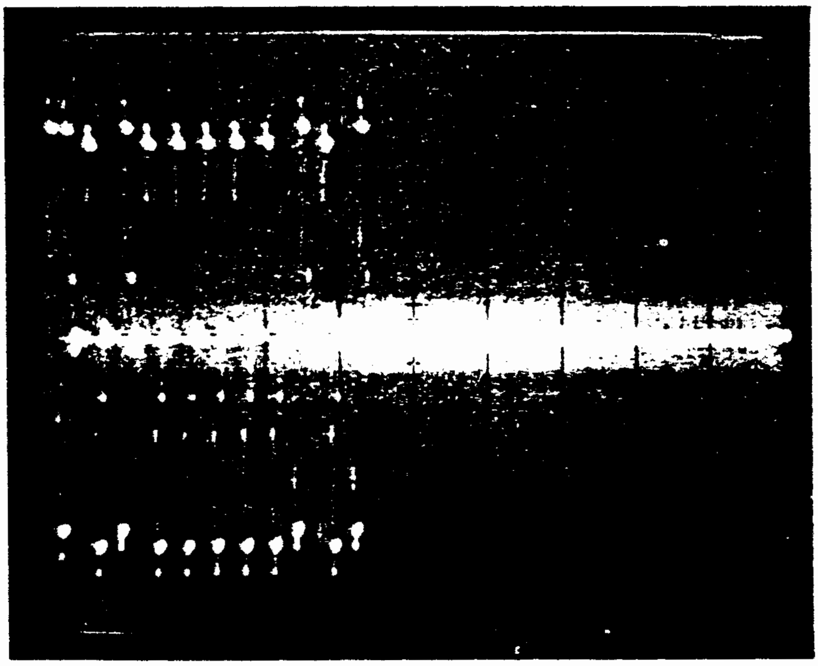
Vertical: 2 V/div. Horizontal: 20 us/div.

Table 4-16. HP-IL Circuit

Use the procedure in this table for repairing the HP-IL circuit when it is not operating properly.		
STEP	SPECIFICATION	ACTION
1. Connect the drive to the calculator test system described in paragraph 4-13h above.		
2. Load the test program HPILCKT in the HP-41CV. (This program is listed in table 4-18 at the end of this section.)		
3. Run HPILCKT. This will provide a signal for checking the HP-IL circuit.		

Table 4-16. HP-IL Circuit (Continued)

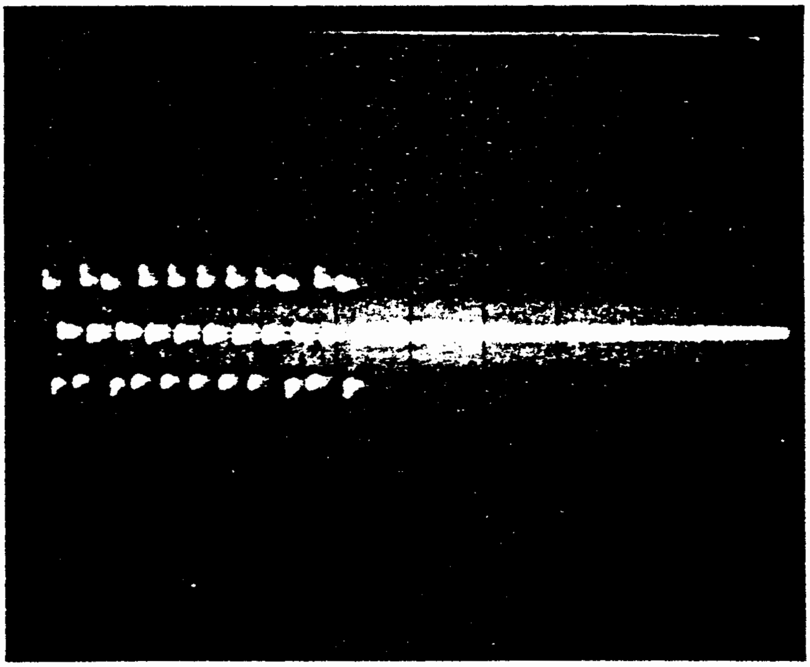
STEP	SPECIFICATION	ACTION
4. Monitor the HP-IL signal by placing the leads of the oscilloscope across pins A1T2-1 and A1T2-2.	signal shown in photo below	If signal is not similar to that shown, check the continuity of the loop and the HP 82160A, then replace A1T2.



Vertical: 0.5 V/div. Horizontal: 10 us/div.

Table 4-16. HP-IL Circuit (Continued)

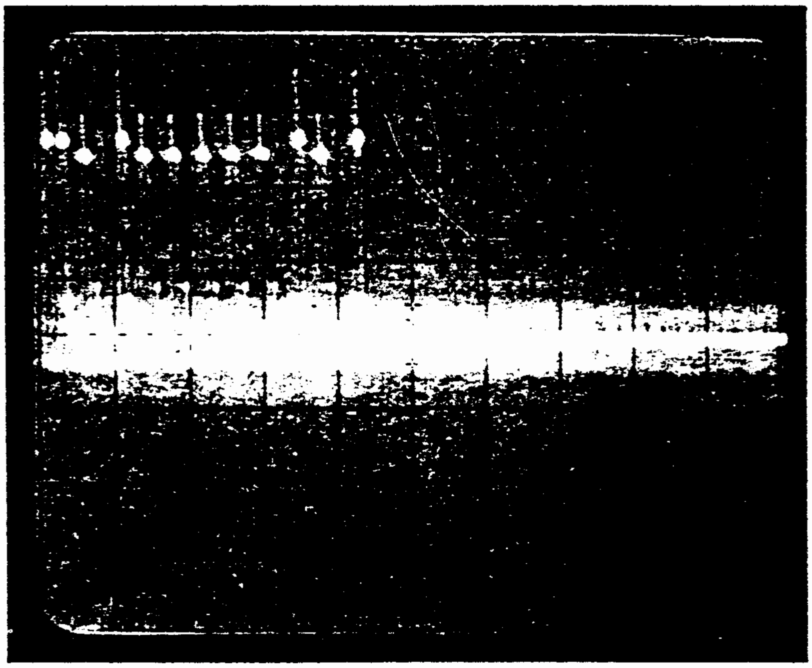
STEP	SPECIFICATION	ACTION
5. Monitor any one of the following pins: A1T2-12, A1T2-13, A1T2-14, or A1T2-16. The ground lead of the oscilloscope should be connected to ground on the unit.	signal shown in photo below	If signal is not similar to that shown, replace in order A1T2, A1CR3, and A1CR4.



Vertical: 0.5 V/div. Horizontal: 10 us/div.

Table 4-16. HP-IL Circuit (Continued)

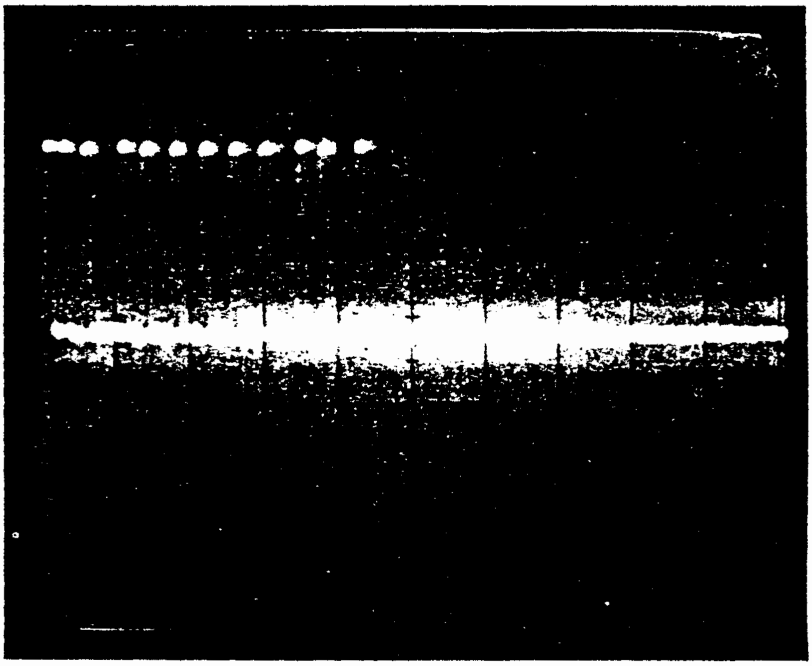
STEP	SPECIFICATION	ACTION
6. Monitor any one of the following pins: A1T2-6, A1T2-4, A1U4-17, or A1U4-18.	signal shown in photo below	If signal is not similar to that shown, replace in order A1T2, A1R18, A1R17, and A1U4.



Vertical: 2 V/div. Horizontal: 10 us/div.

Table 4-16. HP-IL Circuit (Continued)

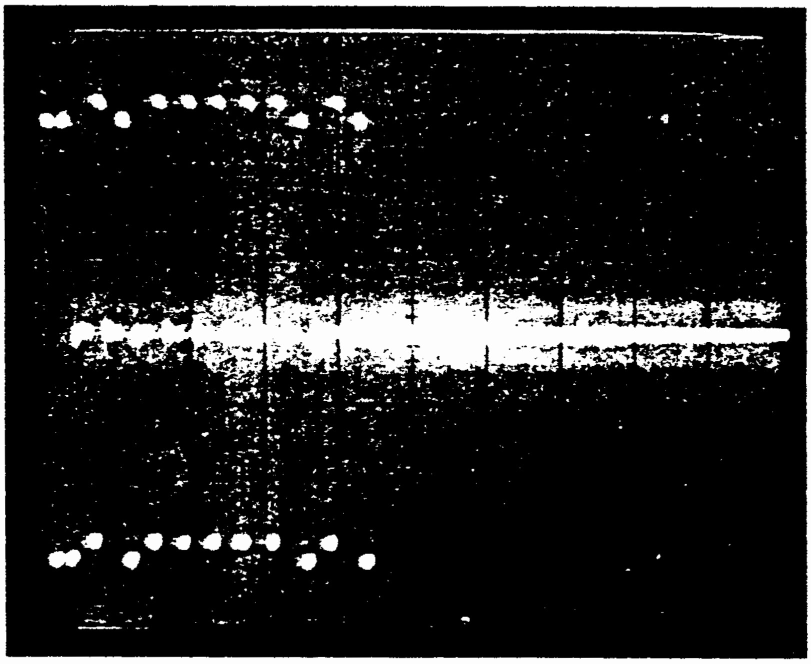
STEP	SPECIFICATION	ACTION
7. Monitor any one of the following pins: A1T2-7, A1T2-8, A1U4-19, or A1U4-20.	signal shown in photo below	If signal is not similar to that shown, replace in order A1U4, A1T2, A1CR1, A1CR2, A1R19, A1R20, A1C11, and A1C12.



Vertical: 2 V/div. Horizontal: 10 us/div.

Table 4-16. HP-IL Circuit (Continued)

STEP	SPECIFICATION	ACTION
8. Monitor across pins A1T2-9 and A1T2-10 with an oscilloscope.	signal shown in photo below	If signal is not similar to that shown, check contiuity of the loop and the HP 82160A, then replace A1T2.



Vertical: 0.5 V/div. Horizontal: 10 us/div.

STEP	SPECIFICATION	ACTION
9. Disconnect the oscilloscope.		

Table 4-17. DRVTST Diagnostic Program Listing

```
01LBL "DRVTST"
02 1.1
03 STO 06
04 SF33
05 CF 00
06 CF 01
07 CF 02
08 CF 03
09 CF 04
10 CF 08
11 CF 09
12 0
13 ENTER^
14 225
15 WREG
16 IDY
17 SIN
18 ORAV?
19 GTO "IFC"
20 "LOOP DEAD"
21 GTO 00
22LBL "IFC"
23 2
24 STO 00
25 IFC
26LBL 01
27 IFCR?
28 GTO 02
29 DSE 00
30 GTO 01
31 "CPU"
32 GTO "ER"
33LBL 02
34 "LOOP INTACT."
35 FS? 55
36 PRA
37 LPD
38 SIN
39 SDA
40 SIN
41 ORAV?
42 GTO 03
43 0
44 ENTER^
45 225
46 WREG
47 ORAV?
48 GTO 04
49 "MCL"
50 GTO "ER"
51LBL 03
52 "LPD"
53 GTO "ER"
54LBL 04
55 IDY
56 SIN
57 ORAV?
58 GTO 05
59 "LPU"
60 GTO "ER"
61LBL 05
62 AAU
63 ORAV?
64 GTO 06
65 "AAU"
66 GTO "ER"
67LBL 06
68 1
69 AAD
70 ENTER^
71 2
72 X=Y?
73 GTO 07
74 "AAD"
75 GTO "ER"
76LBL 07
77 1
78 TAD
79 SST
80 32
81 X<=Y?
82 GTO 07
83 CLX
84 23
85 X=Y?
86 GTO 08
87 XEQ "Y"
88 "NOT NEW TAPE"
89 GTO 00
90LBL 08
91 SST
92 ENTER^
93 XEQ "Y"
94LBL "SETUP"
95 SCI 9
96 RCL 09
97 CHS
98 X<=0?
99 XEQ "RST"
100 1 E-09
101 -
102 X>0?
103 XEQ "RST"
104 RCL 09
105 1 E-18
106 -
107 STO 01
108 1 E-18
109 -
110 STO 02
111 1 E-18
112 -
113 STO 03
114 STO 09
115 .1
116 STO 08
117 SF 00
118 256
119 SETBUFX
120 AIPT
121 15
122 X-BUF
123 X-BUF
124 X-BUF
125 X-BUF
126 0
127 PT=
128 CLA
129 4
130 BUF-AX
131 ASTO 04
132 0
133 PT=
134 240
135 X-BUF
136 X-BUF
137 X-BUF
138 X-BUF
139 0
140 PT=
141 CLA
142 4
143 BUF-AX
144 ASTO 05
145LBL "RAMCK"
146 1.2
147 STO 06
148 CLA
149 0
150 PT=
151 ARCL 05
152 XEQ "LODA"
153 A-BUF
154 XEQ "FILBUF"
155 1
156 STO 07
157 XEQ "WTBUF"
158 XEQ "PILCK"
159 ISG 06
160 10
161 DDL
162 XEQ "PILCK"
163 ISG 06
164 9
165 DDL
166 XEQ "PILCK"
167 XEQ "RDBUF"
168 CLA
169 ARCL 05
170 XEQ "LODA"
171 ISG 06
172 0
173 PT=
174 16
175 A=BUFX?
176 GTO "+160K"
177 PRA
178 "RAM"
179 GTO "ER"
180LBL "+160K"
181 1.3
182 STO 06
183 XEQ 50
184 XEQ "VFY"
185 ISG 06
186 CLA
187 0
188 PT=
189 XEQ "LODA"
190 ARCL 05
191 A-BUF
192 XEQ "FILBUF"
```

Table 4-17. DRVTST Diagnostic Program Listing (Continued)

```
XEQ "WTBUF"
10
DDL
9
DDL
XEQ "RDBUF"
CLA
XEQ "LODA"
ARCL 05
0
PT=
16
A=BUFX?
GTO "-160K"
"RAM"
GTO "ER"
LBL "-160K"
ISG 06
XEQ "VFY"
XEQ 50
LBL "R/WCK"
1.4
STO 06
1
XEQ "LODSEQ"
1
LAD
4
DDL
0
OUTBIN
21
OUTBIN
XEQ "SC"
ISG 06
1
LAD
3
DDL
0
OUTBIN
PT=
DDL
16
OUTBUFX
RFRM
0
ENTER^
2
WFRM
XEQ "PILCK"
XEQ "SC"
LBL "WTSEQ2"
1.5
STO 06
XEQ 50
2
XEQ "LODSEQ"
1
LAD
4
DDL
0
OUTBIN
20
OUTBIN
6
STO 07
XEQ "WTBUF"
0
STO 07
XEQ "RDBUF"
CLA
ARCL 01
0
PT=
16
A=BUFX?
GTO "WTSEQ3"
PRA
"P-W"
GTO "ER"
LBL "WTSEQ3"
1.6
STO 06
3
XEQ "LODSEQ"
1
LAD
4
DDL
1
OUTBIN
250
OUTBIN
XEQ "SC"
1
STO 07
XEQ "WTBUF"
1
TAD
4
DDT
1
LAD
8
DDL
XEQ "PILCK"
XEQ "SC"
LBL "R/WVFY"
1.7
STO 06
XEQ 50
0
STO 00
XEQ "RDSEQ"
ARCL 05
XEQ "LODA"
SF 09
XEQ "VFY"
ISG 06
1
STO 00
SF 08
XEQ "RDSEQ"
1
LAD
7
DDL
ARCL 05
XEQ "LODA"
SF 09
XEQ "VFY"
XEQ "SC"
XEQ "SAD"
CF IND 08
CF33
"PASSED"
FS? 55
PRA
BEEP
AON
STOP
LBL "FILBUF"
16
PT=
10
STO 00
LBL 10
A-BUF
DSE 00
GTO 10
RTN
LBL "LODA"
ARCL 04
ARCL 05
ARCL 04
ARCL 05
ARCL 04
RTN
LBL "WTBUF"
.01
ST+ 06
1
LAD
3
DDL
0
OUTBIN
PT=
RCL 07
DDL
256
OUTBUFX
PSE
RFRM
.01
ST- 06
RTN
LBL "RDBUF"
.02
ST+ 06
256
SETBUFX
AIPT
RFRM
1
LAD
3
DDL
0
OUTBIN
```

Table 4-17. DRVTST Diagnostic Program Listing (Continued)

```
385 PT=
386 1
387 TAD
388 RCL 07
389 DDT
390 256
391 INBUFX
392 .02
393 ST- 06
394 RTN
395LBL "VFY"
396 .03
397 ST+ 06
398 16.25024
399 STO 00
400LBL 20
401 RCL 00
402 PT=
403 A=BUF?
404 GTO 30
405 "RAM"
406 FS?C 09
407 "R/W"
408 GTO "ER"
409LBL 30
410 ISG 00
411 GTO 20
412 .03
413 ST- 06
414 RTN
415LBL "LODSEQ"
416 .04
417 ST+ 06
418 CLA
419 RDN
420 ARCL IND X
421 0
422 PT=
423 A-BUF
424 ARCL 05
425 XEQ "LODA"
426 XEQ "FILBUF"
427 .04
428 ST- 06
429 RTN
430LBL "RDSEQ"
431 .05
432 ST+ 06
433 1
434 LAD
435 4
436 DDL
437 RCL 00
438 OUTBIN
439 20
440 FS?C 08
441 250
442 OUTBIN
443 XEQ "SC"
444 1
445 TAD
446 2
447 DDT
448 0
449 STO 07
450 XEQ "RDBUF"
451 CLA
452 2
453 ST+ 00
454 ARCL IND 00
455 0
456 PT=
457 16
458 A=BUFX?
459 GTO 40
460 PRA
461 "R/W"
462LBL "ER"
463 " ERROR"
464LBL 00
465 FIX 3
466 RCL 06
467 FS? 55
468 PRA
469 CF33
470 AON
471 TONE 9
472 TONE 9
473 TONE 9
474 TONE 9
475 TONE 9
476 STOP
477LBL 40
478 .05
479 ST- 06
480 RTN
481LBL 50
482 CF IND 08
483 ISG 08
484 TONE 9
485 SF IND 08
486 RTN
487LBL "FILCK"
488 .001
489 ST+ 06
490 ORAV?
491 GTO 60
492 GTO 70
493LBL 60
494 .001
495 ST+ 06
496 FRNS?
497 GTO 70
498 .002
499 ST- 06
500 RTN
501LBL 70
502 "FIL"
503 GTO "ER"
504LBL "SC"
505 1
506 TAD
507 RFRM
508 SST
509 32
510 X<=Y?
511 GTO "SC"
512LBL "Y"
513 RDN
514 X=0?
515 RTN
516 UNT
517 STO 09
518 "STATUS "
519 ARCL X
520 GTO 00
521LBL "SAD"
522 1.8
523 STO 06
524 1
525 LAD
526 3
527 DDL
528 50
529 OUTBIN
530 4
531 DDL
532 1
533 OUTBIN
534 10
535 OUTBIN
536 0
537 PT=
538 1
539 TAD
540 3
541 DDT
542 3
543 INBUFX
544 UNT
545 0
546 PT=
547 1
548 BUF-XB
549 1
550 XY?
551 GTO 80
552 ISG 06
553 1
554 BUF-XB
555 10
556 XY?
557 GTO 80
558 ISG 06
559 1
560 BUF-XB
561 50
562 X=Y?
563 RTN
564LBL 80
565 "DDT3"
566 GTO "ER"
567LBL "RST"
568 -1 E-10
569 STO 09
570 RTN
```

Table 4-18. HPILCKT Program Listing

```
01LBL HPILCKT
02 1
03 ENTER^
04 3
05LBL90
06 WREG
07 WFRM
08 WREG
09 WFRM
10 WREG
11 WFRM
12 WREG
13 WFRM
14 WREG
15 WFRM
16 WREG
17 WFRM
18 WREG
19 WFRM
20 WREG
21 WFRM
22 WREG
23 WFRM
24 WREG
25 WFRM
26 WREG
27 WFRM
28 WREG
29 WFRM
30 WREG
31 WFRM
32 WREG
33 WFRM
34 WREG
35 WFRM
36 WREG
37 WFRM
38 WREG
39 WFRM
40 WREG
41 WFRM
42 WREG
43 WFRM
44 WREG
45 WFRM
46 GTO 90
47 .END.
```

SECTION
V

Accessories

5-1. INTRODUCTION

5-2. This section identifies electrical accessories that are available for the HP 82161A Digital Cassette Drive. Defective accessories should be replaced rather than repaired since the cost of a new unit is usually less than the cost of repair.

5-3. HP 82033A BATTERY PACK

5-4. The HP 82033A Battery Pack is shown in figure 5-1. This is the same pack that is used in the HP 82162A Thermal Printer, the HP 82143A Printer, and the HP-91, HP-92, and HP-97 calculators.

5-5. The serial number located on the battery pack indicates the week that the pack was initially charged. The format is described below:

```
Y Y W W
--- ---
 |   |
 |   +------- Week charged.
 |
 +----------- Year charged (years since 1960).
```

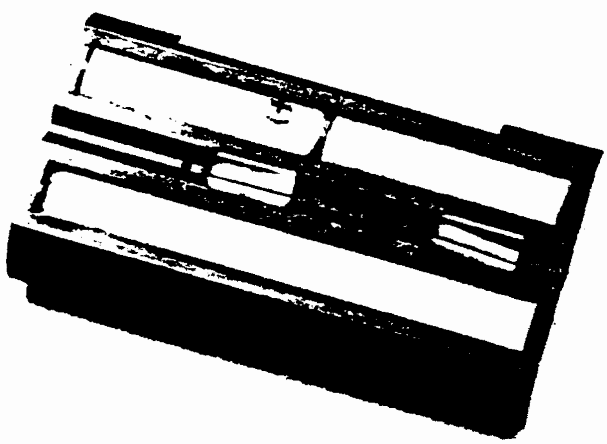


Figure 5-1. HP 82033A Battery Pack

5-6. To determine if the battery pack is bad or merely needs charging, perform the following procedure when time permits:

a. Charge the battery pack for at least 8 hours (in a reserve power pack or in a unit that is good).

b. Remove the battery pack.

c. Connect a 5-ohm, 10%, 10W resistor across the battery contacts.

d. After 45 minutes, remove the resistor.

e. Measure the dc voltage between the battery contacts.

- If the voltage is less than 4 Vdc, the battery pack is bad.

- If the voltage is at least 4 Vdc, the battery pack is good. Charge it again for at least 5 hours, then store the pack for later use.

5-7. RECHARGERS

5-8. Various ac rechargers (table 5-1 and figure 5-2) are available for use with the HP 82161A Digital Cassette Drive.

Table 5-1. Rechargers

MODEL NUMBER	VOLTAGE*	IDENTIFICATION
HP 82059B	110	US
HP 82066B	220	Europe
HP 82067B	220	UK desktop
HP 82067B Opt 001	220	UK with RSA plug
HP 82068B	220	Australia
HP 82069B	110	Europe

* Indicates nominal voltage; acceptable ranges are 210 to 250 Vac and 90 to 120 Vac.

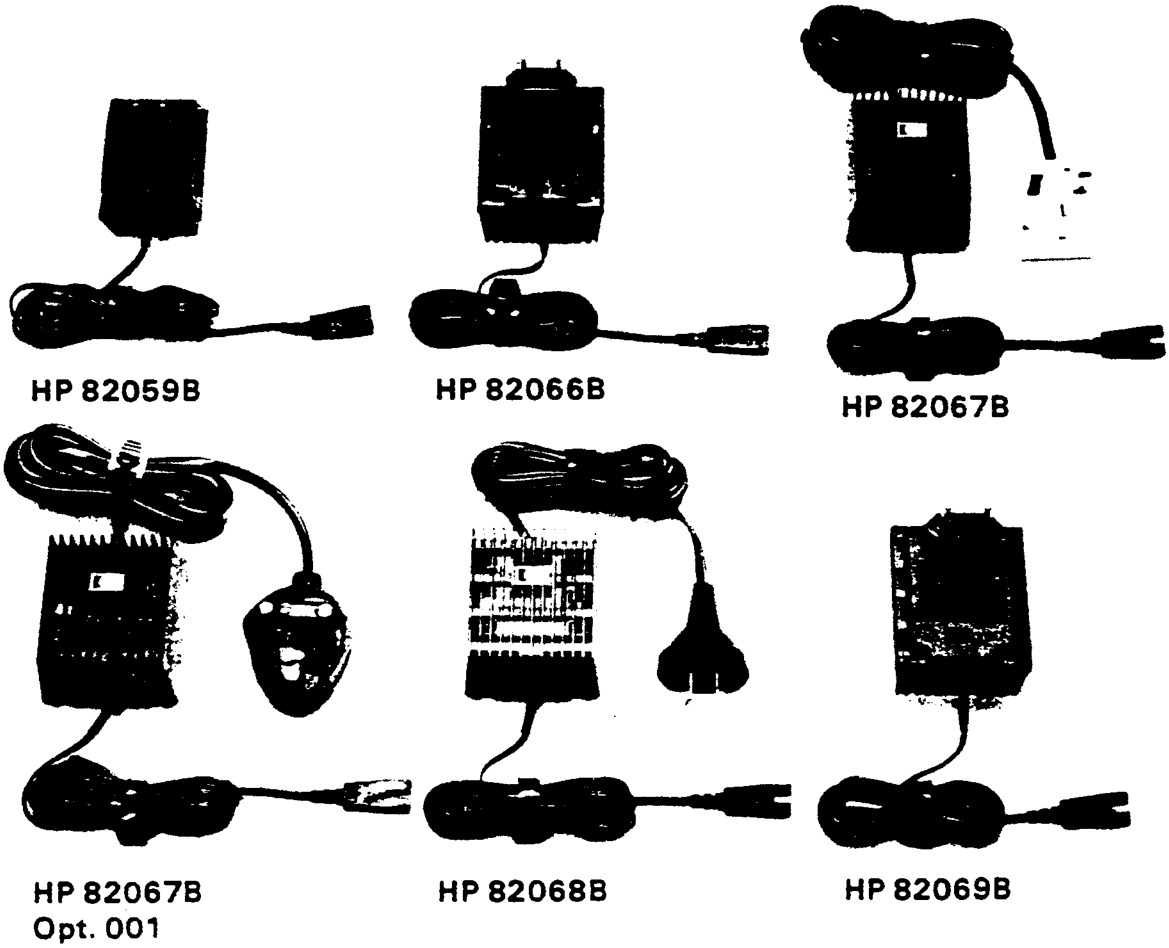


Figure 5-2. Rechargers

-9. The serial number located on the recharger indicates the month that the nit was manufactured. The format is described below:

```
Y Y M M
--- ---
 |   |
 |   +------- Month manufactured.
 |
 +----------- Year manufactured (years since 1960).
```

5-10. To determine whether the recharger is functioning properly, perform this procedure:

a. Plug the recharger into an outlet of the proper voltage. (Refer to table 5-1.) Measure the power-outlet voltage (VIN) using an ac voltmeter.

b. Measure the recharger ac output voltage (VOUT) under no-load conditions using an ac voltmeter. VOUT should be between 9.9 and 13.3 Vac at power voltages of 110 or 220 Vac. More generally, VOUT should equal (VIN / 110) x 11.6 Vac ± 1.7V or (VIN / 220) x 11.6 Vac ± 1.7 V. (VIN is the ac voltage of the power outlet.)

- If VOUT is outside the allowable range, the recharger is bad and should be discarded. Stop testing here.

- If VOUT is inside the allowable range, continue with step c.

c. Connect a 12-ohm, 5%, 5W resistor across the recharger output contacts.

d. Measure the ac voltage across the load using an ac voltmeter.

- If the voltage is between 5.3 and 7.3 Vac, the recharger is good.

- If the voltage is outside 5.3 and 7.3 Vac, the recharger is bad and should be discarded.

SECTION VI

Replaceable Parts

6-1. INTRODUCTION

6-2. This section lists the replaceable parts and assemblies of the HP 82161A Digital Cassette Drive. The reorder part number of the complete Digital Cassette Drive unit is 82161-69901.

6-3. Parts descriptions, HP part numbers, quantities, and reference designations (where applicable) for the cassette drive are listed in table 6-1. (The cassette drive is illustrated in figure 6-1.)

6-4. Replaceable parts information for the transport assembly is listed in table 6-2. (The transport assembly is illustrated in figure 6-2.)

6-5. Replaceable parts information for the logic PCA and the drive PCA is listed in tables 6-3 and 6-4. Component location diagrams and schematic diagrams are shown in figures 7-1, 7-3, and 7-4.

6-6. Replaceable parts information for the EOT PCA is listed as part of the transport assembly replaceable parts in table 6-2. Component location diagram and schematic are shown in figures 7-2 and 7-4.

6-7. In some early units, the positions of the phototransistor and LED associated with the End-Of-Tape circuit are interchanged. The HP part numbers are unchanged. Additionally, on the early units resistor A2R20 is a fixed resistor instead of a variable resistor (refer to table 6-4). The component location diagrams for these early EOT and drive PCAs are shown in figures 7-5 and 7-6. Also, refer to the note on the schematic in figure 7-4.

6-8. ORDERING INFORMATION

6-9. To order replacement parts or assemblies, address your order or inquiry to Corporate Parts Center or Parts Center Europe. Specify the following information for each part ordered:

a. Product model and serial number.

b. HP part number.

c. Part description.

d. Complete reference designation (if applicable).

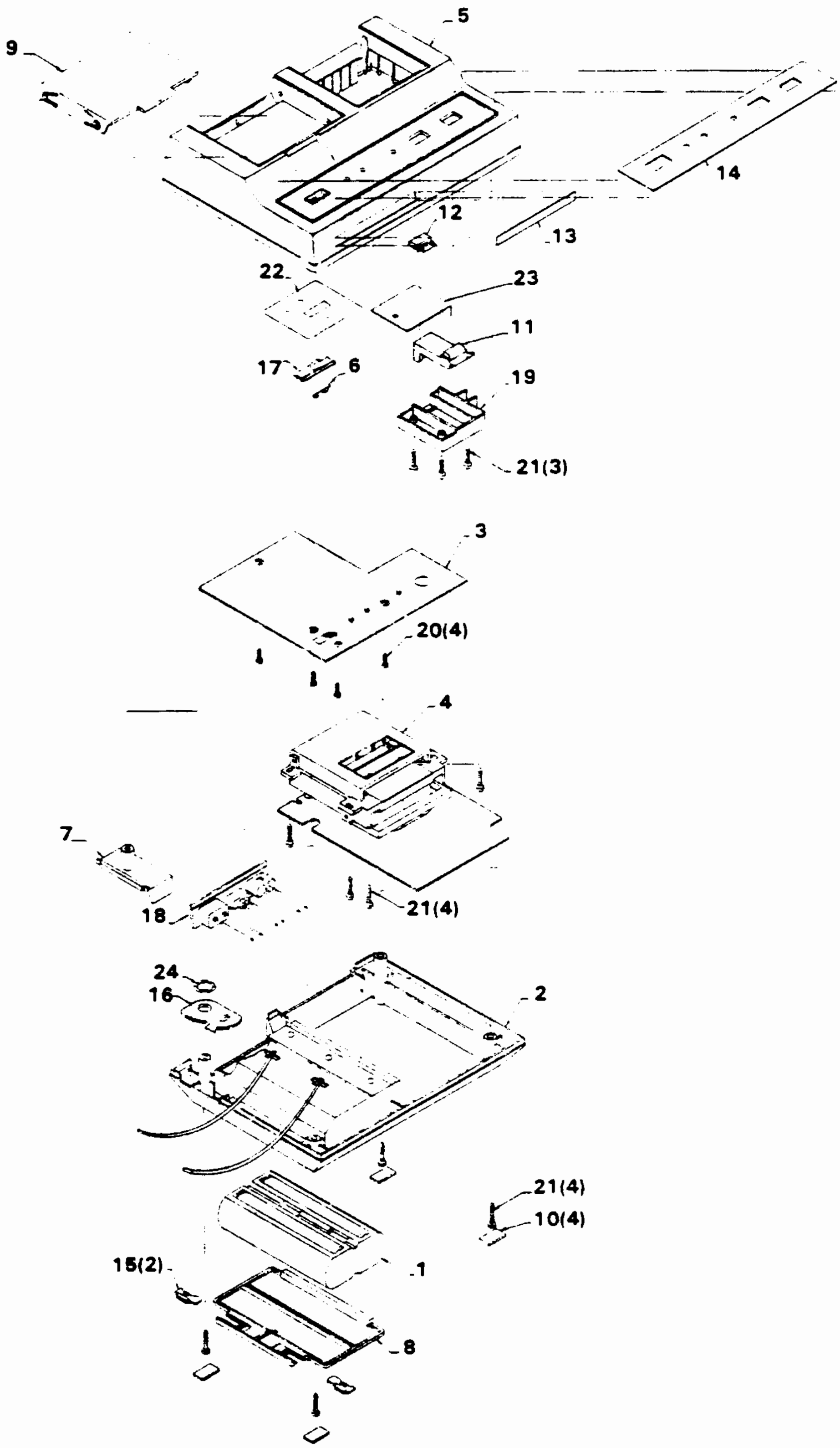


Figure 6-1. HP 82161A Digital Cassette Drive Exploded View

Table 6-1. HP 82161A Digital Cassette Drive Replaceable Parts

INDEX NUMBER, FIGURE 6-1	HP PART NUMBER	DESCRIPTION	QUANTITY
1	00091-60013	ASSEMBLY, battery pack	1
2	82143-60033	ASSEMBLY, bottom case	1
3	82161-60006	ASSEMBLY, logic PCA (refer to table 6-3)	1
4	82161-60004	ASSEMBLY, transport (refer to table 6-2)	1
5	82161-40007	CASE, top	1
6	1460-1471	CONTACT, slide switch	1
7	82143-40022	COVER, latch, security	1
8	82143-40007	DOOR, battery	1
9	82161-40008	DOOR, case	1
10	0403-0267	FOOT, adhesive	4
11	82161-40005	KEY, latch, [OPEN]	1
12	82143-40009	KEY, [REWIND]	1
13	7121-1116	LABEL, front	1
14	7121-1159	LABEL, panel	1
15	82143-40008	LATCH, battery door	2
16	1600-0990	LATCH, security	1
17	82161-40023	LEVER, slide switch	1
18	0950-0854	PLATE, I/O	1
19	82161-40014	RETAINER, key	1
20	0624-0481	SCREW, 2-28 x 0.22-inch, logic PCA	4
21	0624-0281	SCREW, 4-20 x 0.50-inch, case/switch/transport	11
22	4114-0952	SHIELD, static	1
23	4320-0347	SPACER, rubber	1
24	2190-0184	WASHER, wavy, security	1

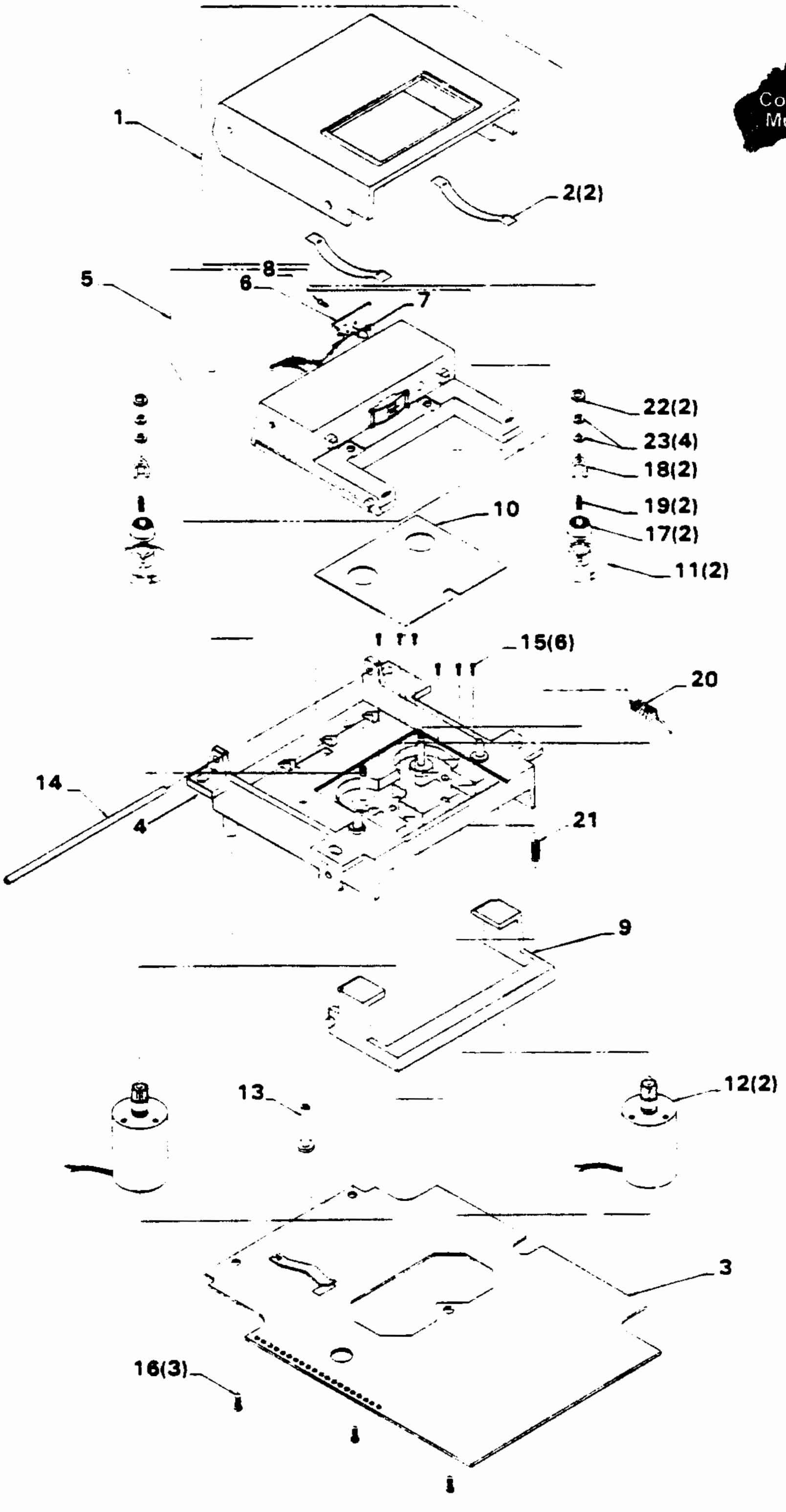


Figure 6-2. Transport Assembly Exploded View

Table 6-2. Transport Assembly Replaceable Parts

INDEX NUMBER, FIGURE 6-2	HP PART NUMBER	DESCRIPTION	QUANTITY
1	82161-60009	ASSEMBLY, door, transport	1
2	1460-1878	• SPRING, cassette	2
3	82161-60005	ASSEMBLY, drive PCA (refer to table 6-4)	1
4	82161-60903	ASSEMBLY, main frame/shaft, service	1
5	82161-60011	ASSEMBLY, head-frame (A3)	1
		• ASSEMBLY, head-frame only	1
6	82161-80008	• BOARD, printed-circuit, end-of-tape	1
7	1990-0782	• PHOTOTRANSISTOR, end-of-tape (A3Q1)	1
8	0624-0343	• SCREW, 2-28 x 0.250	1
9	82161-40015	BAR, latch	1
10	4040-1819	COVER, drive, adhesive	1
11	1430-0599	GEAR, spline	2
12	3140-0662	MOTOR (A2B1, A2B2)	2
13	82161-40012	PIN, cassette	1
14	1531-0194	PIN, hinge	1
15	0515-0346	SCREW, MTRC torx, motor	6
16	0624-0281	SCREW, 4-20 x 0.50-inch, drive PCA	3
17	82161-40022	SNUBBER	2
18	82161-40010	SPLINE	2
19	1460-1917	SPRING, compression, spline	2
20	1460-1879	SPRING, door	1
21	1460-1872	SPRING, latch	1
22	3050-1042	WASHER, flat, retainer, mylar	2
23	3050-1065	WASHER, flat, thrust, nyletron	4

Table 6-3. Logic PCA Replaceable Parts

REFERENCE DESIGNATION*	HP PART NUMBER	DESCRIPTION	QUANTITY
C8,C9	0160-0576	CAPACITOR, 0.1 uF, 20%, 50V	2
C1,C4,C5	0160-0127	CAPACITOR, 1 uF, 20%, 25V	3
C2	0180-2925	CAPACITOR, 82 uF, 10V	1
C7	0180-3080	CAPACITOR, 220 uF	1
C3	0180-0424	CAPACITOR, 470 uF, 25V	1
C10	0160-4800	CAPACITOR, 120 pF, 5%	1
C6,C11, C12	0160-4812	CAPACITOR, 220 pF, 10%	3
J3,J4	1251-6623	CONNECTOR, single-contact, battery	2
J9	1251-7010	CONNECTOR, 20-pin Female, to drive PCA	1
Y1	0410-1305	CRYSTAL, 4-MHz	1
CR9	1901-0693	DIODE, 1N4934	1
CR10-CR13	1901-0704	DIODE, rectifier	4
CR5-CR8, CR10	1901-1098	DIODE, switching	4
CR1-CR4	1902-0970	DIODE, zener, 33V, 0.4W	4
L1	9100-1631	INDUCTOR, 56 uH, 5%	1
	1200-0181	INSULATOR, transistor Q4	1
U2	1826-0287	INTEGRATED CIRCUIT, comparator, quad	1
U4	1LB3-0003	INTEGRATED CIRCUIT, HP-IL	1
U3	1820-2673	INTEGRATED CIRCUIT, processor	1
U5	1818-0643	INTEGRATED CIRCUIT, RAM	1
U1	1826-0555	INTEGRATED CIRCUIT, regulator, reference	1
W1	8159-0005	JUMPER, wire	1
DS1-DS3	1990-0705	LED (light-emitting diode)	3
U7	1810-0524	PASSIVE NETWORK	1
PS1	0950-0408	POWER SUPPLY	1

Table 6-3. Logic PCA Replaceable Parts (Continued)

REFERENCE DESIGNATION*	HP PART NUMBER	DESCRIPTION	QUANTITY
R1	0689-0565	RESISTOR, 5.6-ohm, 5%, 1W	1
R19,R20	0698-3445	RESISTOR, 348-ohm, 1%, 1/8W	2
R4,R22	0683-4715	RESISTOR, 470-ohm, 5%	2
R14	0757-0418	RESISTOR, 619-ohm, 1%, 1/8W	1
R7	0757-0280	RESISTOR, 1K, 1%, 1/8W	1
R8	0757-0274	RESISTOR, 1.21K, 1%, 1/8W	1
R3,R10, R12	0683-4725	RESISTOR, 4.7K, 5%, 1/4W	3
R2,R21	0683-1035	RESISTOR, 10K, 5%, 1/4W	2
R17,R18	0683-1535	RESISTOR, 15K, 5%, 1/4W	2
R15	0698-3136	RESISTOR, 17.8K, 1%	1
R6,R23, R13	0683-3935	RESISTOR, 39K, 5%, 1/4W	3
R5	0683-1045	RESISTOR, 100K, 5%, 1/4W	1
R11	0683-1055	RESISTOR, 1M, 5%, 1/4W	1
R16	1810-0037	RESISTOR NETWORK, 1K, eight-part	1
S2	3131-0405	SNAP DISC, switch, [REWIND]	1
	0460-0970	TAPE, 0.5-inch	
T1	9100-0425	TRANSFORMER, flyback	1
T2	9100-4226	TRANSFORMER, HP-IL, 5V	1
Q2,Q3,Q7	1854-0215	TRANSISTOR, 2N3904	3
Q5,Q6,Q8	1853-0036	TRANSISTOR, 2N3906	3
Q4	1853-0320	TRANSISTOR, 2N4032	1
Q1	1853-0236	TRANSISTOR, 2N5193	1

* Logic PCA parts are designated by an A1 prefix.

Table 6-4. Drive PCA Replaceable Parts

REFERENCE DESIGNATION*	HP PART NUMBER	DESCRIPTION	QUANTITY
C17	0160-4521	CAPACITOR, 12 pF, 5%, 200V	1
C15	0160-4800	CAPACITOR, 120 pF, 5%	1
C12	0160-4810	CAPACITOR, 330 pF, 5%, 100V	1
C16	0160-4820	CAPACITOR, 1800 pF	1
C14	0160-4697	CAPACITOR, 3900 pF, 100V	1
C5	0160-3879	CAPACITOR, 0.01 uF, 20%	1
C6,C11, C19	0160-0576	CAPACITOR, 0.1 uF, 20%, 50V	3
C3,C4,C7 C8,C18	0160-0127	CAPACITOR, 1 uF, 20%, 25V	5
C1,C2, C9,C10	0180-2663	CAPACITOR, 6.8 uF	4
C13	0160-4830	CAPACITOR, 2200 uF, 10%	1
J6	1251-7011	CONNECTOR, 20-pin Male, to logic PCA	1
CR5,CR6	1901-0535	DIODE, Schottky	2
CR1-CR4	1901-1098	DIODE, switching	4
L1	0811-3586	INDUCTOR, wirewound, 4.7-ohm	1
U1,U2	1826-0287	INTEGRATED CIRCUIT, comparator, quad	2
U7	1826-0161	INTEGRATED CIRCUIT, diff amplifier, quad	1
U3	1820-2276	INTEGRATED CIRCUIT, exclusive-OR gate,	1
U5	1820-1753	INTEGRATED CIRCUIT, flip-flop, dual	1
U4	1820-1485	INTEGRATED CIRCUIT, one-shot, dual	1
U8	1820-1016	INTEGRATED CIRCUIT, OR gate, dual	1
U9	1826-0460	INTEGRATED CIRCUIT, regulator	1
U6	1820-2418	INTEGRATED CIRCUIT, sense amplifier	1
DS1	1990-0783	LED (light-emitting diode)	1
	0510-0160	NUT, transistor Q3	1

Table 6-4. Drive PCA Replaceable Parts (Continued)

REFERENCE DESIGNATION*	HP PART NUMBER	DESCRIPTION	QUANTITY
R4	0698-8820	RESISTOR, 4.64-ohm	1
R19	0683-1515	RESISTOR, 150-ohm, 5%, 1/4W	1
R21	0698-3441	RESISTOR, 215-ohm, 1%, 1/8W	1
R23	0757-0416	RESISTOR, 511-ohm, 1%, 1/8W	1
R24	0757-0422	RESISTOR, 909-ohm, 1%, 1/8W	1
R14,R15	0683-1025	RESISTOR, 1K, 5%, 1/4W	2
R5	0698-0085	RESISTOR, 2.61K, 1%, 1/8W	1
R2,R26	0698-3155	RESISTOR, 4.64K, 1%, 1/8W	2
R11	2100-3210	RESISTOR, 10K, 10%, adjustable	1
R7,R17	2100-0558	RESISTOR, 20K, 10%, adjustable	2
R1,R18	0683-2735	RESISTOR, 27K, 5%, 1/4W	2
R3	0757-0123	RESISTOR, 34.8K, 1%, 1/8W	1
R8,R12, R29	0698-3450	RESISTOR, 42.2K, 1%, 1/8W	3
R22	2100-3253	RESISTOR, 50K, 10%, adjustable	1
R6	0683-5635	RESISTOR, 56K, 5%, 1/4W	1
R30	0683-1045	RESISTOR, 100K, 5%, 1/4W	1
R20	2100-3214	RESISTOR, 100K, 10%, adjustable	1
	0698-3136	RESISTOR, 17.8K, 1%, 1/8W	**
	0698-3158	RESISTOR, 23.7K, 1%, 1/8W	**
	0698-3159	RESISTOR, 26.1K, 1%, 1/8W	**
	0757-0123	RESISTOR, 34.8K, 1%, 1/8W	**
R16,R27	0698-3453	RESISTOR, 196K, 1%, 1/8W	2
R25	0698-3458	RESISTOR, 348K, 1%, 1/8W	1
R13	0698-3460	RESISTOR, 422K	1
Q1,Q2,Q5	1853-0036	TRANSISTOR, 2N3906	3
Q3	1854-0368	TRANSISTOR, 2N5191	1
Q4	1853-0236	TRANSISTOR, 2N5193	1
	2200-0728	SCREW, 4-40 x 0.312-inch, transistor Q3	1
S1B	0363-0186	SWITCH CONTACT, cassette-present	1
S1A	0360-2038	SWITCH SPRING, cassette-present	1

* Drive PCA parts are designated by an A2 prefix.

** Used on early-style units which have a fixed EOT resistor A2R20. Only one of the four values is used, depending on the circuit characteristics. Refer to table 4-13, EOT Circuit, section B.

SECTION
VII

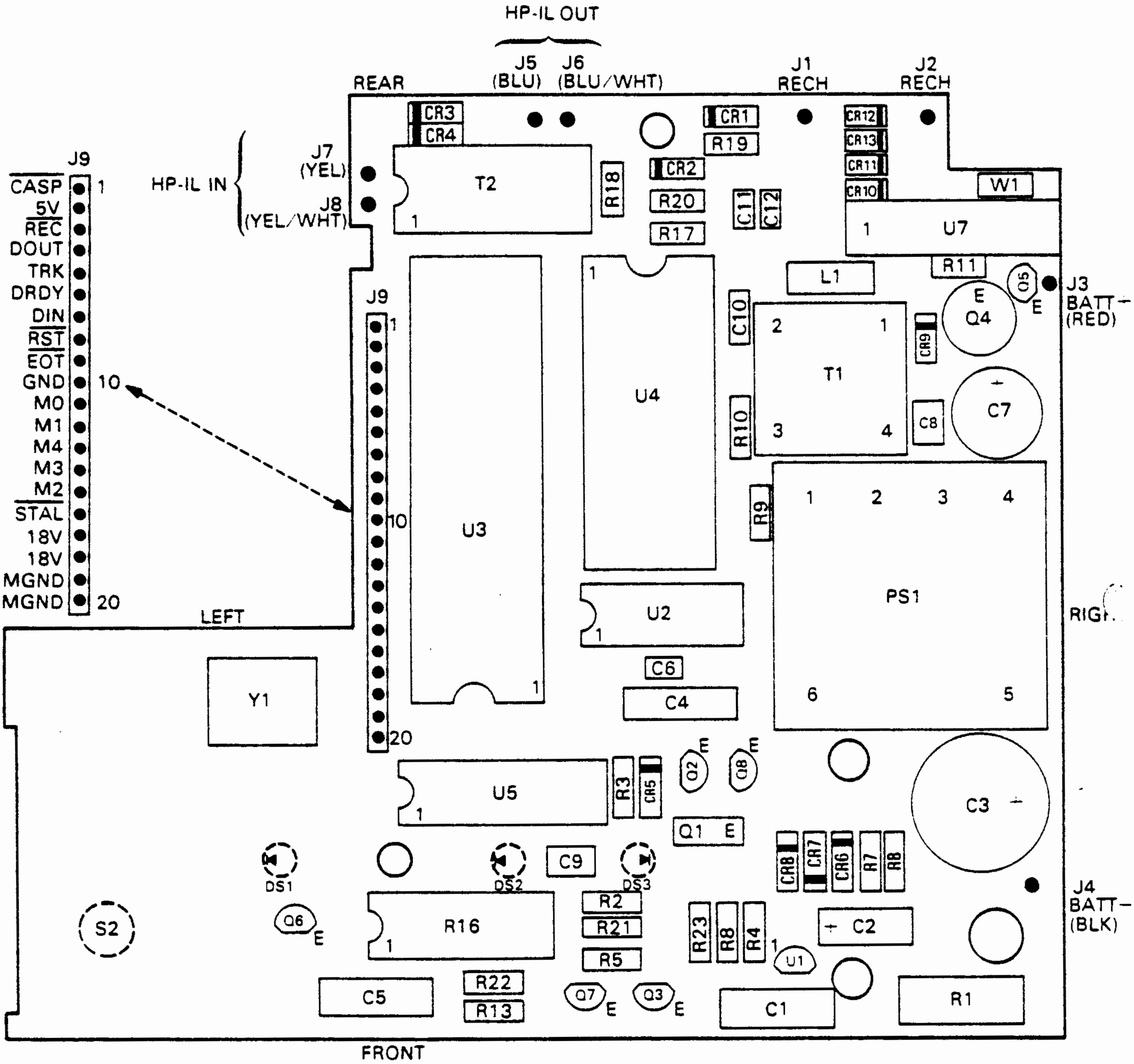
Reference Diagrams

-1. This section includes reference diagrams for the HP 82161A Digital assette Drive.

-2. The component location diagrams for the logic PCA, the EOT PCA, and he drive PCA are shown in figures 7-1, 7-2, and 7-3 respectively. Replaceable parts are listed in section VI.)

-3. The HP 82161A Digital Cassette Drive schematic diagram is shown in igure 7-4.

-4. On some early units, the positions of the phototransistor and LED ssociated with the End-Of-Tape circuit are interchanged. The component ocation diagrams for the EOT PCA and the Drive PCA for these early units re shown in figures 7-5 and 7-6 respectively.



Note: Insulator is installed under transistor Q4.

Figure 7-1. Logic PCA Component Location Diagram

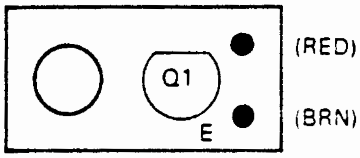


Figure 7-2. EOT PCA Component Location Diagram

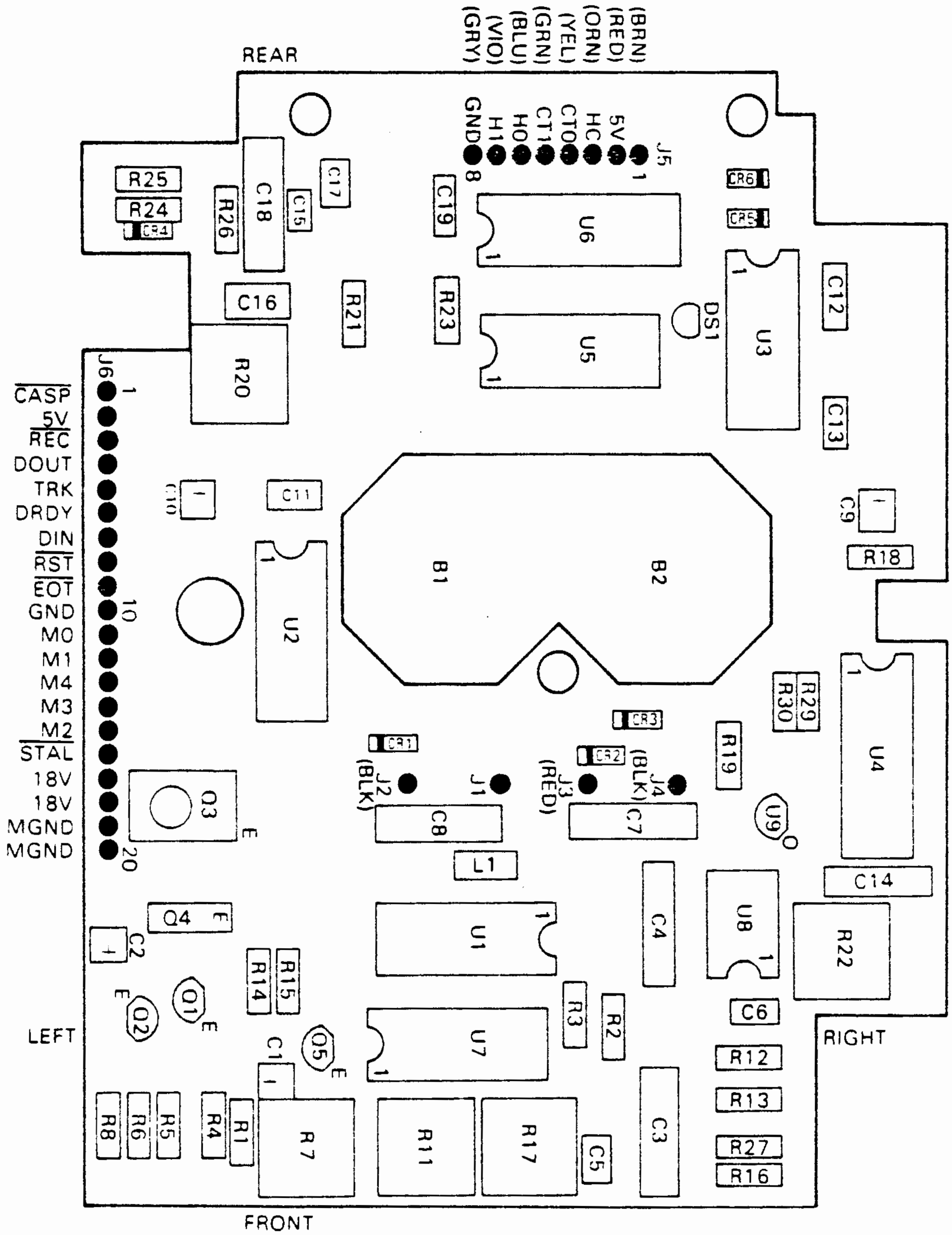
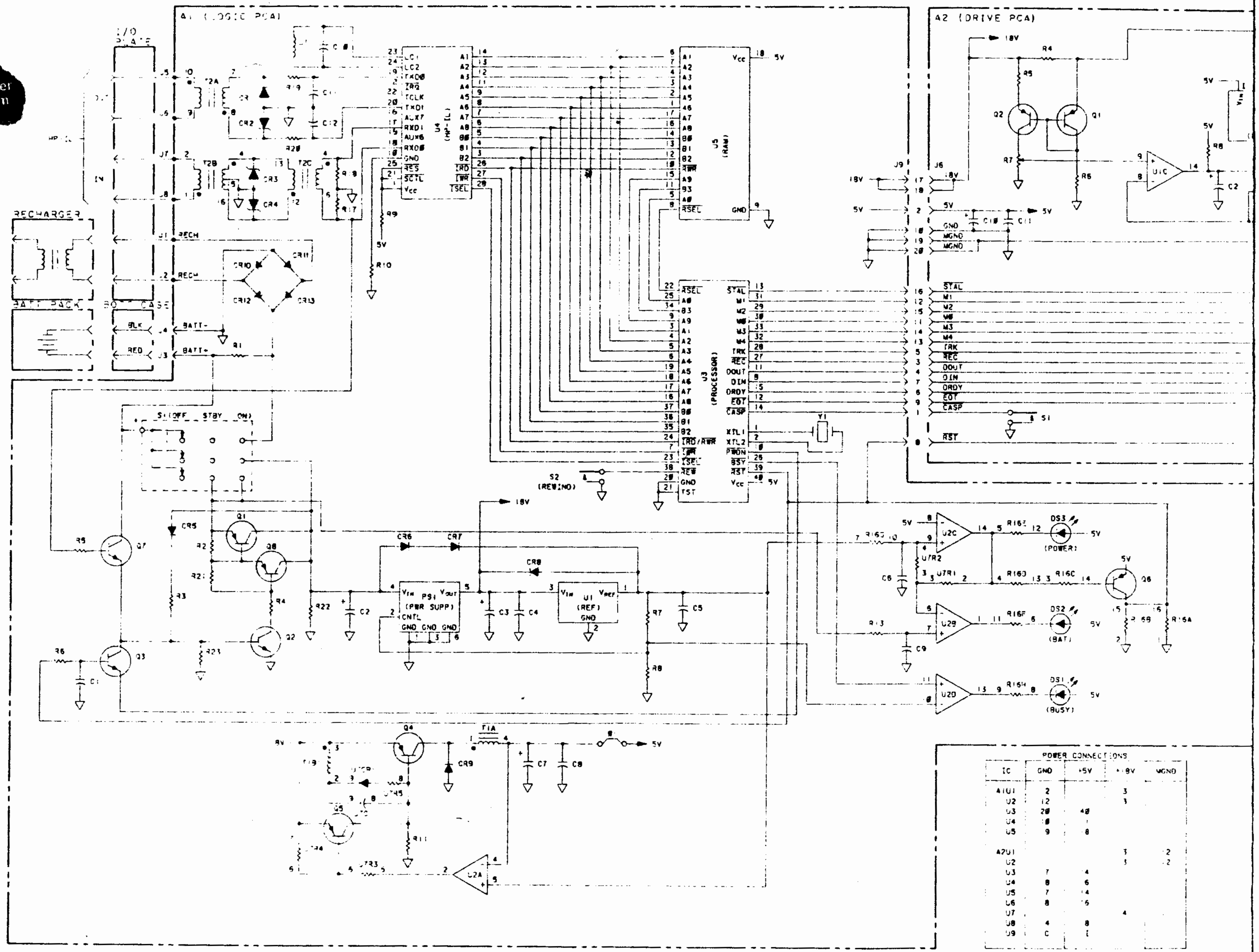
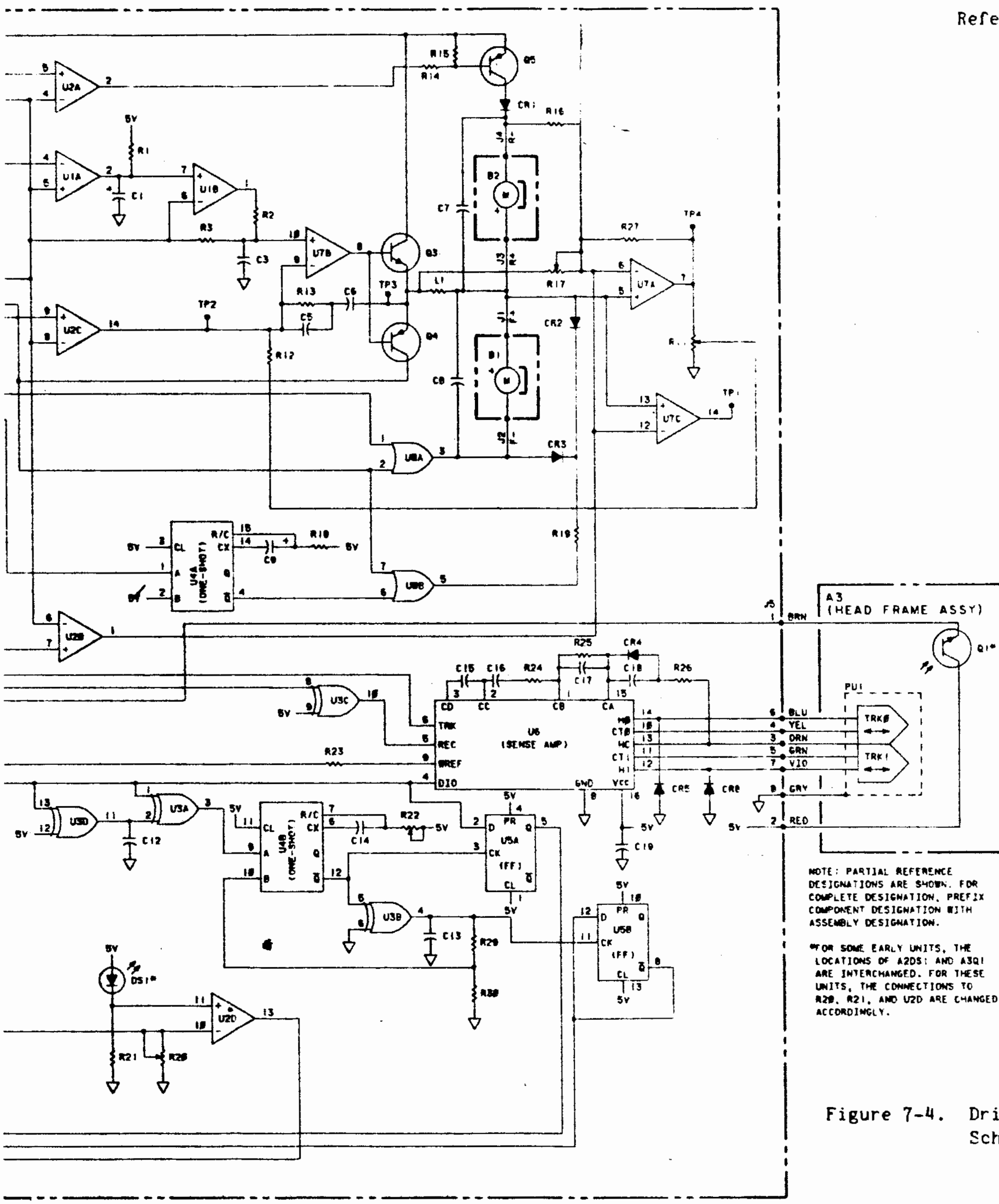


Figure 7-3. Drive PCA Component Location Diagram

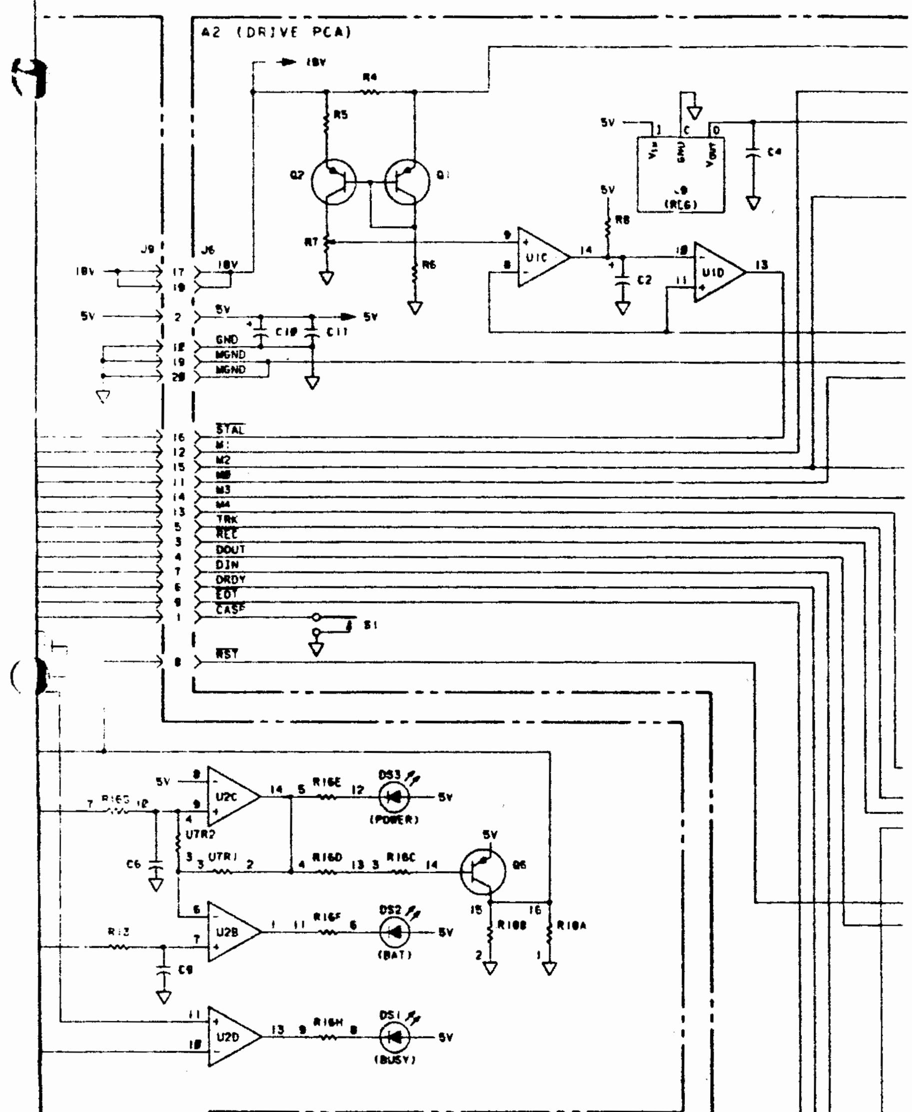

A1 (LOGIC PCA)
A2 (DRIVE PCA)
I/O PLATE
RECHARGER
BATT PACK
BOTT CASE
U5 (RAM)
U3 (PROCESSOR)
U4 (HP-IL)
PS1 (PWR SUPP)
U1 (REF)
S1 (OFF STBY ON)
S2 (REWIND)
DS3 (POWER)
DS2 (BAT)
DS1 (BUSY)
POWER CONNECTIONS
IC
GND
+5V
+18V
MGND



NOTE: PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. FOR COMPLETE DESIGNATION, PREFIX COMPONENT DESIGNATION WITH ASSEMBLY DESIGNATION.

*FOR SOME EARLY UNITS, THE LOCATIONS OF A2DS1 AND A3Q1 ARE INTERCHANGED. FOR THESE UNITS, THE CONNECTIONS TO R20, R21, AND U2D ARE CHANGED ACCORDINGLY.

Figure 7-4. Drive PCA Schematic Diagram



POWER CONNECTIONS

IC	GND	+5V	+18V	MGND
A1U1	2		3	
U2	12		3	
U3	20	40		
U4	10	1		
U5	9	10		
A2U1			3	12
U2			3	12
U3	7	14		
U4	8	16		
U5	7	14		
U6	8	16		
U7			4	11
U8	4	8		
U9	C	I		

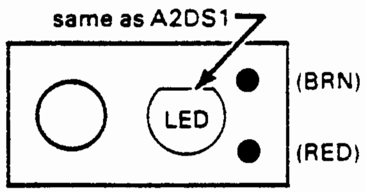


Figure 7-5. Early EOT PCA Component Location Diagram