HP 35401A
Hardware Support Manual

Manual part number: 35401-90904

OPTIONS COVERED

In addition to the standard model, this manual covers the following options: 100.

HEWLETT PACKARD

Notice

The information contained in this document is subject to change without notice.

FOR U.S.A. ONLY

The Federal Communications Commission (in 47 CFR 15.838) has specified that the following notice be brought to the attention of the users of this product.

FEDERAL COMMUNICATIONS COMMISSION
RADIO FREQUENCY INTERFERENCE
STATEMENT

Warning: This equipment generates and uses radio frequency energy and if not installed and used properly, that is, in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: re-orient the receiving antenna; relocate the computer with respect to the receiver; move the computer away from the receiver; plug the computer into a different branch circuit. If necessary, the user should consult the dealer or authorized field service representative for additional suggestions. The user may find the following booklet prepared by the Federal Communications Commission helpful: "How to Identify and Resolve Radio-TV Interference Problems". This booklet is available from the U.S. Government Printing Office, Washington, DC 20402. Stock No. 004-000-00345-4.

Printing History

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new edition or a new update is published. No information is incorporated into a reprinting unless it appears as a prior update; the edition does not change when an update is incorporated.

A software code may be printed before the date; this indicates the version level of the software product at the time the manual or update was issued. Many product updates and fixes do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one-to-one correspondence between product updates and manual updates.

Edition 1...MARCH 1986
Edition 2...OCTOBER 1988

Safety Considerations

GENERAL - This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

SAFETY SYMBOLS

Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the product against damage.

Indicates hazardous voltages.

Indicates earth (ground) terminal.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure or practice that, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure or practice that, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

SAFETY EARTH GROUND - This is a safety class I product and is provided with a protective earthing terminal. An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and be secured against any unintended operation.

BEFORE APPLYING POWER - Verify that the product is configured to match the available main power source according to the input power configuration instructions provided in this manual.

If this product is to be operated with an autotransformer make sure that the common terminal is connected to the earth terminal of the main power source.

SERVICING

WARNING

Any servicing, adjustment, maintenance, or repair of this product must be performed only by service-trained personnel.

Adjustments described in this manual may be performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside this product may still be charged after the product has been disconnected from the main power source.

To avoid a fire hazard, fuses with the proper current rating and of the specified type (normal blow, time delay, etc.) must be used for replacement. To install or remove a fuse, first disconnect the power cord from the device. Then, using a small flat-bladed screw driver, turn the fuseholder cap counterclockwise until the cap releases. Install either end of a properly rated fuse into the cap. Next, insert the fuse and fuseholder cap into the fuseholder by pressing the cap inward and then turning it clockwise until it locks in place.

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Product Information

This section contains general information about the HP 35401A 1/4-inch Cartridge Autochanger Tape Subsystem, which will be known as the Tape Drive. This information consists of a general description, details of options and accessories, specifications and serial number information. Also included is information about supported equipment, any test equipment and special tools needed, and the product support strategy.

1-1. GENERAL DESCRIPTION

The HP 35401A is a 1/4-inch cartridge tape drive which provides backup for systems with a disc capacity of up to 536 Mbytes. This is done by providing an HP 9144A Tape Drive Mechanism with an autochanger unit and a stack of up to eight 1/4-inch cartridges in a removable magazine. The unit is designed for connection to the Hewlett-Packard Interface Bus (HP-IB),* and uses the CS/80 Instruction Set (see sections 10-2 to 10-9).

The HP 35401A provides read-while-write capability for data verification, as well as data recovery and auto-sparing. A media monitor is included for data protection which gives a front panel warning when a tape cartridge is nearing the end of its useful life. The data can then be copied onto a new tape and the old cartridge discarded.
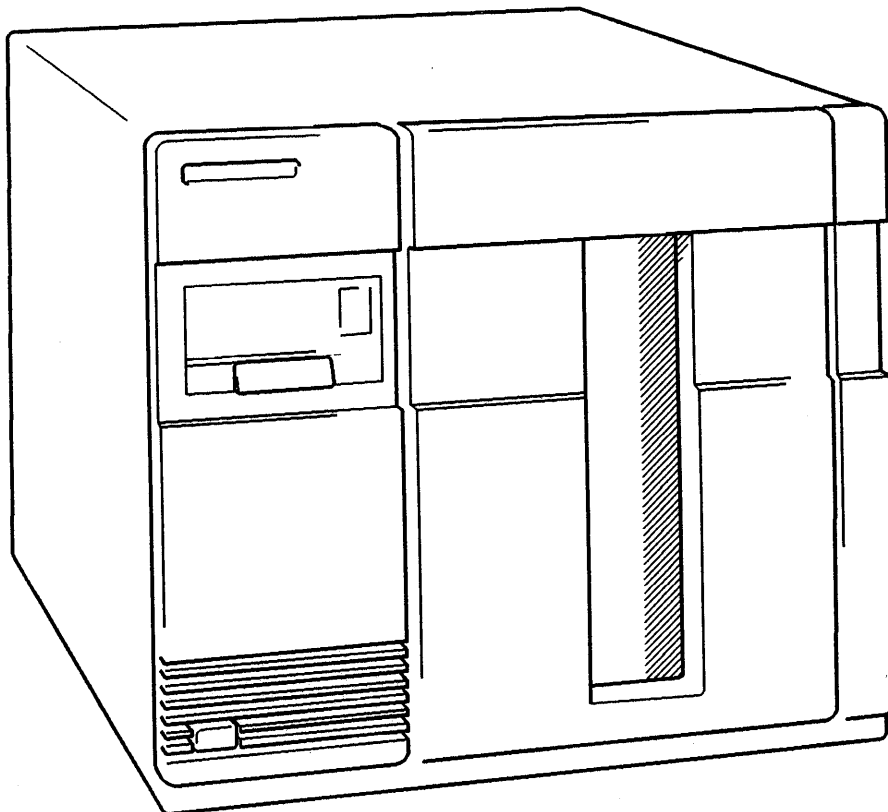
Figure 1-1. The HP 35401A Tape Drive

* **DESIGNED FOR HP-IB SYSTEMS** Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path to a computer system.

The HP 35401A can be used in two ways:

- Sequential Mode, where the Tape Drive behaves exactly as an HP 9144A Tape Drive. The tapes are accessed sequentially from 1 to 8 (from the bottom to the top of the magazine).

- Selective Mode, where the cartridges in the magazine can be accessed in any order.

1-2. OPTIONS

In addition to the standard drive, there is an option 100. The drive itself is standard, but instead of the blank 600 foot cartridge normally supplied, there is a 150 foot cartridge tape. This is a patch tape which holds revised software (the driver DD*33 and physical utilities ASAVE and ARSTR) to support HP 1000 host systems. The part number of this tape is HP 24999-13331.

1-3. ACCESSORIES SUPPLIED

When the Tape Drive is received, the shipping container should contain the following items:

Tape Drive: HP 35401A
One 600 foot cartridge (150 foot Opt. 100)
One cleaning cartridge kit: HP 92193E
1 meter HP-IB cable: HP 10883A
Power cord: As appropriate (see section 3-7)
1 spare fuse: 2110-0003
User's Manual: 35401-90902
Quick Reference Guide: 35401-90903
Applications Guide: 35401-90951
CS/80 Support Manual: 35401-90921

1-4. ACCESSORIES AVAILABLE

The following accessories may be purchased separately to supplement those which are supplied.

HP 35401A Hardware Support Manual: 35401-90904

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*"C" denotes factory certified tapes.

HP 35401A Customer Engineer Handbook: 35401-90905
HP-IB Interface Cable
    0.5 meter: HP 10833D
    1.0 meter: HP 10833A
    2.0 meter: HP 10833B
    4.0 meter: not recommended
Package of five 16.7 Mbyte, 150 foot tape cartridges: HP 88140SC*
Package of five 67.1 Mbyte, 600 foot tape cartridges: HP 88140LC*
Cartridge Magazine: HP 92192C
Cleaning Cartridge Kit: HP 92193E
Replenishment Kit for above: HP 92193P
Design Plus mobile mini-rack system cabinet: HP 92211R
Rail Kit for HP 92211R. Contains 4 sets of rails and module locks: HP 92211S
Filler Panel Kit for HP 92211R. Contains twenty 26mm high snap-in panels to fill the space not occupied by equipment: HP 92211T
19-inch Rack Mount Kit: HP 35490A

1-5. PERFORMANCE SPECIFICATION

The Tape Drive has the following performance specifications.

1-6. DATA CAPACITY (FORMATTED)

67.1 Mbytes per "L" cartridge (600 foot)
16.7 Mbytes per "S" cartridge (150 foot)
8 cartridges maximum per magazine
536.8 Mbytes maximum per magazine

1-7. DATA TRANSFER RATE

Maximum sustained: 2 Mbytes per minute (SYSTEM DEPENDENT)

Maximum sustained transfer rate does not necessarily reflect system throughput which varies depending upon application, file structure and host/tape driver implementation.

Tape Read/Write Speed: 60 inches per second
Tape Search/Rewind Speed: 90 inches per second

1-8. ACCESS TIME

Cartridge select time
(cartridge from magazine to drive mechanism)
  10 seconds minimum
  30 seconds maximum

Cartridge load/unload times in drive
Load: 1 minute 15 seconds (150 foot cartridge)
    2 minutes 15 seconds (600 foot cartridge)
Unload: 35 seconds (150 foot cartridge)
    1 minute 30 seconds (600 foot cartridge)

The Total Access Time is the sum of the cartridge select time and the cartridge load/unload time.

1-9. RECORDING PARAMETERS

Encoding Technique: MFM
(Modified Frequency Modulation)
Bit Density: 10,000 Bits/inch (bpi)

1-10. HARD ERROR RATE

1 in 10^{11} bits transferred

1-11. SERIAL NUMBER INFORMATION

HEWLETT·PACKARD
MODEL : 35401A
SERIAL : 0000 E 00000
OPTION :
OO   MADE IN UNITED KINGDOM

Figure 1-2. The Serial Number label

The serial number label consists of a four digit prefix, a letter, and a five digit suffix (0000 E 00000). The first four digits indicate design changes. The letter designates the country in which the unit was manufactured ("E" indicates England). The five digit suffix is a sequential number which increments with each Tape Drive shipped. This label is located below the self-test displays on the rear panel.

In addition to the serial number label on the rear panel, there is a similar label on the tape drive mechanism. The serial numbers should be quoted when ordering parts.

1-12. TEST EQUIPMENT AND SPECIAL TOOLS

To repair the unit, you need the Customer Engineer toolkit and a TORX* kit. In addition, the following tools are needed:

Ball driver (8710-1570)
Box wrench, ratchet (8710-0805)
Belt setting tool (35401-60030)
Door Alignment Tool (35401-20067)

These are found in the Expensed Tools Package (35401-67100).

The HP 85 Service System is required for detailed troubleshooting.

1-13. HOST SUPPORT

The HP 35401A Tape Drive is supported on the host systems shown in figure 1-3.

This support matrix shows the earliest versions of operating system on which you can use the Tape Drive. These, and all later versions are supported. Use in the sequential (SEQ) and selective (SEL) mode is allowed where shown by an asterisk.

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*TORX$^{(R)}$ is a registered trademark of the Camcar Division of Textron, Inc.

HOST SYSTEM	OPERATING SYSTEM	SEQ	SEL	COMMENTS
HP 3000 - 37/39/40/42/44/ 48/52/58/64/68/ 70/MICRO 3000/ MICRO 3000XE	MPE V/E UB Delta 1 with Patch U000	*		
HP 9000 - SERIES 200/300	BASIC 4.0	*		SEE NOTE 1
	PASCAL 3.1	*		SEE NOTE 1
	HP-UX 5.1	*	*	SEE NOTE 1, 2
HP 9000 - SERIES 500	HP-UX 5.0	*		SEE NOTE 5
HP 9000 - SERIES 800	HP-UX 1.1	*	*	SEE NOTE 1, 2
HP 9000 - SRM	SRM 3.0	*		
HP 1000 - A SERIES	RTE-A 4.1	*		SEE NOTE 4
- M,E,F SERIES	RTE-6/VM	*		SEE NOTE 3

Note 1: Multiple cartridge use with this operating system in Sequential mode may require some operator intervention to change the cartridges.

Note 2: Selective mode operation with this operating system allows cartridges to be loaded in any order under software control (e.g. 2, 6, 3, ...).

Note 3: You will need the HP 24999-13331 Software Utility, which is supplied and supported by the DSD Specials Group.

Note 4: Order HP 35401A with Option 100. (From RTE-A 5.0 onwards, Option 100 is not required).

Note 5: Requires Autobkup script for unattended backup. This is available from your local Response Center. The Autobkup script is also included in HP-UX 5.1.

Figure 1-3. Host Support
(see Peripheral Configuration Guide 5953-9472)

1-14.   SUPPORT STRATEGY

Level of Repair
The HP 35401A is repaired to the Field Replaceable Assembly (FRA) level. A combination of both non-exchange and exchange parts from the Product Support Division (PrSD) exchange program are used to achieve this.

Field Repair Center Strategy

If the HP 35401A is repaired at a Field Repair Center it should only be to the FRA level.

Diagnostics
See also Section 8. It is the aim of the diagnostic firmware to determine the most suspect FRA (MSFRA) and display this information on the rear panel. The customer can read the rear panel display and provide the Customer Engineer with information about the failure prior to his visit. This enables the Customer Engineer to take sufficient parts on-site and minimize the repair time. More

than one FRA may be indicated; the most suspect FRA being displayed first. Pressing the self-test results button on the rear panel cycles through the remainder of the indicated failures.

To aid troubleshooting a module has been added to the CS/80 External Exerciser diagnostic tape.

This diagnostic need only be used when the fault LEDs and the system level exerciser are not adequate to facilitate a repair. (see sections 3-11 and 8-5).

Site Preparation and Requirements 2

This section contains the information needed to set up a suitable site for the HP 35401A Tape Drive. It includes electrical, environmental and physical specifications, and cable restrictions.

The following paragraphs discuss the requirements for proper operation of the Tape Drive. For detailed site environmental information, refer to the HP publication *CEO Site Prep Handbook* (HP 5958-2370).

2-1. ELECTRICAL SPECIFICATIONS

The electrical specifications of the Tape Drive are to be found in Tables 2-1 and 2-2. The unit is a single phase, dual voltage (switch selectable) device which comes supplied with an appropriate power cord and fuse.

SAFETY

- CSA Certified to CSA 22.2 No. 154

- Meets all applicable safety standards of IEC 380 and IEC 435

- UL listed to UL 114 and UL 478

Units shipped will meet the requirements of the country of destination.

2-2. ENVIRONMENTAL SPECIFICATIONS

The HP 35401A Tape Drive is designed to meet the Class B requirements of the HP Corporate Environmental Specification. However, the conditions under which the Tape Drive will operate are limited to those allowed for the media. These limitations are:
Temperature:
Operating: +5°C to +40°C (41°F to 104°F)
Non-operating: -40°C to +45°C (-40°F to 113°F)

Humidity: 20% to 80% with maximum wet bulb temperature (non-condensing) not to exceed 26°C (79°F).

Tape Drive Environmental specifications are given in Table 2-3.

Cartridge Tape specifications are given in section 4-1.

2-3. PHYSICAL SPECIFICATIONS

Details of the Tape Drive physical specifications are given in Table 2-4.

Product: TAPE DRIVE   No. 35401A

Responsible Division: Computer Peripherals Bristol

Table 2-1. ELECTRICAL SPECIFICATIONS: POWER AND HEAT

INPUT VOLTAGE / FREQUENCY

Nominal	115V, 60Hz or 230V, 50Hz (switch selectable)
Range	90V min to 132V max.
	180V min to 264V max.
	47Hz to 66Hz

CURRENT, in AMPERES

PHASE A, or 1-PHASE:	Single Phase
Typical Steady-State	115V, 60Hz - 0.8A 230V, 50Hz - 0.5A
Maximum Steady-State	115V, 60Hz - 1.0A 230V, 50Hz - 0.8A

POWER USE, in VOLT-AMPS

Typical	115VA
Maximum	184VA

POWER USE, in WATTS

Typical	60W
Maximum	100W

HEAT GENERATION

Typical:	BTUs/h	204.7
	kcals/h	51.6
Maximum:	BTUs/h	341.2
	kcals/h	86

Product: TAPE DRIVE   No. 35401A

Table 2-2. OTHER ELECTRICAL SPECIFICATIONS

POWER LINE SUSCEPTIBILITY TO LINE TRANSIENTS

Voltage Transients

% of Nominal   ±10% and ±30% of 240V

Duration ms   10

Frequency Transients

% of Nominal   ±5% and ±10%

Duration ms   10

Spike Transients

Amplitude volts   1500V

Rise Time   5ns

CIRCUIT BREAKER REQUIRED   NO

Product: TAPE DRIVE   No. 35401A

Table 2-3. ENVIRONMENTAL SPECIFICATIONS

AMBIENT TEMPERATURE

OPERATING (media limited):
Minimum   +5°C (41°F)
Maximum   +40°C (104°F)

MEDIA NON-OPERATING:
Minimum   -40°C (-40°F)
Maximum   +45°C (113°F)

DRIVE NON-OPERATING:
Minimum   -40°C (-40°F)
Maximum   +75°C (167°F)

RELATIVE HUMIDITY

OPERATING (no media)   MAX 95% @ +40°C

NON-OPERATING   MAX 90% @ +65°C for 24hrs

ALTITUDE

OPERATING   15 000 feet 4 572m

NON-OPERATING   50 000 feet 15 240m

RADIATED EMI SUSCEPTIBILITY
(VOLTS/METER @ 14kHz - 1GHz)   Meets FCC "CLASS A"

ESD SUSCEPTIBILITY (VOLTS)   >25kV

Product: TAPE DRIVE

Table 2-4. PHYSICAL SPECIFICATIONS

CRATED DIMENSIONS AND WEIGHT

HEIGHT		WIDTH		DEPTH		WEIGHT	
mm:	420	mm:	490	mm:	74J	kg:	28
in:	16.5	in:	19.3	in:	29.1	lb:	62.7

UNCRATED DIMENSIONS AND WEIGHT

HEIGHT		WIDTH		DEPTH		WEIGHT	
mm:	260	mm:	325	mm:	575	kg:	22.5
in:	10.2	in:	12.8	in:	22.8	lb:	50.5

POWER CABLES (LENGTH, mm - in)

STANDARD	OPTIONAL	CONNECTOR TYPE
1210mm	--x--	Male: See Figure 3-3.
48in	--x--	Female: CEE

HP-IB DEVICE LOADS

SHIPPED LOADS	OPTIONAL RANGE	INTERNAL HP-IB CABLE LENGTH
1	--x--	--x--

Installation and Configuration **3**

This section contains information needed for you to set up and check out the Tape Drive.

3-1.   UNPACKING AND INSPECTION

The HP 35401A should, under normal circumstances, be unpacked by the customer and instructions are included in the User's Manual to this effect. These instructions are repeated here for the benefit of service personnel.

The Tape Drive was carefully inspected before shipment. When the shipment arrives, ensure that the container has been received as specified by the carrier's bill of lading. Inspect the shipping container immediately upon receipt for evidence of mishandling during transit. If it is damaged or water-stained, request that the carrier's agent be present when the container is unpacked.

Figure 3-1. The Tape Drive, as shipped

WARNING

To avoid dangerous electric shock, do not apply power to the HP 35401A when there are signs of damage to any portion of the outer casing. If any damage is observed, immediately notify your dealer or Hewlett-Packard Sales and Support Office and file a claim with any carriers involved.

A list of Hewlett-Packard Sales and Support Offices is provided at the back of this manual.

If the shipping container appears to be in good condition proceed to unpack the Tape Drive.

The shipping container consists of a strong cardboard box and two preformed foam blocks. These are shown in figure 3-1.

To unpack the unit, cut the self-adhesive tape which holds the top flaps of the box together. Open the flaps and remove the accessories box which is found on top of the Tape Drive.

WARNING

The Tape Drive is heavy (22kg - 50lb). Avoid injury by lifting it out of its container with your back straight.

Lift out the unit, together with the foam packing blocks, by sliding your hands down between the box and the sides of the unit. Hold the Tape Drive under its base, noticing that the unit is rear-heavy.

Having removed the unit from the shipping container, inspect the unit for any mechanical damage that may have occurred during shipment.

The packaging also contains the accessories supplied with the unit, in an accessories box on top of the Tape Drive. Ensure that the equipment supplied complies with the Packing List and that this agrees with the Purchase Order. A list of the contents of the shipping container is given in section 1-3. Having unpacked the Tape Drive it is worth keeping the shipping container and packing materials for future use.

3-1

| NOTE |

For instructions on how to unpack and repack earlier models of the HP 35401A, which had two red plastic door-clips, refer to chapter 11 - Product History.

The cartridge magazine comes installed in the front door. To open the door, pull the red door-puller tab downwards (see figure 3-2).
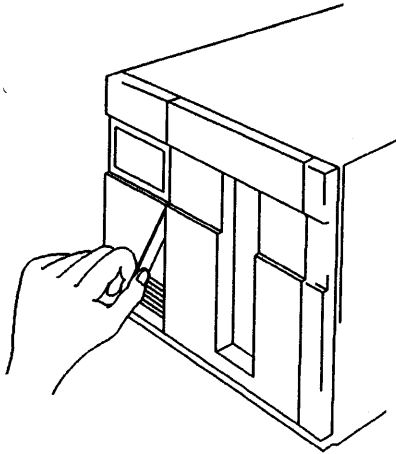
Figure 3-2. The Door-Puller Tab

Once the door is open, store the red tab away safely, in case the drive needs to be repacked and shipped in the future.

Pull out the cartridge magazine, noting the cord attached to its bottom. This cord is attached to two black, plastic coated transit clips which secure the autochanger mechanism. Pull the cord and detach the clips, freeing the mechanism. Detach the cord from the magazine and store it, in case the drive requires future shipping. Remove the foam block from the magazine. The Tape Drive is now fully unpacked.

If any items are incorrect or missing, please accompany all enquiries with the following information:

* Original order number or unit serial number

* Receiving address

3-2. REPACKING

If, for any reason, the Tape Drive is to be returned to Hewlett Packard it should be sent back in its original packaging.

REPACKING INSTRUCTIONS

1) Remove ALL cartridges from the magazine.

2) Identify the two clips which hold the interior platform steady. In some units, there may be a single, wider clip, also with a length of cord attached.

3) Pass the cord through the magazine handle and feed the spring clip(s) through the loop in the cord. Pull tight, so that the clips are tied to the magazine by about 1/2 meter of cord.

4) Insert the foam block into the magazine.

5) Reach through the front door and fix the spring clip so that it clips the moveable platform (which has a Serial Number Label attached to it) to the base casting. Note that the platform must be in its lowest position.

6) Slide the magazine down through the front door, BUT DO NOT CLOSE THE DOOR. Ensure that the cord is NOT trapped under the magazine. This could cause the magazine to sit high and jam the door shut. If this happens, you can open the door by pushing down on the magazine and pulling the door open at the same time.

7) Refit the red door-puller tab and close the door.

8) Place the drive in its plastic bag and fit the foam end pieces.

9) Lower the drive carefully into the box. Place the foam top piece on top. Place the accessories box in the depression in the top piece and close and seal the box.

3-3.   STORAGE

If the Tape Drive is not to be used for extended periods, its life will be prolonged by storing it in its shipping container in a cool dry place. Select the storage site considering the non-operating environmental limits set out in section 2-2.

3-4.   LINE VOLTAGE AND FUSING

The voltage select switch on the rear panel must be set to the appropriate nominal line voltage for the area in which the Tape Drive is used. This switch is normally set to the appropriate voltage prior to shipping. The choice is either 115VAC or 230 VAC. Use a 3.0A fuse (normal/fast blow) for either voltage, even though you would expect a higher fuse rating for the lower voltage. The switch-mode supply should only be protected by a fuse of the given rating.

WARNING

Always disconnect the Tape Drive from any AC line before changing fuses.

The correct fuse to use is a 3.0A, 250VAC, Normal/Fast Blow. This is obtainable as HP Part Number 2110-0003. Refer to the Safety Considerations Page at the front of this manual for instructions on fuse replacement.

3-5.   MOUNTING INSTRUCTIONS

The HP 35401A is a desktop unit which can also be mounted in a desk-height stand-alone cabinet (HP 92211R). To fit the Tape Drive into the HP 92211R cabinet a mounting rail kit (HP 92211S) is needed, in addition to a filler panel kit (HP 92211T). See section 1-4. Mounting instructions for the Tape Drive in the stand-alone cabinet are found in the installation guide 35401-90907.

The Tape Drive may also be mounted in a standard EIA 19-inch Rack cabinet by using the HP 35490A Rack Mount Kit. Instructions for this are given in the Installation Manual 35490-90901.

3-6.   INTERCONNECTIONS

There are only two interconnections for the Tape Drive, the HP-IB connection to the host computer and a connection to the power source. A typical setup is shown in figure 3-3, where the Tape Drive is connected to an HP 3000 Series 37 computer.
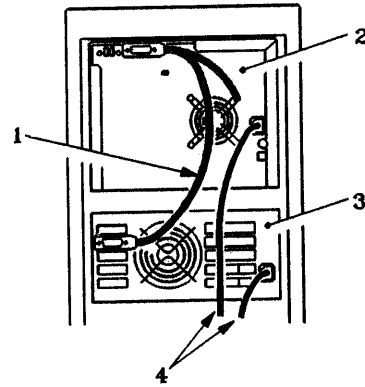
1.....HP-IB Cables
2.....HP 35401A Tape Drive
3.....HP 3000 Series 37 Computer (example)
4.....AC LINE Cords

Figure 3-3. Interconnections to Host and Power

The Tape Drive is supplied with a 1 meter HP-IB cable (HP 10833A). This, or longer cable may be used to connect the Tape Drive to a host computer so long as the following rules are observed:

- All the AC line switches must be turned "OFF" when connecting and disconnecting devices to the system.

- No devices on the HP-IB are to be powered-on or off while there is activity on the bus.

- All devices must be powered-on during any bus transaction with a "high transfer rate" peripheral. When the host is talking to a lower transfer rate peripheral, such as a printer, at least two-thirds of the devices connected to the HP-IB must be powered-on.

- The total length of cable permitted in one bus system must be less than or equal to two meters multiplied by the number of devices connected together.

- The total length of the cable must not exceed 15 meters. The individual cables should be connected together in a linear configuration and the total length must not exceed 15 meters.

- The maximum number of devices that can be interconnected in one bus system is eight.

- Do not stack more than 3 of the connector blocks one on top of another. Large stacks can damage the connector mounting by exerting leverage on it.

- Do not use a screwdriver to tighten the lock screws on the connector blocks, they are designed for tightening by the fingers only. The screwdriver slots are provided to assist removal.

- For best results use only RFI shielded HP-IB cables. (These generally have metal bodied connectors).

The Tape Drive power cable supplied should be the correct type for the country of destination. Those available are shown in figure 3-4.

WARNING

If it is necessary to replace the power cable, the replacement must have a suitable earth conductor. Otherwise an internal failure of the unit could result in a safety hazard.
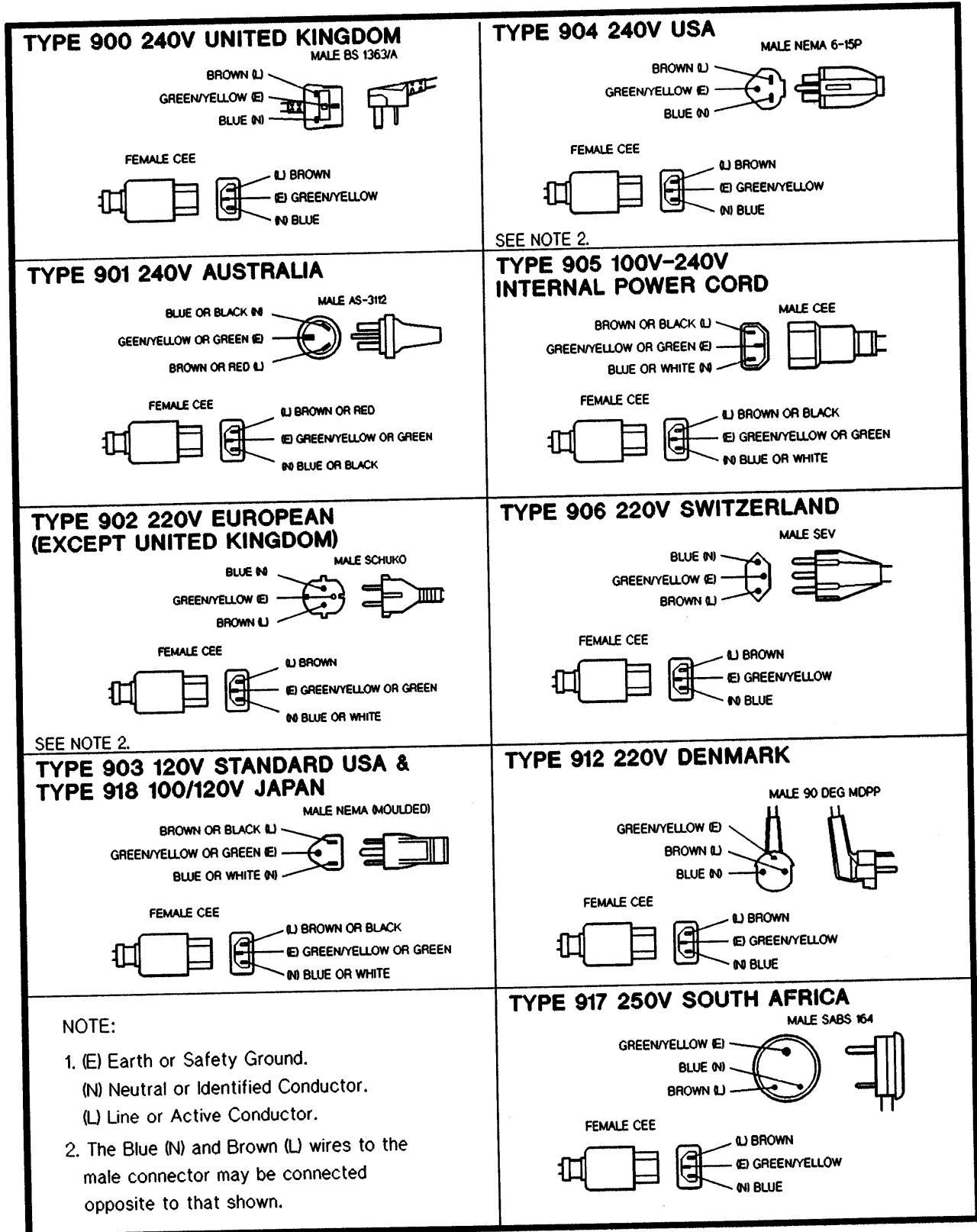
Figure 3-4. Available Power Cords

3-7.   SWITCH SETTINGS

The Tape Drive has seven switches which the user can set. Those on the front panel include the AC Line switch and the [EJECT] button. These are shown in figure 3-5.
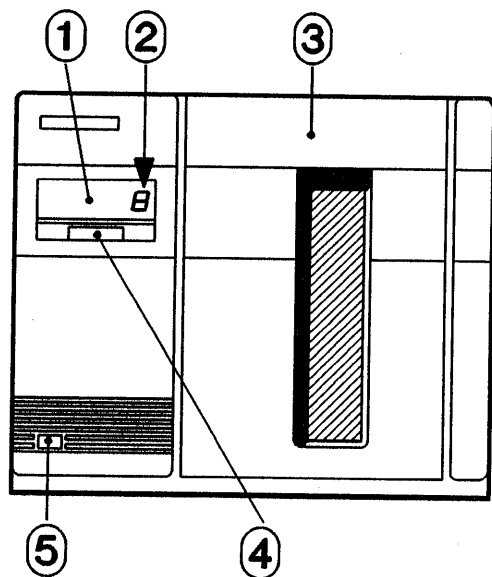
1......LED Displays
2......Cartridge Number Display
3......Front Door
4......[EJECT] Button
5......AC LINE Switch

Figure 3-5. The Front Panel

The AC line switch is on when the button is in and is off when the button is out. Normally the display above the [EJECT] button is not illuminated. Pressing the button initiates an unload sequence or, if in the sequential mode, it can cause the loading of a specific cartridge. Reaction to the switch only begins when the the unit is in a position to respond (that is, when all current tasks have been completed). Once pressed, the EJECT display is illuminated until the eject sequence is complete. This provides the user with evidence that the unit is responding to the eject command.

The rear panel switches include the Display Results (DR) push-button, Initiate Self-Test push-button, Mode Select slide-switch, HP-IB Device Address toggle switches and the Voltage Select slide-switch. These are shown in figure 3-6.
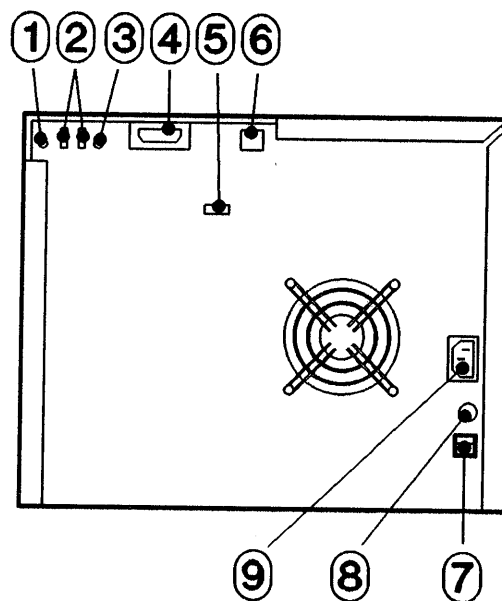
1......Display Results
2......Self-Test Displays
3......Initiate Self-Test Button
4......HP-IB Cable Socket
5......Mode Selector
6......Device Address Switches
7......Voltage Select Switch
8......Fuseholder and Fuse
9......Power Input Socket (AC LINE)

Figure 3-6. The Rear Panel

The Display Results and Initiate Self-Test switches are both miniature push-buttons operated by pressing them with a fine-tipped implement such as a small screwdriver (please do not use a pen or pencil). Their operation and purpose is explained in section 3-11.

The Mode Select switch can be set to either Sequential or Selective Mode. These are two distinct operational modes of the Tape Drive. In Sequential Mode, the host has knowledge only of the cartridge which is currently in the drive. Tape cartridges are used sequentially from the bottom to the top of the magazine. The Selective Mode involves the host having knowledge of up to 8 cartridges. According to the host computer program the cartridges may be used in any order and the cartridges may even have different capacities.

NOTE

The Mode Select switch is examined only at power-on, so the mode must be set before switching on and not altered during use of the Tape Drive.

The HP-IB address switches are set to give the unit the address 3, by which the host can identify it. This address setting should only be altered if the host is also connected to another device whose address is 3. The normal switch positions for this address are shown in figure 3-7. The miniature toggle switches are operated using a fine-tipped tool, such as a small screwdriver (please do not use a pen or pencil).

The address can be set to any value between 0 and 7 according to table 3-1:

Table 3-1. HP-IB Addresses

Switch Settings X 4 2 1	HP-IB Address
0 0 0	0
0 0 1	1
0 1 0	2
0 1 1	3
1 0 0	4
1 0 1	5
1 1 0	6
1 1 1	7

NOTE

When setting the HP-IB address switches, disregard any markings on the switch body. Set the switches according to the markings on the rear panel. It does not matter which way the switch marked X is set.

To register the new address, you must either power-cycle the drive or initiate a self-test by pressing the self-test button (see figure 3-6).
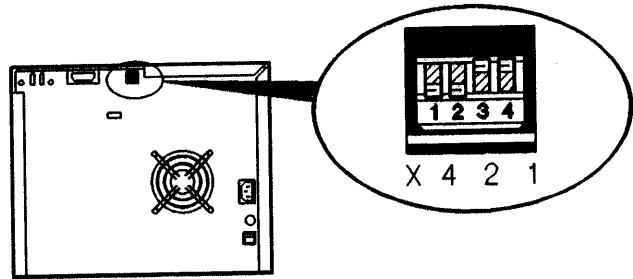
Figure 3-7. HP-IB Address Setting

WARNING

The Voltage Select switch should be set to the appropriate line voltage before the Tape Drive is switched on.

The choice is either a nominal 115 VAC or 230 VAC and this is preset to the appropriate voltage for the country of destination. If it is necessary to alter the voltage setting, the slide switch may be operated with a small screwdriver. The switch location is shown in figure 3-6.

3-8.   CONFIGURATION

The Tape Drive has the capability of operating in two modes. These are the Sequential mode and the Selective mode. Each may be configured by setting the mode select switch on the rear panel (see section 3-7).

SEQUENTIAL MODE

The Sequential mode is the simpler of the two, where the cartridges are accessed in order from the bottom to the top of the magazine. The cartridges may vary in capacity from one to another (16.7 or 67 Mbyte). The Tape Drive loads the cartridges in that order unless the operation is aborted by the host or the operator (see section 3-9).

During Sequential operation the host computer has knowledge only of the cartridge which is currently loaded in the drive. Because of this, the cartridges must be put into the magazine in the order in which they are to be accessed.

SELECTIVE MODE

For this mode the host is aware of up to 8 cartridges; any one of which may be loaded and on-line at a time. The cartridges may vary in capacity from one another, and the order of access of the cartridges depends entirely upon the host computer program.

Random access may be made to any of the cartridges in the magazine using the Load command (see section 10-8 and Table 10-3).

3-9. USER INFORMATION/OPERATION

CONTROLS AND INDICATORS

The Tape Drive controls are limited to switches that the operator can set. Information about these switch settings is given in the previous section (3-7.) and also in the User's Manual (35401-90902).

The indicators are to be found on both the front and rear panels (see figures 3-6. and 3-8.).
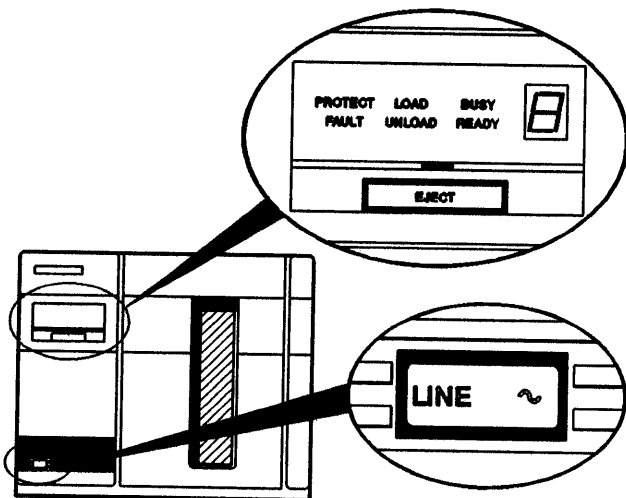
Figure 3-8. Front Panel and its Displays

Eight front panel status displays are provided. Four of these are used to indicate mechanism/system operation. These are the LOAD, UNLOAD, BUSY,

and READY displays. Two of the other displays show write-protect (PROTECT) and fault (FAULT) information and a seven-segment display is used to show cartridge number information. The eighth display is just above the eject button. The EJECT display is illuminated from when the button is pressed until the Tape Drive has responded to the Eject request.

There are also two rear panel seven-segment LED displays which are used to give diagnostic results and HP-IB address information.

The front panel displays are explained below:

LOAD

The LOAD LED is illuminated from the time that the Tape Drive commences to load a cartridge from the magazine until the cartridge has gone through the pre-conditioning sequence in the drive mechanism and is ready for use.

The cartridge number display shows the number (1-8) of the cartridge that is being loaded.

During the Pre-load sequence, which is performed each time a new magazine is installed, the LOAD LED flashes. During this time the cartridge number display shows the number of the latest "found" cartridge. It remains blank until the first cartridge is found. Also, between cartridge numbers, the cartridge number display shows whether, or not, each cartridge is write-protected. It is essential to find and change any write-protected cartridges if the Tape Drive's full capacity is to be used for an unattended backup.

In Sequential mode only, the LOAD LED flashes for at least five seconds at the end of the Pre-load sequence to allow manual selection of the cartridges. At the start of this period, the cartridge number display shows the number of the cartridge which will be loaded, if the (EJECT) button remains unpressed. For each pressing of the (EJECT) button, the display increments to the next available cartridge. Loading of the selected cartridge commences after the button has not been pressed for five seconds.

The two processes above are distinguished by different flash rates of the LOAD LED. The faster

of the rates occurs during the manual selection phase.

UNLOAD

The UNLOAD LED is illuminated from the time the drive mechanism commences to unload a cartridge until the cartridge has been replaced in the magazine slot from which it came.

In Selective mode the cartridge number display shows the number (1-8) of the cartridge which is being unloaded. In Sequential mode, the number of the cartridge which is NEXT to be loaded is displayed. This will be the next higher numbered cartridge in the magazine, if there is one, or will be a ⊡ if no cartridge is to be loaded (this occurs if there are no more cartridges or if Media Unload Mode is selected).

READY

The READY LED is illuminated when the Tape Drive is ready to respond to commands. It is normally extinguished during release and when commands are being processed.

If the READY display is on, and the cartridge number display is showing a ⊡ , then the door may be opened by pressing the EJECT button, enabling the removal of the magazine.

BUSY

The BUSY LED is illuminated during command processing by the Tape Drive. One of these commands is the Release granted command. If the Tape Drive requests release from the host and release is granted, then the BUSY LED will be illuminated. If release is granted internally by the Tape Drive, then the READY LED will be extinguished without the BUSY LED being illuminated.

ACTIVE CARTRIDGE NUMBER

The seven-segment cartridge number display is used to show, under normal operating conditions, the number of the cartridge which is currently loaded, is being unloaded, or is being loaded. This number is always in the range 1-8.

This display will also show several letters corresponding to other conditions which occur. These include the letters ⊡ , ⊡ , ⊡ , ⊡ and ⊡ . Each time the Tape Drive is switched-on there is a power-on self-test. During this self-test the cartridge number display initially shows the version of the firmware installed and then illuminates each of its segments sequentially before displaying the letter ⊡ during the remainder of the test.

If at the end of the test there is a hardware fault, then the cartridge number display will show the letter ⊡ and the FAULT LED will be illuminated. This could also occur as a result of host or user initiated self-tests when there is a hardware fault.

When the READY LED is illuminated and the cartridge number display shows the letter ⊡ , then the door is open or there is no magazine present.

If the READY LED is illuminated and the cartridge number display is showing the letter ⊡ , then the EJECT button may be pressed to open the door. This condition occurs when the host issues an Unload command.

In Sequential mode when a cartridge is loaded and the EJECT button is pressed and recognized, the UNLOAD LED is illuminated and the cartridge number display shows the letter ⊡ . The EJECT button may then be pressed again to cause the loading of the next cartridge (or pressed several times to load the required cartridge).

The cartridge number display shows the letter ⊡ during a head cleaning cycle (see section 4-2).

Finally, if the READY LED is illuminated, the WRITE PROTECT LED is flashing and the cartridge number display is flashing with one or more numbers, then the magazine may be removed but there has been a Media Monitor warning on the cartridge number(s) displayed. This warning is displayed whenever no cartridge is loaded, but is cleared when a new magazine is inserted and the door is closed.

WRITE PROTECT

This is displayed continuously if the cartridge whose number is shown by the cartridge number display is write protected. This gives warning of the currently loaded cartridge being write

protected. Each cartridge is individually write protected by setting its Write-Protect switch.

WRITE PROTECT is also flashed when a Media Monitor warning is given, as described above. The Tape Drive does not automatically go into a write protected state based on the Media Monitor. It is provided only as a warning.

FAULT

The FAULT LED is illuminated either to indicate an unrecoverable fault or to display a warning to the operator. A media problem is indicated if the cartridge number display shows one or more cartridge numbers. A hardware problem exists if the cartridge number display shows the letter F , while the FAULT LED is illuminated.

EJECT

The EJECT LED in the Eject push-button is illuminated whenever the button is pressed. If release is required in order to perform the desired operation (unloading or loading sequentially), then the LED remains illuminated until the release request has been answered by the host. If release is denied by the host then the LED is extinguished and nothing further happens.

MAGAZINE LOAD OPERATION

This information is also to be found in the User's Manual (35401-90902).

Loading is achieved by opening the door, placing the magazine into the door and then closing the door. A short time after this the Tape Drive performs its Pre-load sequence. The Pre-load consists of steps which determine which cartridges are present in the magazine and whether they are write-protected.

The Pre-load sequence is only performed when a new magazine is loaded into the Tape Drive. The information gained by this process is stored in non-volatile memory on the Mechanism Dependent Controller Printed Circuit Assembly (MDC PCA), so that if there is a power failure the Pre-load sequence is not repeated.

In Sequential mode only, either after the power-on tests have been completed or after the Pre-load has finished, the Tape Drive waits for five seconds to see whether the (EJECT) button has been pressed. During this time the LOAD LED flashes together with the cartridge number display showing the number of the cartridge to be loaded. For each press of the (EJECT) button the cartridge number is incremented. Loading of the selected cartridge takes place when the (EJECT) button has been left alone for five seconds. The number of the cartridge being loaded is shown on the cartridge number display.

The Tape Drive door is latched at all times when the magazine is present unless the Unload command has been accepted and acted upon (either from the host or from the operator via the (EJECT) button). This would be either in the Selective mode or the Sequential mode with the last cartridge loaded.

Thus, the only time that the door is unlatched is under the following conditions:

- When the READY LED is illuminated and the cartridge number display shows the letter U .

- When the WRITE PROTECT LED is flashing and the cartridge number display is showing the numbers of the cartridges with Media Monitor failure.

- When the power is on and there is no magazine present (the cartridge number display shows the letter E).

- When the FAULT LED is illuminated and the cartridge number display is showing a number between 1 and 8 (indicating a media problem).

- Sometimes when the FAULT LED is illuminated and the cartridge number display shows the letter F ; but this depends on the type of hardware failure.

Note that there is a difference between the door being unlatched and being open. When the door is open the magazine is physically accessible to the operator. This condition can only be reached by pressing the (EJECT) button. When the door is in

the state of being unlatched, it may be opened by pressing the [EJECT] button.

MAGAZINE UNLOAD OPERATION

Magazine unloading is performed by pressing the [EJECT] button. This button is not examined until the Tape Drive is in a position to respond (when all current operations have been completed). The EJECT LED remains illuminated to acknowledge the Eject request.

Once the unload process begins, the UNLOAD LED becomes illuminated and the cartridge number display shows either a ☐ (Sequential mode) or the cartridge number (Selective mode).

At this time, in Sequential mode only, the operator may select a particular cartridge either by repeated pressing of the [EJECT] button or by continually holding it in. In this mode, with the Eject button activated, the cartridge number display slowly cycles through the cartridge numbers from 1 to 8, then to ☐ and then back through 1 to 8 again. This continues until the [EJECT] button is released whereupon the cartridge, whose number is currently displayed, is loaded. The loading only occurs after the current unload is completed. This procedure may be followed at any time when the UNLOAD LED is illuminated, or when the LOAD LED is flashing and the cartridge number display is showing the letter ☐ . If done under this latter condition, the [EJECT] button must remain unpressed for five seconds.

If the UNLOAD LED is illuminated and the cartridge number display is left on the letter ☐ , then no tapes are loaded and the door will become unlatched at the end of the unload sequence. If the [EJECT] button is then pressed while all the cartridges are in the magazine, the door will open immediately.

3-10. UPGRADE INSTALLATION

The HP 35401A has no upgrades now. Consequently there is no information.

3-11. PRODUCT SELF TEST PROCEDURES

The HP 35401A contains self-test routines which test all the major assemblies within the unit. These self-tests can be initiated in 3 ways:

- There is a power-on self-test every time the Tape Drive is turned on.

- There is an initiate self-test push-button switch on the rear panel (see figure 3-6).

- Self-tests may be initiated from the host controller through the HP-IB interface (see section 8-6).
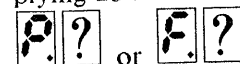
POWER-ON SELF-TESTS

The power-on self-test checks whether the major assemblies are operational. If all are functioning correctly, then switching the power on results in the front panel displays being sequentially illuminated (showing that each one works), and ends with the seven-segment (Cartridge Number) display showing the letter ☐ and the READY display being illuminated. You are now able to insert a magazine of cartridges after opening the front door by pressing the [EJECT] button. If a magazine of cartridges is already loaded prior to switching on, the sequence continues and the seven-segment display shows the presence of each cartridge in turn. At the same time the PROTECT display shows whether individual cartridges are write-protected. If a fault condition exists in any of the assemblies inside the unit, the sequence ends with the seven-segment display showing the letter ☐ and the FAULT display being illuminated. If this is the case then the rear panel self-test displays should be observed. Upon pressing the Display Results button, the two seven-segment displays should show the following sequence:

☐☐ Off

☐☐ Indicates a microprocessor test failure

☐☐ Indicates that the power supply is supplying ±5V

☐☐ or ☐☐ Pass or Fail. ☐ is the HP-IB address of the Tape Drive

Once this sequence is complete, further results of the self-test can be displayed by repeatedly pressing the Display Results (DR) button. The switch is to be found recessed behind the rear panel to the left of the self-test displays and is operated by pressing it with the tip of a pen or similar object.

```
┌─────────────┐
│    NOTE     │
└─────────────┘
```

While the self-test results are being displayed, communication between the Tape Drive and the host computer is disabled. Once the display returns to either Pass or Fail communication is re-established.

There are now three paths that the self-test results may follow, depending on whether release has been granted and then whether the unit has passed or failed.

If release is not granted by the host:

[r][d] Release Denied

If release is granted from the host: If the test resulted in a Pass Condition:

[P][?] Pass on address [?]

PRESS Display Results

[U][0] Unit 0 (tape drive) and DDC

PRESS Display Results

[U][1] Unit 1 (autochanger)

PRESS Display Results

[U][2] Unit 2 (internal controller) and HDC

PRESS Display Results

[P][?] Return to Pass display

If the test resulted in a Fail condition:

[F][?] Fail on address [?]

PRESS Display Results

Say test 13 in the self-test routine has failed and that A3 and A7 are the most suspect field replaceable assemblies (MSFRAs) in Unit 1, then:

[U][0] Unit 0 self-test

PRESS Display Results

[U][1] Unit 0 has passed self-test since the display now shows a Unit number

PRESS Display Results

[A][3] Unit 1 has failed and A3 is an MSFRA. If Unit 1 had passed, Unit 2 would now be displayed

PRESS Display Results

[A][7] A7 is the next MSFRA

PRESS Display Results

[1][3] Test 13 failed

PRESS Display Results

[F][?] Return to fail display

FAILURE DIAGNOSIS

Depending on the failure, up to three unit numbers can be displayed (as in the example). Unit 0 includes all the parts common to the HP 9144A; the Device Dependent Controller, Read/Write, Servo and Drive Mechanism assemblies. Unit 1 is the Autochanger Mechanism (including motors and sensors) and Mechanism Controller. Unit 2 is the internal controller which includes the Host Dependent Controller.

For each unit that failed, up to 4 MSFRAs can be displayed by pressing the DR switch (A3, A7 in the example).

After the MSFRAs have been displayed, the failing test number is next shown (13 in the example). A list and detailed explanation of these tests is given in section 8-5.

If Unit 0 or 1 has a failure the next display after the failed test number will be of the next unit number in the test sequence. If, as in the example, it is Unit 1 which has failed, the next display will revert to the "F" symbol with the HP-IB address. This shows that the self-tests are finished.

OPERATOR INITIATED SELF-TESTS

The self-test routines may be initiated by pressing the Initiate Self-Test push-button on the rear panel. This can be done at any time but the self-test does not begin until the drive has completed any current tasks. The self-test routines are exactly the same as those initiated at power-on.

HOST INITIATED SELF-TESTS

The host initiated self-tests are carried out by issuing the CS/80 command Initiate Diagnostic. This method has the flexibility of initiating individual tests or executing the entire test. For test purposes the Tape Drive is separated into HP 9144A common parts and HP 35401A specific parts.

Details of the individual tests and their results are given in section 8-5.

Preventive Maintenance

The only preventive maintenance involved with the Tape Drive is concerned with taking care of the cartridge tapes and using a head cleaning cartridge.

4-1. CARTRIDGE TAPE GUIDELINES

The cartridge tapes used with the HP 35401A Tape Drive provide a compact and portable storage medium. For this reason, they may be exposed to rapid changes in environmental conditions.

The guidelines given here are recommended in order that the Tape Drive should continue to perform in a highly reliable manner, and that confidence may be placed in a high standard of data integrity.

CARTRIDGE SPECIFICATIONS

The ANSI X3.55 - 1982 specification applies to the tape cartridges used with the HP 35401A. In part, this states:

> "*Temperature ... 5°C to 45°C (41°F to 113°F)*
> *Relative Humidity.................. 20% to 80%*
> *(non-condensing)*
> *Maximum Wet Bulb Temperature .... 26°C (79°F)*
>
> *The cartridge shall be conditioned by exposure to the operating environment for a time equal to, or greater than, the time away from the operating environment (up to a maximum of 8 hours). If the user of a data cartridge knows or suspects that the cartridge has been exposed to a drop in temperature exceeding 30°F (16.7°C) since last used, it is recommended that the cartridge be rewound one complete cycle on the tape transport before it is used for data interchange."*

This specifies the normal operating limits for cartridges, but does not clarify restrictions applying to changing conditions within those limits.

Hewlett-Packard has tested cartridges in order to determine conditions for reliable data recovery after temperature changes. Stable conditions help to ensure data integrity, but where they do not occur, the following precautions are recommended.

CARTRIDGE GUIDELINES

The following three conditions refer to changes in the ambient temperature. It is assumed that:

- the cartridges have been stabilized to the temperature of the room before the change; that is, they have been in the room long enough to reach room temperature

- the cartridge is installed in the Tape Drive

- the Tape Drive is switched on

- the temperature does not go outside the specified operating range for the HP 35401A (5°C to 40°C - 41°F to 104°F)

In each case, the ANSI specification requires up to 8 hours stabilization time after the temperature has changed and before the cartridges should be used.

HP's factory tests have explored the stabilization times necessary to ensure excellent performance, and these times are given for each condition.

Condition 1: Controlled Temperature Environment
The temperature varies within ±5°C (±9°F).

HP's factory tests show that no stabilization is necessary.

Condition 2: Moderately Varying Temperature Environment

The temperature variation is between 5°C (9°F) and 16.6°C (30°F).

HP's factory tests show that 35 minutes stabilization is sufficient.

Condition 3: Extremely Varying Temperature Environment

The temperature varies more than ±16.6°C (±30°F) while remaining within the specified range of 5°C to 40°C (41°F to 104°F).

HP tests recommend stabilizing for one hour, followed by retensioning the cartridge. Retensioning is achieved by performing a load/unload sequence on the cartridge.

CONDITIONS TO BE AVOIDED

- Do not place the Tape Drive in or near the flow of air from a heater or air conditioner. The cycling of the heater or air conditioner can cause data recovery problems.

- Do not place the Tape Drive near a door which is used frequently, and which separates different temperature conditions. If the Tape Drive is placed near an outside door, for example, the blast of hot or cold air when the door is opened can cause data recovery problems.

- Do not leave cartridges in severe temperature conditions for any extended periods. This includes leaving the cartridges in a car standing in the cold overnight or in the sunlight during the day. If this has happened, then before the cartridge is used for data recovery, it should be stabilized for one hour and then retensioned by performing a load/unload sequence.

- Avoid transferring data (reading from or writing to a cartridge) when the temperature is varying by more than 3°C (5.5°F) per hour.

- Position the Tape Drive away from all sources of dust. These include frequently used doors, walkways, stacks of supplies that collect dust and smoke-filled rooms.

4-2. CLEANING THE TAPE DRIVE

Tape head cleaning has been simplified by the introduction of a head cleaning cartridge. Each Tape Drive is shipped with a kit of cleaning materials (HP 92193E) including a cleaning cartridge, cleaning fluid and replaceable cleaning pads. The box in which they are shipped also contains printed cleaning instructions. A replenishment kit containing pads and fluid is also available (HP 92193P).

Tape head cleaning is accomplished by moistening the cleaning pad in the cleaning cartridge with the cleaning fluid and inserting the cartridge into the magazine. It may be inserted into any of the 8 slots in the magazine, but it is best to use the bottom slot for the reason given below.

The magazine is then loaded into the Tape Drive and the front door is shut. The cleaning cycle is then begun by the Tape Drive as it starts its pre-load sequence. During the pre-load sequence the Tape Drive identifies the cleaning cartridge using the Write Protect and Cartridge Present sensors. The cleaning cartridge presents the unique situation of being NOT write-protected and being NOT cartridge present. Once this condition is found, the pre-load sequence is aborted; the cleaning cartridge is loaded, and a cleaning cycle is performed. After this, the cleaning cartridge is returned to the magazine and the front door is opened.

The Tape Drive will not allow any other cartridges to be loaded if a cleaning cartridge is present in the magazine. Thus, the cleaning cartridge should be loaded in the bottom slot of the magazine so that it will be found quickly and loaded before the cleaning fluid evaporates.

Tape head cleaning should be performed at least once a week and after using every magazine which has at least one new cartridge. More importantly, the tape head should be cleaned if data errors are being experienced.

The cleaning pad should be replaced after using it once as an apparently clean, used, pad can contain contaminants.

CLEANING PRECAUTIONS

HP ONLY supports LIQUID FREON TF* (trichlorotrifluoroethane) for use as a tape path cleaning solvent. Freon TF cuts oil and grease, evaporates quickly, leaves no residue, and will not damage the transport. If using a vendor other than HP, make sure that the cleaning fluid is a high quality (100%) liquid Freon TF. Avoid solutions of Freon TF and other solvents.

| CAUTION |

Do not use cleaner solutions which contain lubricants. They deposit lubricant on the tape head and degrade performance.

Do not use soap and water on the tape path. Soap leaves a thick film and water may damage electronic parts.

Do not use standard hub cleaners or strong alcohol solutions. These solutions damage the tape guides and capstan.

Do not use aerosol cleaners; even if they are Freon TF. The spray is difficult to control and often contains metallic particles which damage the tape head.

Do not touch the tape. Do not attempt to clean the tape or tape guides within the cartridge.

---

*FREON TF is a registered trademark of the Dupont Corporation.

Functional Description

This section contains a description of the components which make up the HP 35401A Tape Drive. It begins with an overview of the whole system (Section 5-1) and then proceeds to a detailed functional description of each circuit assembly (sections 5-2. to 5-6.). It concludes with a description of the mechanisms which make up the Tape Drive (5-7. to 5-9.) and a description of the cartridge tape layout (5-10.).

5-1.   SYSTEM OVERVIEW

The HP 35401A Tape Drive contains the following major electronic assemblies:
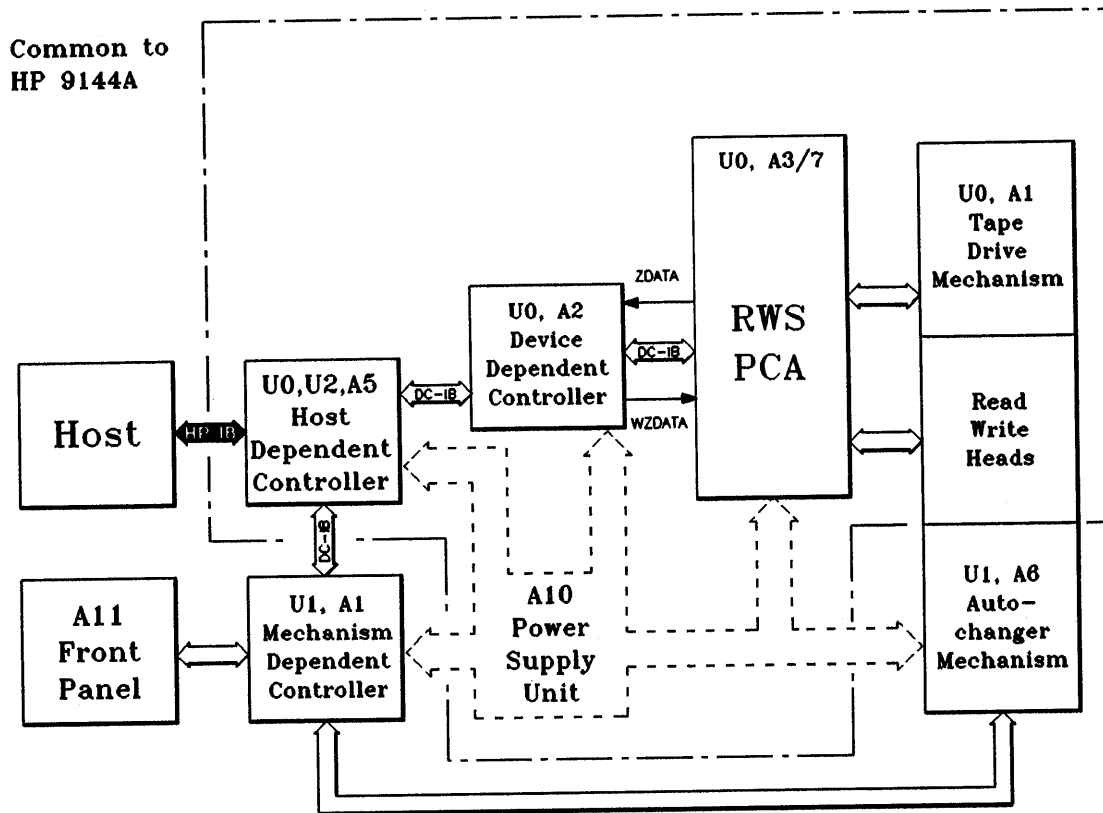
Figure 5-1. Overview of the HP 35401A Tape Drive

Table 5-1. Major Electronic Assemblies

Field Replaceable Assembly		Part Number
Host Dependent Controller	(HDC)	07940 – 60195
Device Dependent Controller	(DDC)	09144 – 66512
Mechanism Dependent Controller	(MDC)	35401 – 60091
Power Supply Unit	(PSU)	09133 – 67120
Read Write Servo Assembly	(RWS)	09144 – 66518

These assemblies are located, as shown in Figure 5-2., together with the autochanger and drive mechanisms to produce the complete Tape Drive.
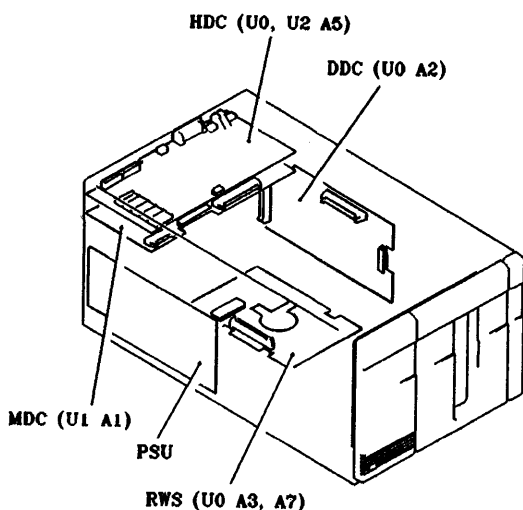
Figure 5-2. Location of Major Electronic Assemblies

The functions of the electronic assemblies are outlined in the following overview:

HOST DEPENDENT CONTROLLER

- Communicates with the Host

- Separates HP-IB commands and data

- Sends data to and from DDC and Host

- Contains Executive firmware

- Contains Mechanism and MDC controlling firmware

- Contains DDC controlling firmware

- Controls self-test and diagnostics

DEVICE DEPENDENT CONTROLLER

- Controls Read/Write and Servo functions

- Analyses MFM data sent from the Read/Write circuitry

   -finds keys

   -checks CRCs

   -performs error correction

- Writes 1k blocks of data to Read/Write circuitry

   -generates CRC

   -generates frames 5 and 6 for error correction

   -generates headers for each frame

MECHANISM DEPENDENT CONTROLLER

- Sequencing and control of autochanger mechanism and front panel display.

POWER SUPPLY UNIT

- Develops operating voltages from AC line

- Generates power-on reset signal

READ/WRITE/SERVO ASSEMBLY

The read/write circuitry does the following:

- Writes and reads from selected head gaps

   -selects head gaps on instruction from the servo microprocessor

   -provides write current

   -amplifies and filters read data from the head gaps

   -detects PVAL, which inhibits write during power-up

The servo circuitry does the following:

- Controls capstan and head-stepper motors

   -maintains correct capstan speed and direction

   -positions head gaps on required tracks

All these assemblies are interconnected according to the following cabling diagrams:

Fan

PSU

J2
+12VP −01
GND −02
+12VP −03
GND −04
+5V −05
GND −06
+5V −07
GND −08
+5V −09
GND −10
KEY −11
PVAL −12
+12V −13
GND −14
−12V −15

HDC

J4
01− NC
02− +5V
03− KEY

RWS

J8
01− GND
02− KEY
03− NC
04− +12V

DDC

J4
01− GND
02− +5V
03− GND
04− +5V
05− GND
06− KEY
07− PVAL
08− +12V
09− GND
10− −12V

MDC

J3
−01
−02
+12VP −03
GND −04
+5V −05
GND −06
+5V −07
GND −08
+5V −09
GND −10
KEY −11
PVAL −12
+12V −13
GND −14
−12V −15

Figure 5-3. Cabling Diagram (sheet 1 of 4)

Front Panel
PCA

MDC

J1			J2			J4			J6	
PROT	-01		01-	PROTECT		GND	-01		01-	GND
FAULT	-02		02-	FAULT		BUF PROT	-02		02-	
UNLOAD	-03		03-	UNLOADING		GND	-03		03-	GND
LOAD	-04		04-	LOADING		BUF LOAD	-04		04-	
BUSY	-05		05-	BUSY					05-	KEY
READY	-06		06-	READY						
G	-07		07-	G						
F	-08		08-	F						
E	-09		09-	E						
D	-10		10-	D		GND	-05		01-	
C	-11		11-	C		WRITE PROT	-06		02-	
B	-12		12-	B		CART U ARM	-07		03-	
A	-13		13-	A		+5V	-08		04-	
NC	-14		14-	MODE		HLEDS	-09		05-	
EJECT	-15		15-	EJECT		GND	-10		06-	
EJECTLED	-16		16-	EJECTLED		HORIZB	-11		07-	
NC	-17		17-	+5V		ARMSOL	-12		08-	
DOND	-18		18-	GND		HORIZC	-13		09-	
+12V	-19		19-	+12V		+12VP	-14		10-	
NC	-20		20-	GND		HENC	-15		11-	
						HMOTOR2	-16		12-	
						GND	-17		13-	
						HENCLED	-18		14-	
						+5V	-19		15-	
						HMOTOR1	-20		16-	
						VSENS	-21		17-	
						GND	-22		18-	
						+5V	-23		19-	
						VSENSLED	-24		20-	

RWS

Flexible
PCA

J3			
01-	+12VP		
02-	EJECTSOL		
03-			
04-			
05-			
06-			
07-			
08-			
09-			
10-			
11-			
12-			
13-			
14-			
15-			

Eject
Solenoid

GND -25
GND -26 ——SPARE

GND	-27		01-
VMOTOR2	-28		02-
GND	-29		03-
VENC	-30		04-
GND	-31		05-
VENCLED	-32		06-
+5V	-33		07-
VMOTOR1	-34		08-
GND	-35		09-
GND	-36		10-

Vertical
Motor

			J1	
GND	-37		01-	GND
VHOME	-38		02-	VHOME
GND	-39		03-	GND
GND	-40		04-	GND
GND	-41		05-	GND
VHLED	-42		06-	VHLED
GND	-43		07-	GND
+5V	-44		08-	+5V
CADDY PRES	-45		09-	CADDY PRES
GND	-46		10-	GND
+12VP	-47		11-	+12VP
DOORSOL	-48		12-	DOORSOL
+12VP	-49		13-	+12VP
DOORSOL	-50		14-	DOORSOL

Microswitch
PCA

		J2
DOORSOL	-01	
+12VP	-02	

Door Latch
Solenoid

Figure 5-3. Cabling Diagram (sheet 2 of 4)

Read Write Servo

BOTTOM READ COIL

Stepper
Motor

J2
01–
02–
03– GND
04–
05– KEY
06– NC
07– GND
08–
09–
10–

SHIELD

SHIELD

TOP READ COIL

J1
–01   BL1
–02   WH1
KEY –03
–04   BL2
–05   WH2
–06   YL1
–07   YL2
–08   RD2
–09   RD1

J3
01–
02–
03–
04– GND
05– GND
06– KEY
07–
08–
09–

BOTTOM WRITE COIL

SHIELD
SHIELD

TOP WRITE COIL

J4
–01   –
–02   +
GND –03   CASE
KEY –04

Capstan
Motor

J6
01– GND
02–
03– GND
04–
05– KEY

WRITE PROTECT
SWITCH   N.O.

CARTRIDGE IN
POSITION   N.O.
SWITCH

J5
–01
GND –02
–03
KEY –04
–05

Optical
Sensor

Figure 5-3. Cabling Diagram (sheet 3 of 4)

HP-IB

HDC

J3	J2
01- DIOIL	MPOL -01
02- DIO2L	-02
03- DIO3L	GND -03
04- DIO4L	-04
05- EOIL	GND -05
06- DAVL	PVALH -06
07- NRFDL	GND -07
08- NDACL	-08
09- IFCL	-09
10- SRQL	GND -10
11- ATNL	-11
12- GND	GND -12
13- DIO5L	CSRSL -13
14- DIO6L	CSWSL -14
15- DIO7L	GND -15
16- DIO8L	CSAOH -16
17- RENL	CSA1H -17
18- GND	CSA2H -18
19- GND	GND -19
20- GND	CSA3H -20
21- GND	CSA4H -21
22- GND	SELL -22
23- GND	CSA5H -23
24- GND	GND -24
	CSBOH -25
	CSB1H -26
	CSB2H -27
	CSB3H -28
	GND -29
	CSB4H -30
	CSB5H -31
	CSB6H -32
	CSB7H -33
	GND -34
	DATAOH -35
	DATA1H -36
	DATA2H -37
	DATA3H -38
	-39
	DATA4H -40
	DATA5H -41
	DATA6H -42
	DATA7H -43
	-44
	DRINL -45
	DROUTL -46
	-47
	DSINL -48
	DSOUTL -49
	GND -50

MDC

J1
01- MPO
02- PVALL
03- GND
04- NC
05- GND
06- NC
07- GND
08-
09- UNIT
10- GND
11- SBCL
12-
13- CSRSL
14- CSWSL
15- GND
16- CSAO
17- CSA1
18- CSA2
19- GND
20- CSA3
21- CSA4
22- SEL
23- CSA5
24- GND
25- ICSBO
26- ICSB1
27- ICSB2
28- ICSB3
29- GND
30- ICSB4
31- ICSB5
32- ICSB6
33- ICSB7
34- GND
35- DATAO
36- DATA1
37- DATA2
38- DATA3
39- GND
40- DATA4
41- DATA5
42- DATA6
43- DATA7
44- GND
45- DRINL
46- DROUTL
47- GND
48- DSINL
49- DSOUTL
50- GND

DDC

J1	J2
01- MPO	SERVO DATAO -01
02- PVALL	DGND -02
03- GND	SERVO DATA1 -03
04-	+5V -04
05- GND	SERVO DATA2 -05
06-	DGND -06
07- GND	SERVO DATA3 -07
08-	+5V -08
09- UNIT	SERVO DATA4 -09
10- GND	DGND -10
11- SBCL	SERVO DATA5 -11
12-	+5V -12
13- CSRSL	SERVO DATA6 -13
14- CSWSL	DGND -14
15- GND	SERVO DATA7 -15
16- CSAO	+5V -16
17- CSA1	4MHZ -17
18- CSA2	DGND -18
19- GND	RESETL -19
20- CSA3	+5V -20
21- CSA4	WENL -21
22- SEL	GABLE -22
23- CSA5	PVAL -23
24- GND	DGND -24
25- CSBO	KEYFND -25
26- CSB1	CGND -26
27- CSB2	CHS -27
28- CSB3	CGND -28
29-	RHWL -29
30- CSB4	CGND -30
31- CSB5	BOT -31
32- CSB6	CGND -32
33- CSB7	EOT -33
34- GND	-12V -34
35- DATAO	OVRTH -35
36- DATA1	-12V -36
37- DATA2	NCART -37
38- DATA3	+12V -38
39- GND	WRTPT -39
40- DATA4	+12V -40
41- DATA5	ZDATA -41
42- DATA6	DGND -42
43- DATA7	SVWL -43
44- GND	DGNL -44
45- DRINL	SVRL -45
46- DROUTL	DGND -46
47- GND	GNSL -47
48- DSINL	DGND -48
49- DSOUTL	WZDATA -49
50- GND	CGND -50

RWS

J7
01- DB0
02- GND (D)
03- DB1
04- +5V
05- DB2
06- GND (D)
07- DB3
08- +5V
09- DB4
10- GND (D)
11- DB5
12- +5V
13- DB6
14- GND (D)
15- DB7
16- +5V
17- 4MHZ
18- GND (D)
19- RST
20- +5V
21- WENL
22- GABLE
23- PVAL
24- GND (D)
25- KEYFND
26- GND (D)
27- CHS
28- GND (D)
29- RHWL
30- GND (C)
31- BOT
32- GND (C)
33- EOT
34- -12V
35- OVRTHH
36- -12V
37- NCART
38- +12V
39- WRPT
40- +12V
41- ZDATA
42- GND (D)
43- SVW
44- GND (D)
45- SVR
46- GND (D)
47- GNSL
48- DGND
49- WZDATA
50- GND (D)

DC-IB   **DC-IB**

Figure 5-3. Cabling Diagram (sheet 4 of 4)

5-2. HOST DEPENDENT CONTROLLER (U2 A5)

Figure 5-4. Host Dependent Controller Schematic

The Host Dependent Controller (HDC) provides an interface between the host computer and the Device Dependent Controller (DDC) of the Tape Drive. The HDC also interfaces with the Mechanism Dependent Controller (MDC). The HDC interface with the host is via the Hewlett-Packard Interface Bus (HP-IB) and with the DDC/MDC via the Data/Control Interface Bus (DC-IB).

Host Dependent Controller functions include:

- A host interface via the HP-IB with the software to interpret the commands from the host and respond with status or data.

- Direct memory access (DMA) capability.

- A random access memory (RAM) buffer for data examination for integrity, error correction, and speed matching.

- Firmware and microprocessor for execution of DDC and MDC commands and status monitoring.

- Self-test capabilities.

Circuits within the HDC include an HP-IB interface IC, a microprocessor, firmware in EPROM, RAM, a custom-designed DMA gate array IC, and self-test switches and displays.

THE HP-IB INTERFACE

Interface between the host data channel (HP-IB) and the Tape Drive is provided by a Talker/Listener IC. The IC is accessed by the microprocessor and by the DMA gate array IC input and output processes. The microprocessor must read and write to the various registers in the HP-IB interface IC in order to prepare for data transfers

to and from the host computer. Buffers separate the HP-IB data bus from the RAM data bus.

The HP-IB interface IC implements all of the talker/listener functions of the HP-IB including data transfers, handshake protocol, talker/listener addressing, service request, and serial and parallel polling. HP-IB signals connected to the IC include HP-IB Data I/O Bus DI01-L through DI08-L, End or Identify EOI-L, Data Valid DAV-L, Not Ready for Data NRFD-L, Not Data Accepted NDAC-L, Interface Clear IFC-L, Attention ATL-L, Service Request SRQ-L, and Remote Enable REN-L.

THE MICROPROCESSOR

The microprocessor provides overall control of all the Tape Drive functions. The HDC employs an internal 8-bit microprocessor. Firmware associated with the microprocessor is contained in five EPROMS: the EXEC EPROM, two DDC EPROMs, and two MDC EPROMs. Approximately 72 kbytes of code are kept in the five EPROMs.

EPROM FIRMWARE

The firmware on the HDC consists of three segments. One segment is the executive operating system (EXEC EPROM) which controls resource allocation (including the DMA gate array IC and the RAM), and the passing of messages and information between the DDC firmware and the Host interface firmware.

The remaining two segments comprise the control firmware for the DDC and the MDC. The microprocessor is shared between the DDC, MDC and the executive firmware by timesharing, each being accessed by the microprocessor for approximately 500 microseconds. Each set of firmware takes care of its own task, performing whatever function the host or device has requested. Self-test firmware is included in each of the three segments. The MDC and DDC communicate with the HDC over the DC-IB. This bus contains an 8-bit control/status data bus with appropriate read/write strobes and associated 6-bit control/status address bus, and a completely independent 8-bit read/write data bus with associated strobes.

RANDOM ACCESS MEMORY (RAM)

The random access memory (RAM) is a temporary storage location for all data transfers. The HDC contains 16K of RAM on two ICs. The use of RAM is time multiplexed, so that for one half of a microprocessor clock cycle, the microprocessor has access to the RAM. On the other half cycle the DMA gate array IC has access to the RAM.

DIRECT MEMORY ACCESS (DMA)

Direct memory access is defined as the ability to perform complete memory cycles without the intervention of the HDC microprocessor. The DMA gate array IC is a custom designed integrated circuit which controls data transfers between the host and the RAM. It also transfers self-test status information from the microprocessor to the self-test display. The DMA gate array is set up for either an input to or an output from the RAM. Once activated, the DMA gate array IC performs reads or writes to the RAM completely transparent to the microprocessor.

SELF TEST

Two momentary contact push-button switches, accessible through openings in the rear panel of the Tape Drive, allow the operator to initiate operation of the internal self-test diagnostic routines. One switch, labeled SELF TEST, initiates the self-test routines. The other switch, labeled DISPLAY RESULTS, causes the self-test results to be displayed on the self-test display. The self-test display is visible through openings in the rear panel between the self-test switches, and comprises two seven-segment LEDs. The display is controlled by the microprocessor and provides a two-digit hexadecimal readout of self-test results, including the defective unit, field replaceable assembly (FRA), and subtest failure number. Information on how to interpret the self-test readout is contained in section 8-5.

HDC INTERNAL BUS ARCHITECTURE

The internal bus architecture of the HDC is shown in Figure 5-4. and comprises the following buses:

- HP-IB Data Bus

- RAM Data Bus

- Microprocessor Address Bus

- Microprocessor Data Bus

- DMA Gate Array Data Bus

- Data Control Interface Bus (DC-IB)

A description of each bus is given below:

HP-IB DATA BUS

The HP-IB Data Bus connects the HP-IB interface IC to the microprocessor and the DMA gate array IC. The microprocessor reads and writes to the various registers in the HP-IB interface IC in order to prepare for data transfers to and from the host computer. Communication between the microprocessor, DMA IC and the HP-IB interface IC passes through the RAM and RAM Data Bus. Buffers separate the HP-IB Data Bus from the RAM Data Bus and permit speed matching between the HP-IB data rate and the DMA gate array IC data transfer rate.

RAM DATA BUS

The RAM Data Bus is used for all data transfers between the RAM and the microprocessor, the RAM and the DDC/MDC, and the RAM and the HP-IB. The use of the RAM is time multiplexed, so that in one half of the microprocessor clock cycle, the microprocessor has access to the RAM, and in the other half, the DMA gate array IC has access to the RAM.

MICROPROCESSOR ADDRESS BUS

The Microprocessor Address Bus is used to point to the next source of instructions or data.

The circuits addressed by the Microprocessor Address Bus include the HP-IB interface IC; RAM (via the address multiplexer), the DMA gate array IC, the EXEC EPROM, the DDC EPROMs, and the MDC EPROMs. The DDC EPROMs and the MDC EPROMs are overlaid on the same address space. A flip-flop selects the DDC ROM or the MDC ROM at the correct time for the appropriate ROM to have access to the microprocessor. The microprocessor can write directly to the DDC and MDC via a buffer and the DC-IB Control/Status Address Bus to operate the tape drive or the autochanger mechanism.

MICROPROCESSOR DATA BUS

The Microprocessor Data Bus interconnects the microprocessor, the EXEC EPROM, the DDC EPROMs, and the MDC EPROMs. The microprocessor RAM exists on a separate bus so that the RAM can be shared by the microprocessor and the DMA gate array IC. The bi-directional data on the Microprocessor Data Bus includes preprogrammed control sequences (algorithms) in EPROM and control/status information from the DDC/MDC. The Microprocessor Data Bus is connected to the DDC/MDC via a bi-directional buffer and the DC-IB Control/Status Data Bus.

DMA GATE ARRAY DATA BUS

The DMA Gate Array Data Bus is used when the microprocessor must read or write to registers in the DMA gate array IC, including the DMA registers and the free running timer used to sequence between Executive, DDC, and MDC operations.

DATA CONTROL INTERFACE BUS (DC-IB)

The Data/Control Interface Bus (DC-IB) is the communication link between the HDC, the DDC and the MDC. The DC-IB is buffered to both the RAM Data Bus and the Microprocessor Address/Data Bus on the HDC. The DC-IB consists of two independent data buses: a Control/Status Data Bus and a Read/Write Data Bus.

The Control/Status Bus is used to send commands to the DDC or HDC. This bus is used to initiate the transfer of information to or from the recording medium, to interrogate the status of the DDC and its drive mechanism, and to interrogate the status of the MDC and its autochanger mechanism. A Control/Status Address Bus associated with the Control/Status Data Bus provides an addressing capability.

The Read/Write Data Bus is used to pass data between the HDC and the DDC. It does not link the HDC to the MDC since the MDC has no access to large amounts of data. The Read/Write Data Bus is the path taken by all the data which passes between the host computer and the DDC.

5-3. DEVICE DEPENDENT CONTROLLER (U0 A2)
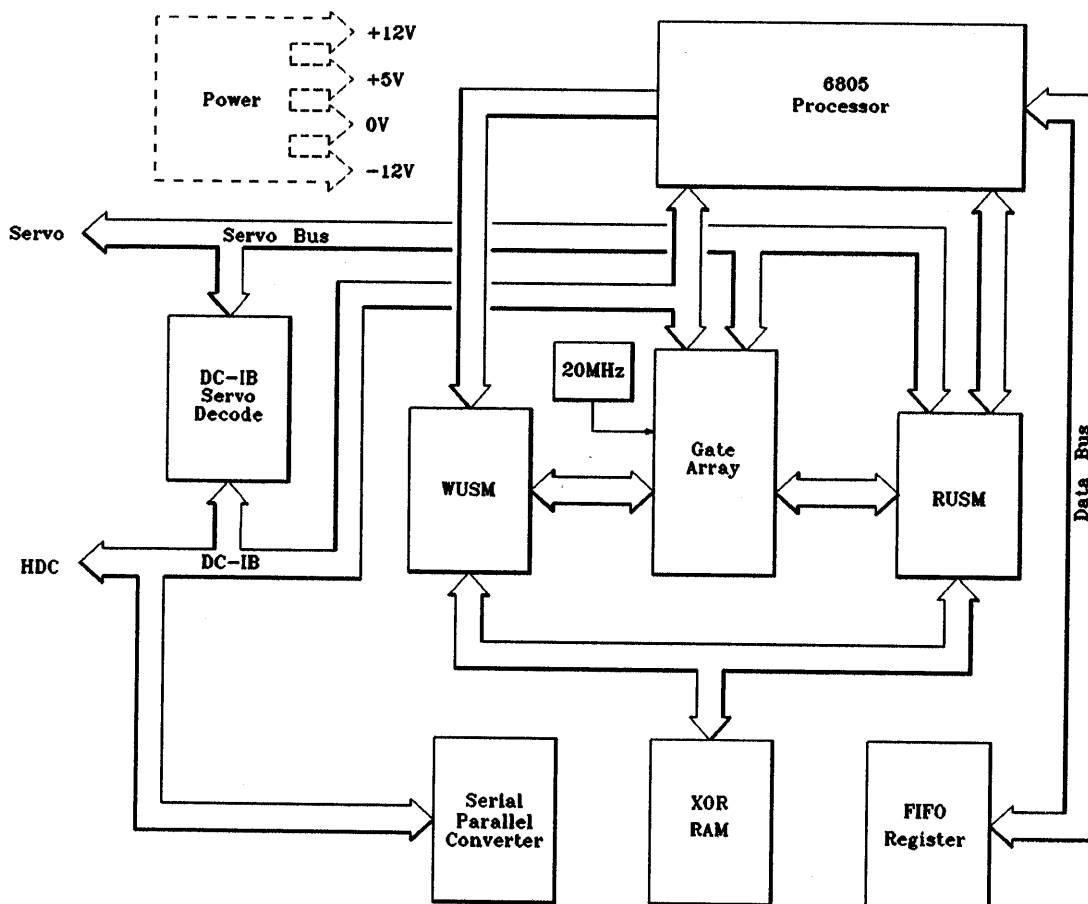
Figure 5-5. Device Dependent Controller Schematic

The Device Dependent Controller performs three main interfacing functions. It interfaces between the HDC, the write state machine and the read state machine. Interfacing is controlled by a 6805 microprocessor resident on the DDC.

THE MICROPROCESSOR

The microprocessor on the DDC is responsible for the following functions:

- It receives commands from and reports status to the HDC

- It issues commands to the two state machines

- It monitors status of both state machines

The microprocessor handles low level commands such as READ, WRITE and SEEK. During a write command, 1 kbyte (4 times 256) of user data is passed from the HDC to the DDC. This is a block of data. The HP 35401A handles data in this block (1 kbyte) format. Added to this block of user data are sync bits, headers, CRCs (Cyclic Redundancy Check error detection), and exclusive-OR information stored on the tape. The exclusive-OR information comprises frames 5 and 6 (256 bytes/frame). The added data items are used in data management and data recovery and are all stored on the tape. During a read operation, the DDC sends 1.5 kbytes of data to the HDC. This data is flagged with an error if the CRCs do not match. If an error is detected, the exclusive-OR frame for that data

block is used to rebuild the bad frame. All overhead and error correction are stripped from the data before it is sent back to the host computer.

The microprocessor is designed to handle overlapped commands. This allows the tape drive to function in the streaming mode, which is done in the following manner:

- The HDC tells the DDC (6805) to read a block of data

- While beginning the first read, the HDC tells the DDC to read a second block of data

- The 6805 holds the results of the two status reports providing feedback to the HDC

IDENTIFY REGISTER

On the HDC are mounted five replaceable EPROMS; the EXEC EPROM, two DDC EPROMs, and two MDC EPROMS. To ensure that the correct EPROMs for the DDC have been inserted, the identify register on the DDC is read by the HDC during initialization and compared with information on its EPROMs. The HDC will tolerate DDC EPROMs in the MDC EPROM sockets as a pair but will not tolerate any other combination except where the ICs are in their correct sockets. An initial switch-on self test error will result.

WRITE STATE MACHINE

The write state machine is responsible for the generation of the WZDATA signal. WZDATA contains a pulse for every flux transition that appears on the tape. The write state machine is under the control of the 6805 through the use of two signals; Write Go (WGO) and self-test Errors (STE).

The Write Go signal tells the state machine to begin its writing sequence. Contained inside the state machine is the definition for the tape format. The format consists of the tape gaps, headers, sync fields, data, and exclusive-OR information. Each of these format items contains a set number of bits and is stored in locations accessible to the state machine. When writing a sync field, zeros are written and a one bit is written for the sync bit. Header data is put into the FIFO (First-In,

First-Out register) by the 6805 and clocked out to the tape when the state machine requires header information. User data is obtained from the HDC. Then the state machine issues DMA requests to obtain user data. Also, exclusive-OR data is obtained from the exclusive-OR RAM for the 5th and 6th frames. All data going to the tape is serialized, precompensated, and processed through the MFM encoder. MFM encoding is accomplished by a section of EPROM resident in the DDC microprocessor.

Once processed, the WZDATA (write data) signal is generated and sent to the Read/Write assembly. WZDATA contains a negative pulse for every flux transition or flux reversal that is to appear on the tape.

The Self-test Errors signal initiates a self-test mode. This mode checks the CRC generation and the error correction circuitry. With this circuitry operational, the state machine can detect and correct errors caused by the write process using the read-while-write process.

Both state machines use the FIFO buffer, but not at the same time. The write state machine uses the buffer for storing data to be written.

The buffer is cleared only after the read-while-write verifies that the data is correctly written onto the tape. The read state machine uses the buffer data and keys that are read.

WRITE PROCESS

The write process involves the use of a serializer and a multiplexer. The serializer latches in an 8-bit word from the HDC. This word is then clocked out using the read-bit clock (RBITC) a bit at a time (serial data). As the last bit is clocked out the serializer issues a DMA request to the HDC for another 8-bit word of data. This serial data becomes the user portion of the WZDATA signal that will eventually be written as frames 1 to 4 on the tape.

The serial data from the serializer is the input data to the multiplexer, exclusive-OR circuitry, and the CRC generator.

The multiplexer selects and gates the proper signals together to create the raw form of the signal

WZDATA. The output of the multiplexer (WZDATA) must still be encoded and compensated. The inputs to the multiplexer are as follows:

- Two hardwire lines:

  One tied to +5 volts (used to write the sync bit)

  One tied to ground (used to write the sync field and postamble)

- An input from the FIFO buffer (header information)

- The input from the serializer (frames 1 to 4)

- An input from the CRC generator (CRC field)

- Data from the exclusive-OR RAM (frames 5 and 6)

All the signals listed above are gated through the multiplexer at the proper time. The cycling and counting control comes from the write state machine control. To begin with, the sync field is generated by selecting and gating 47 zeros. This is followed by switching the input to the +5 volts line and outputting one sync bit. The header information follows, comprising 48 bits. This data is placed in the FIFO by the 6805. The next line selected by the multiplexer is the serialized user data from the serializer output (2048 bits). The multiplexer then switches to the CRC generator and writes out 16 bits of CRC data. This is followed by 4 bits of postamble (0s). The next output is the write gap which is 14 clock cycles without a pulse. This is the first frame and is repeated another three times using user data.

For the fifth and sixth frames exclusive-OR data is switched in, in the place of user data. Frame 5 is generated from user data frames 1 and 3, and frame 6 is generated from user data frames 2 and 4. See section 5-10 for tape data storage information.

The output of the multiplexer is encoded into MFM coding. This encoding is a flux transition per clock cycle for each "1" and no transition for a "0".

The data is then precompensated to avoid bit crowding. The precompensation is to one of five values: ±12.5%, ±6.25%, or 0%. This output signal (WZDATA) leaves the DDC and goes to the Read/Write assembly.

The write state machine control is enabled by the 6805 using the WGO (Write Go) signal. This block is a series of counters and outputs to the multiplexer. Control of the multiplexer consists of sorting out when to step through the individual multiplexer inputs. All the bit counting functions are maintained in the write state machine control.

READ STATE MACHINE

The read state machine continually monitors data read from the tape, searching for BOT and EOT patterns, keys and frames, and determining whether it has found a key or a frame. Also under the control of the 6805, the read state machine issues DMA requests for the read process. If an error condition exists, all error latches are sensed and the status is provided to the 6805.

For a read operation, data processing is the converse of the write state machine. That is, ZDATA is brought in from the Read/Write assembly and decoded. If no error conditions exist the read state machine issues DMA requests to the HDC and transfers data to the HDC. If an error does exist, the read state machine attempts to rebuild the data using the exclusive-OR data in the RAM. All data sent to the HDC is considered good data and to be of a uniform amount (256 bytes of data from each frame with a total of four frames).

If the read state machine is unable to rebuild the frame through the exclusive-OR RAM, the HDC issues retries. If these methods are unable to send good data to the HDC (determined by the HDC), the data is considered unrecoverable.

A verify operation simply checks the CRCs and reports a pass or fail check. The operation does not involve the use of the FIFO buffer. Verify does not issue DMA requests or use the exclusive-OR RAM.

READ PROCESS

By monitoring the gaps (RGAP), the read state machine control knows the beginning of each frame. As soon as the gap goes away the data separator locks onto the sync field and begins looking for the sync bit. Once this bit is found, the read state machine control begins the CRC checker and clocking data into the FIFO. This is a count of 48 bits of header information.

After the header comes the user data for frames 1-4 to the serial to parallel converter. User data for frames 5 and 6 is EXCLUSIVE-ORed through the exclusive-OR block to the serial to parallel converter. After counting eight bits the read-state-machine control issues a DMA request to the HDC. The HDC then reads the available 8-bit byte. After the user data the read-state-machine counts another 16 bits and latches the output of the CRC checker. This output is a zero if no error has occurred and a one if there is an error. The CRC codes have the property that given themselves as an input, the result is zero. This error status is provided to the 6805 which in turn passes it on to the HDC on completion of reading an entire block. The input data is now in the next gap and the data separator waits for the next sync field. The 6805 handles each frame independently and keeps track of which frame is being read.

Associated with both state machines is the exclusive-OR RAM. This RAM is used to generate data for the exclusive-OR frames (frame 5 and frame 6) on a write. When the write state machine receives data from the HDC, the data to be written in frames 1 and 3 is used to create exclusive-OR data for frame 5. The data for frame 6 is created from the data to be written in frames 2 and 4.

During a read operation, an entire block of data is read. The read state machine monitors for errors and dropouts (missing data) in the entire block (frames 1 to 6). If errors are detected the user data is reconstructed as much as possible using the exclusive-OR frames 5 and 6.

THE INTERRUPT ARBITER

The 6805 microprocessor is interrupt driven. Because the number of different interrupt requests exceeds the number of lines into the microprocessor, a finite state machine is used as an arbiter to manage which interrupts get priority and to queue the rest. The read state machine interrupts when it has finished processing frame or key header information. The write-state-machine interrupts when it has finished using the FIFO, as when writing a frame header. This informs the 6805 that more information can be put into the FIFO for the next frame. The read after write function causes read interrupts during a write process. A tape read generates only read interrupts, while a write generates both write and read (verify) interrupts. This tells the 6805 what state the read or write process is in at all times.

CLOCKS

This assembly runs off a 20 MHz clock, which enables the precompensation circuitry to write a bit accurately at a 50 nanosecond increment. The 20 MHz clock is fed directly to the gate array IC which then generates 4 MHz clock pulses for the microprocessor. The gate array IC also generates the precompensation.

5-4. MECHANISM DEPENDENT CONTROLLER (U1 A1)
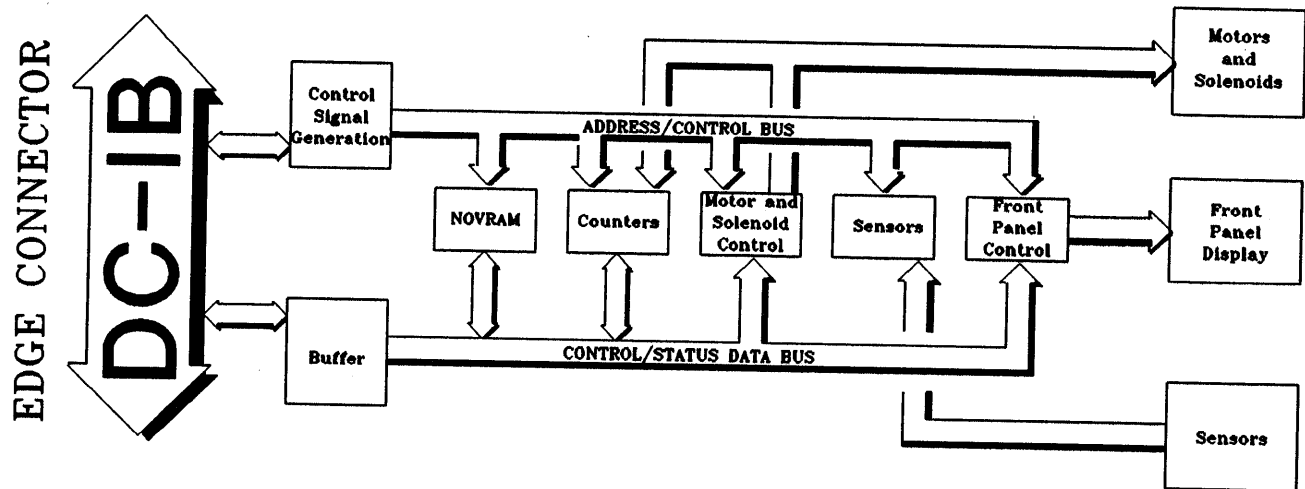
Figure 5-6. Mechanism Dependent Controller Schematic

The Mechanism Dependent Controller contains all the circuitry necessary to control the autochanger mechanism. The functions which it performs include:

- An interface to the DC-IB, by which it is connected to the HDC.

- Control of front panel displays.

- Sensor reading.

- Motor and Solenoid control.

- A counter for the motor optical encoders.

- Non-volatile RAM for power failure recovery.

THE DC-IB INTERFACE

The Mechanism Dependent Controller (MDC) is connected to the HDC through the DC-IB. However, since the MDC has no access to large amounts of data, only the control/status part of the DC-IB is used.

The control signals from the DC-IB are buffered immediately they reach the MDC by an octal tristate buffer IC. The outputs of this IC are permanently enabled so that buffered signals may directly drive other ICs in the MDC. The status data signals are also buffered on their input to the MDC. For a Write operation, data is latched into a transparent octal D-Type register by the buffered write strobe. This IC is enabled at all times unless a Read operation is occurring. However, this latch may also be read as a normal register to allow "loop-back" testing of the DC-IB. During a Write operation another octal buffer is enabled so that status data can flow from the MDC to the HDC.

READ AND WRITE STROBE GENERATION

The read and write strobes are multiplexed into eight separate read and write strobes using two 3-to-8 decoders. These strobes are then used to read or latch data from individual registers. These strobes are only generated when the MDC is selected by the HDC.

FRONT PANEL DISPLAYS

The front panel displays comprise a number of bar LEDs and a single seven-segment LED. These displays are controlled by two octal D-Type latches. The outputs of these latches drive Darlington arrays which sink enough current, when active, to turn on the appropriate LED. An LED is turned on when a logical one is written to the appropriate bit in one of the registers.

The PROTECT display can be flashed at 2Hz using a signal derived from a 555 oscillator (at 450Hz) and a counter IC.

SENSOR READING

The MDC has the ability to read up to eight sensors. These sensors are all active low and are either microswitches or infra-red opto-sensors. The sensor inputs to the MDC are all connected through octal inverting buffers whose outputs are enabled when the ICs are addressed during a read cycle. The buffered sensor inputs to the MDC are thus active high.

The sensor circuitry also looks at the settings of the [EJECT] button and the Mode button (Sequential / Selective). The [EJECT] switch is active low and connection is made through the front panel PCA. The switch is sensed using a state machine which ensures that the button has been pressed for about 10ms before enabling the register. The output from the state machine also drives the circuitry that illuminates the eject button LED.

The Mode button is read as a sensor by the sensor latch. A logical 0 indicates Selective Mode and a logical 1 indicates Sequential Mode.

MOTOR AND SOLENOID CONTROL

Two direct current motors are used in the autochanger mechanism. These are driven by a dual full-bridge driver IC which allows bi-rotational control of both motors. The direction of the motors is controlled by data written to another D-Type latch on the MDC.

The arm and eject solenoids on the autochanger mechanism are controlled by the active high outputs of one of the registers. The register outputs trigger transistor circuits, which saturate, powering-on the solenoids.

The door solenoid is controlled and powered in the same way as the mechanism solenoids.

COUNTER FOR OPTICAL ENCODERS

The outputs from the optical encoders mounted on the two autochanger motors are passed to two Schmitt triggers before being input into the counter. The counter is implemented on a programmable interval timer IC (Intel 8253).

NON-VOLATILE RAM (NOVRAM)

In order to preserve information about the status of the autochanger mechanism in the event of a power failure, a non-volatile RAM is used. This is updated after every operation performed by the mechanism.

The NOVRAM consists of some static RAM overlaying an array of EEPROM. The NOVRAM is controlled by a sensor register on the MDC. This is connected to the RECALL and STORE lines of the NOVRAM. On the STORE line going low, data in the static RAM is copied into the non-volatile RAM in a maximum time of 10ms. Similarly, on the RECALL line going low, data is copied from the non-volatile RAM back into the static RAM.

The PVAL signal from the power supply is also connected to the STORE line of the NOVRAM. This line falls low at least 500µs before the supply drops below +4.75 V. This falling edge is used to trigger a store cycle. The requirement for a store is that the power supply remains above +3.0 V for 10ms. The NOVRAM thus has its own power supply capacitor of 200µF, fed by a Schottky diode to prevent current from the capacitor being used by the rest of the circuit.

At power-on, the RECALL line is held low by one of the registers which is then cleared by a signal from the MDC (under firmware control). This automatically triggers a recall cycle.

5-5. POWER SUPPLY UNIT

The power supply is a 4 output, switching supply. It provides outputs of +5 V at 5.6 A, +12 V at 1.5 A, +12 VP (unregulated) at 4.5 A and -12 V at 0.6 A. (Output voltage tolerances are given in Table 8-1). The power-on reset signal, PVAL, is also produced by the power supply. Details of the power supply circuitry are provided in the following paragraphs.

INPUT CIRCUITRY

The AC line voltage is connected to the power supply PCA through an assembly mounted line cord receptacle. The front panel mounted line switch, which is next in the circuit, controls both sides of the AC line into the power supply. The fuse is after the line switch and is in the "line side" of the AC line. The fuse value for both 115 VAC and 230 VAC is 3.0 A at 250 V. A line filter following the fuse reduces the level of line transients entering the power supply and the amount of switching noise leaving the power supply. After the filter there is a line VOLTAGE SELECTOR switch which selects nominal voltages of 115 VAC or 230 VAC. When the switch is in the 115 VAC position, a surge voltage protection device is connected across the line to protect the power supply from damage if it is inadvertently connected to 230 VAC. A blown line fuse is the only damage that can occur. A diode array and several capacitors rectify and filter the incoming AC lines. Included in this network are two thermistors that limit the initial power-on surge to approximately 25 A peak at 115 VAC or 230 VAC.

SWITCH-MODE SUPPLY

The rectified and filtered AC line voltage is used to power a flyback-mode DC-DC converter. This converter chops the DC input into time varying voltages, transforms them to lower levels and filters the outputs to supply the desired voltages of +5, +12 and -12 VDC. The +5 and +12 V outputs are monitored by the switching circuitry to maintain close regulation. The -12 V output is further regulated by a three terminal voltage regulator.

POWER-ON RESET

The power-on reset circuit is activated by the +5 V output of the power supply and produces the Power Valid signal PVAL. At power-on, PVAL remains low for at least 100 milliseconds after the +5V output reaches 4.75V or higher. Signal PVAL then goes to a high level. On power-off PVAL will go low for at least 500 microseconds prior to the +5V going below 4.75V. The power-on reset signal is connected to the Device Dependent Controller, Read/Write circuitry and Mechanism Device Controller.

5-6.   READ/WRITE/SERVO ASSEMBLY (U0 A3, A7)

The Read/Write/Servo assembly resides with the tape drive mechanism and controls all aspects of its operation. This function is divided into two main task areas of tape mechanism control and tape data read/write control.

Servo Control
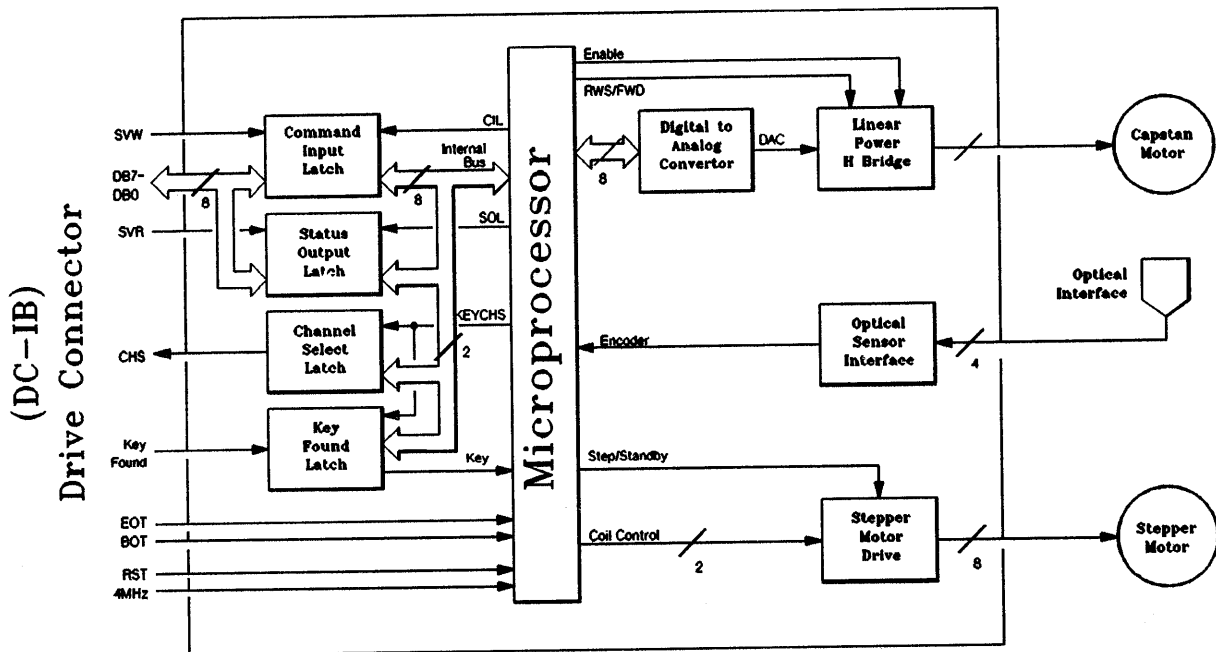
Figure 5-7. Servo Schematic

The servo control part of the assembly consists of two control systems; a tape drive system to control cartridge tape acceleration and speed, and a head positioning system to position the read/write head. These two systems are controlled by a 6805 microprocessor. The tape drive system controls a DC torque motor in a closed loop system; whereas the head positioning system uses both an open or closed loop configuration with a stepper motor. Also, the microprocessor accepts commands from and returns status to the HDC.

The servo control circuitry is also responsible for the selection of the correct gap pair on the read/write head, stopping the tape drive motor upon detection of BOT or EOT, and its diagnostics. The assembly can be divided into four main functional blocks:

- Data/Control Interface Bus (DC-IB)

- Microprocessor

- Capstan Motor and Loop Circuitry

- Head Stepper Motor and Circuitry

DATA BUS INTERFACE

The interface with the DC-IB consists of two 74LS374N devices. These are tri-state devices which serve as input and output data latches, being tied together to obtain bi-directional bus communication.

The input data latch receives command and handshake bytes from the HDC. Data is latched from the eight data lines DB0 through DB7 when a positive transition occurs on signal line SVW-L (Servo Write).

The output latch contains the servo status. The contents of the latch are placed onto the eight data lines, DB0 through DB7, when a negative transition occurs on signal line SVR-L (Servo Read).

MICROPROCESSOR

The microprocessor (6805) consists of 112 bytes of RAM, 4 kbytes of ROM, and an 8-bit timer. The microprocessor reads the input latch, provides and expects the proper handshake sequence for receiving commands, processes the command, and updates the output latch with resulting status of the ensuing operation. The microprocessor controls the following lines and functions on the Servo Assembly:

- Enables the power driver for the capstan motor when tape motion is required.

- Provides "input" to the control loop for ramp to speed, cruise, and decelerate the capstan motor.

- Controls the control line to the sample and hold circuitry.

- Measures the output of the optical sensor interface, which is proportional to the tape speed.

- Compares this output with a reference and generates a speed error signal.

- Feeds this error signal to the DAC which causes the power bridge to drive the capstan motor at the correct speed.

- Determines when the error signal is too large (excessive load) and shuts off the capstan motor.

- Controls the control lines to the stepper drive circuitry.

- Selects the proper gap pair of the read/write head.

- Performs the diagnostics of the assembly.

CAPSTAN MOTOR AND LOOP CIRCUITRY

The control loop for driving the capstan motor includes the following parts:

- Capstan Motor

- Encoder Disc and Optical Sensor

- Microprocessor

- Digital to Analog Converter (DAC)

- Linear Power H-Bridge

Capstan Motor and Encoder

The capstan motor consists of the following items:

-Motor (bi-directional, brush type, DC motor)

-Motor bucket (mounting around the motor)

-Capstan drive (glued to the motor shaft)

-Encoder disc (200 line)

-Diode and transistor pair (infra-red sensor)

The encoder disc spins with the motor shaft. The disc interrupts the beam of the infra-red sensor which then generates current pulses. These pulses are input to the sensor interface and converted to voltage pulses. The sensor interface first amplifies the current pulses from the optical sensor. It then converts these pulses into TTL level voltage pulses which can be measured at the test point (ENC). These voltage pulses are then input to the microprocessor.

Microprocessor

The microprocessor measures the period of a number of encoder pulses. From this period it computes the encoder frequency. It then subtracts this frequency from a reference frequency and produces a frequency error. The error value is monitored by the microprocessor and the motor is powered-off if the error exceeds a given tolerance band.

The error signal is used as an input value for a digital filter within the microprocessor, which forms a compensator. The output from this compensator is fed to the DAC.

In this way capstan motor speed is kept within ±0.4% of the desired value.

Digital to Analog Converter (DAC)

The DAC is used to convert an eight bit command from the microprocessor into a unipolar, analog voltage. The output voltage of the DAC is proportional to the digital input and is used as an input to the power bridge.

Linear Power H-Bridge

The power bridge circuit is arranged to drive a DC brush motor in both forward and reverse directions. This is achieved by driving one or other of the upper transistors in the bridge into saturation. At the same time the corresponding lower transistor is operated in its linear region.

The bridge is controlled by the microprocessor, which selects the motor direction (REV/FWD) and when it should run (ENABLE).

HEAD STEPPER MOTOR AND CIRCUITRY

This comprises the following elements:

- Power Switch

- Stepper Drive Circuitry

- Stepper Motor

- Microprocessor

Power Switch

The power switch provides power to the stepper motor. Maximum power is available when sequencing the coils. Standby power (25% power) is provided when the motor is not being stepped (to keep the head in place).

Stepper Drive Circuitry

This is used to select the proper motor coil and sink the coil current. Coil selection is controlled by two lines from the microprocessor. The two lines allow control of the four stepper motor coils, energizing two coils at a time.

Stepper Motor

The stepper motor is a four coil motor that is driven at 100 steps/second by the circuitry. Two coils are energized at a time to provide maximum stepping torque. When not stepping, 25% of the maximum stepping current is applied to the coils to hold the motor and head in place.

Microprocessor

The microprocessor provides the stepping sequence to the stepper motor drive and also the appropriate timing between steps. It also controls which motor coils are energized and whether the coil current should be at the stepping level or at the standby level.

The stepper motor positions the read/write head. By rotating the motor shaft clockwise or counterclockwise the head can be moved up or down.

During the tape drive load sequence the head stepper motor is driven in a closed control loop. PREPOS and EDGE commands are sent to the microprocessor which then commands the head to move up or down until the head is over track 0. This position is then used as a reference for future open loop head positioning.

Feedback for the closed loop control comes in the form of KEYFOUND signals, generated when a read gap is over a track and a key is encountered. The PREPOS command causes the servo microprocessor to move the tape back and forth while moving the head up and down until KEYFOUND signals are detected on both channels of the read/write head.

Open loop positioning can then be used to move from track to track simply by stepping the motor a given number of steps.

Read/Write Control
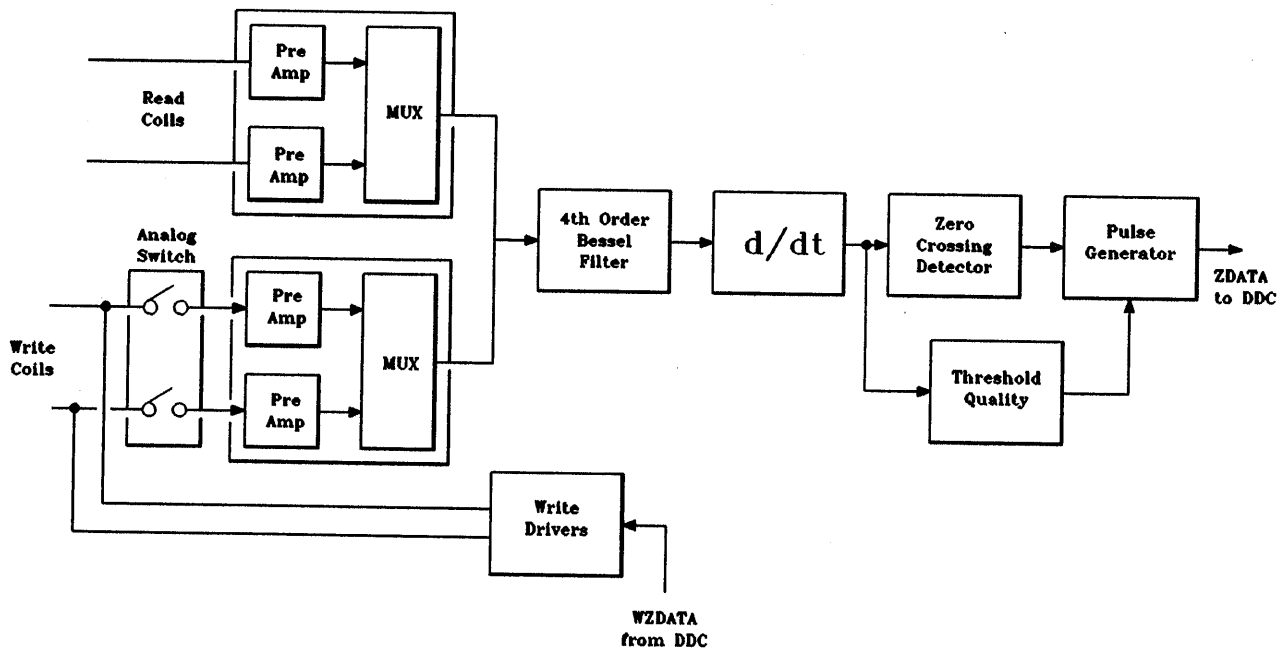
Figure 5-8. Read/Write Schematic

WRITE CONTROL LOGIC

The write control logic is responsible for selecting the correct write drivers. WRITE PROTECT and WRITE ENABLE signals are used to generate the ENABLE signal. If ENABLE is high, the write driver is able to drive one of the write coils. CHANNEL SELECT is used to select either the top write coil drivers or the bottom write coil drivers to be active. WZDATA toggles the drivers to actually write the data onto the tape.

WRITE DRIVER

The write driver provides write current to the two write coils (upper and lower). There is one set of drivers for each coil and they operate by grounding each end of the write coils individually. When writing, the center tap of each write coil is connected to +12V. Thus current can pass through opposite sides of a write coil, providing flux reversals on the tape.

The Power Valid (PVAL) signal is used to disable the write driver during power-up conditions. This is to protect the tape from being written to during unstable power conditions. It operates simply by removing the +12V from the coil center taps until the PVAL signal is asserted.

PREAMPLIFIER

The tape head contains four coils; two read coils and two write coils. Each coil has its own preamplifier. These are SSI-117 preamplifier/multiplexer ICs set for a gain of 100 and are extremely phase-linear with a flat response. An analog switch in the input lines to each write coil preamplifier isolates the preamplifiers when the write coils are being used to write data. These analog switches are controlled by the Write Control Logic. The READ HIGH WRITE LOW (RHWL) signal is used to trigger the switches on or off.

MULTIPLEXER SECTION

The multiplexer section is used to switch the proper head gap into the remainder of the read channel.

The multiplexers are controlled using the READ HIGH WRITE LOW and CHANNEL SELECT control lines. When one multiplexer is enabled, the other is disabled. The outputs of the multiplexers are ac-coupled and paralleled to form the input to a fourth order Bessel filter. This filter produces optimum phase linearity in the signal. The signal is then passed from the filter to a differentiator.

DIFFERENTIATOR

The purpose of the differentiator is to shift the phase of the signal peaks and so convert them into zero-crossings. In addition, the feedback path of the differentiator is a series resonant LCR circuit. This causes the differentiator to behave as such at data frequencies, but also to behave as a low-pass filter to higher frequencies. This means that high frequency noise is filtered out.

ZERO-CROSSING DETECTOR

The output of the differentiator is ac-coupled to a zero-crossing comparator, driven differentially for greatest accuracy. For each zero crossing of the input the comparator outputs change state. The outputs are used to fire two complementary monostables. The monostable outputs are ANDed together to produce ZDATA pulses which represent flux transitions on the tape.

THRESHOLD QUALIFY

The threshold qualify circuit is included to enhance data integrity by rejecting baseline noise. This is achieved in the following way:

Each time a tape is loaded, the tape drive firmware performs a calibration routine. One of the differentiator outputs is used to set a reference amplitude on a DAC, which relates to the peak signal amplitude of this tape/head combination. This peak value is stored for each cartridge during the load sequence. The peak value is then used as a reference. It is put into a resistive divider which produces a threshold qualification level of 24% of the peak amplitude. Two threshold comparators are then used (one for positive-going transitions and the other for negative-going transitions) to compare the data signal with this threshold

qualification level. If the signal passes qualification, the comparator enables the monostable. This can then be triggered by the output of the zero-crossing detector. If the signal does not pass qualification (a noise signal) the monostable cannot be triggered and ZDATA pulses are not produced.

5-7. AUTOCHANGER MECHANISM (U1 A6)

The function of the autochanger mechanism is to move a selected cartridge tape from the cartridge magazine to the tape drive mechanism and back to its original slot in the magazine.

This is achieved by the mechanism shown in Figure 5-9.

Two steel shafts are mounted vertically on a cast aluminium base. A vertically moving platform slides up and down these shafts. On the platform is mounted a horizontal carriage assembly. This assembly has an arm which slides horizontally along two more steel shafts.

There are ten vertical positions at which the platform will stop. At the bottom of the travel there is a vertical "home" position used by the control electronics as a reference position.

There is a vertical position where the platform is level with the top of the tape drive mechanism. A cartridge tape can then slide between the platform and the tape drive.

There are eight positions where the platform is level with the cartridge slots in the cartridge magazine. Cartridges can then slide between the platform and magazine.

Cartridges are moved between the magazine, platform and tape drive by the horizontal sliding arm. This arm has three horizontal positions at which it will stop to collect or deposit a cartridge. A solenoid on the arm actuates a CUA (Cartridge Under Arm) which traps the selected cartridge.

SLIDING
ARM

TOOTHED
BELT

CARRIAGE
ASSEMBLY

MOTORS
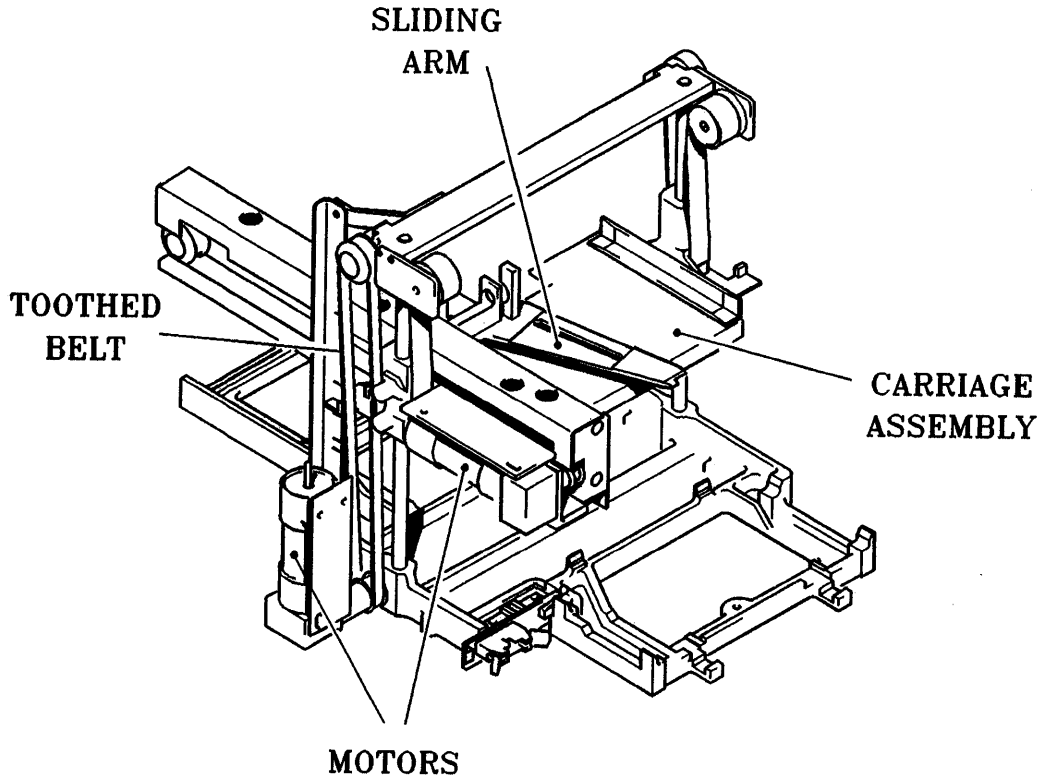
Figure 5-9. The Autochanger Mechanism

A typical sequence to move a cartridge from the magazine to the tape drive would be:

1) The mechanism starts with the platform at vertical home and the arm over the platform (one of its stationary positions - horizontal home).

2) The platform rises to the appropriate height for the selected cartridge, the arm solenoid activates, and the arm moves into the magazine over the cartridge.

3) When the arm is positioned over the cartridge, the CUA solenoid is deactivated, trapping the cartridge (second stationary position).

4) The arm is moved back to its rest position over the platform, taking the cartridge with it.

5) When the eject solenoid is operated, the platform is raised or lowered to the height of the tape drive mechanism. The

arm then moves rearwards, taking the cartridge into the tape drive.

6) The arm stops when the cartridge is fully engaged in the tape drive, and remains there while the cartridge is used (third stationary position).

The platform and arm are moved by 12 volt DC motors, which drive toothed belts, through gearboxes. There are two vertical belts which are tensioned automatically by a sliding cone arrangement on the top pulley. Horizontal belt tension is set manually using an adjuster screw on the arm casting (see section 7-4).

There are two constant force drum springs at the top of the mechanism attached to the platform. These counterbalance the platform and ensure even loading and speed of the motor when the platform is raised or lowered.

Each motor assembly contains a reduction gearbox and an optical encoder. Encoder pulses are counted by the MDC PCA and are used to

measure approximate horizontal and vertical positions. Mechanism jams can also be detected by the pulse count stopping during a movement.

Vertical rest positions are determined accurately by two infra-red opto-couplers. One, mounted on the platform detects position slots (nine; eight for cartridges and one for tape drive height) cut in a fixed vertical "bit bar". The other, mounted on the base casting, detects the bottom of the platform and gives the vertical home position.

The three horizontal positions are detected by two reflective infra-red opto-couplers mounted on the arm casting. These sense cut-outs in the horizontal sensor bar attached to the platform.

Two microswitches are mounted beneath the arm and are actuated by the presence of a cartridge. One switch detects the presence of a cartridge and the other detects whether the cartridge is write-protected.

5-8. TAPE DRIVE MECHANISM (U0 A1)

The tape drive mechanism includes the following parts:

- Capstan Motor

- Head Stepper Motor

- Read / Write Head

- Tape Eject Mechanism

The first three of these parts are described in section 5-6.

The cartridge tape eject mechanism is operated by an external rotary solenoid controlled by the MDC PCA. The mechanism has two wheels below the tape guides, which engage the slots in the metal base of the tape cartridge, locking it into the tape drive. The cartridge is held while data is passed to or from the tape.

When the solenoid is energized it pulls the cartridge eject lever which actuates the eject mechanism, lowering the wheels and disengaging

the cartridge. The cartridge can then be moved in and out of the tape mechanism. (see section 5-7).

5-9. DOOR LATCH MECHANISM

A solenoid, controlled by the MDC PCA, via the microswitch PCA, releases the door containing the cartridge magazine. The door is damped while opening by a mechanical speed governor assembly.

5-10. CARTRIDGE TAPE LAYOUT

Before data can be written onto the cartridge, the cartridge must be formatted and then certified. The formatting process establishes blocks (spaces for 1024 characters) with headers throughout the tape. Certifying divides the tape width into 16 individual tracks. Each track is divided lengthways into six 256-character frames per block.

Formatting (which prepares the tape cartridge for certifying) is done at the factory. THE HP 35401A CANNOT FORMAT A BLANK OR BULK ERASED CARTRIDGE. The Tape Drive can certify cartridges when the Initialize Media (see Table 10-3) command is sent to it. It takes approximately 40 minutes to certify a 600 foot tape and 10 minutes to certify a 150 foot tape. For this reason factory certified tapes should be used. These tapes must be initialized by the Host before they can be used.

FORMATTING

Each tape cartridge is formatted before it is sent from the factory. Formatting uses one large head that spans the entire width of the tape. Key headers and data block sections are established along the entire tape length. Manufacturing information, EOT (End Of Tape), and BOT (Beginning Of Tape) fields, which are necessary for tape access, are also written at this time.

> **CAUTION**
>
> No procedure for detecting bad tape sections is performed during formatting. The headers and data blocks are established for the life of the tape. Do not erase, bulk erase, degauss, or use any

other methods of destroying the block sectors established by formatting.

Each header contains the timing and block information needed to allow the data blocks to be written and/or read. Each header is written twice, one the mirror image of the other, allowing it to be read from either tape direction.
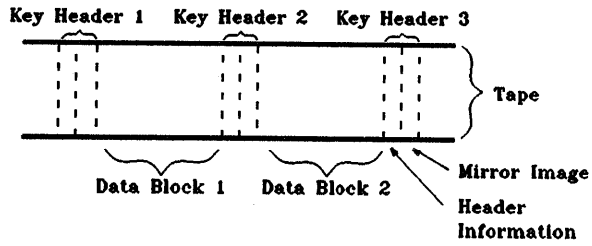
Figure 5-10. Blocks and Headers

Each data block contains the space for 1024 data characters plus 512 error correction characters.

CERTIFYING

Certifying a formatted tape cartridge divides the tape into smaller sections. The width of the tape is divided into 16 tracks and each data block length is divided into six 256-character frames.

The working area of the tape is thus divided into 16 tracks and a large number of blocks. To read and write data to the tape a tape head with two read gaps and two write gaps is used.

It is set up such that data can be read from the tape immediately after it has been written (Read-While-Write). This allows verification of the written data.

To keep from rewinding the tape after each track is read or searched the read and write gaps are repeated in reverse order. One set of gaps is positioned over the tape for writing and reading in one direction and the other pair are used in the opposite direction.

The gaps are very small and only span the width of a single track. By moving the head up and down over the width of the tape (using a head stepper motor) a pair of gaps can be positioned over any track. One pair of gaps can be positioned

over eight tracks and the other pair cover the other eight.
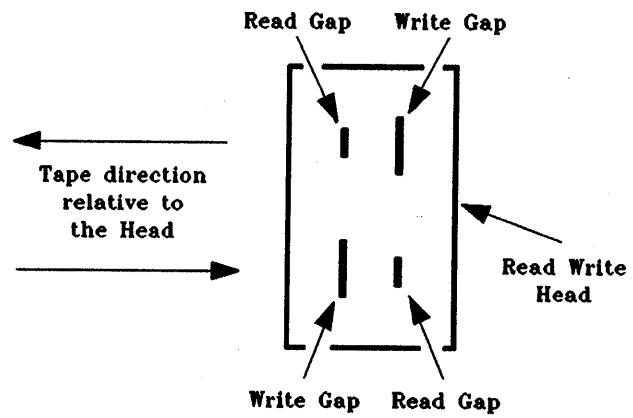
Figure 5-11. Tape head

One pair of gaps is used to read and write data on the tape in one direction. When the End Of Tape is reached, the tape direction is reversed and the other pair of gaps reads and writes data on another track. In this way, data is put onto the tape in a serpentine fashion, as shown in Figure 5-12.
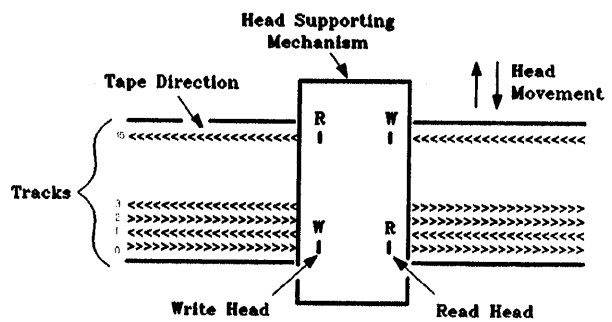
Figure 5-12. Data layout on tape

READ-WHILE-WRITE

When data is read from the tape, the appropriate read gap is used.

When data is written to the tape, it is placed accurately between the headers (see Figure 5-10). The headers are detected by using the write gap as a read gap (see Figure 5-8).

The analog switch connects the write coil to the read circuitry, while the write driver is disabled. Once a header is detected, the analog switch opens

and the write drivers are enabled. Data is then written to the tape using the write gap.

At all times the read gap is downstream of the write gap. As the tape passes over the read gap, the newly written data is read back. It is compared with the original, using the exclusive-OR circuitry. This generates data which is written to the tape before the next header.

Once the 4 frames of user data and 2 frames of exclusive-OR data are written, the write gap is again configured to detect the next header.

This sequence forms the basis of read-while-write data verification.

This section provides removal and replacement procedures for field replaceable assemblies (FRAs) and parts in the Tape Drive. Procedures are given in the normal order of disassembly. Each part or assembly which must be removed before access can be gained to another part or assembly is given first, followed by the next assembly which can be removed. The order of disassembly is shown in figure 6-1. The Figures in sections 6-11 and 6-14 identify the connectors on the PCAs and their mating cable assembly connectors. Figure 5-3 provides an overall cabling diagram of the Tape Drive. References are also made to figures 9-1 and 9-2, HP 35401A Exploded View, to assist in identifying and locating parts.

6-1. SAFETY CONSIDERATIONS

GENERAL - This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

SAFETY SYMBOLS

⚠ Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the product against damage.

⚡ Indicates hazardous voltages.

⏚ Indicates earth (ground) terminal.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure or practice that, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure or practice that, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

SAFETY EARTH GROUND - This is a safety class I product and is provided with a protective earthing terminal. An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and be secured against any unintended operation.

BEFORE APPLYING POWER - Verify that the product is configured to match the available main power source according to the input power configuration instructions provided in this manual.

If this product is to be operated with an autotransformer make sure that the common terminal is connected to the earth terminal of the main power source.

SERVICING

WARNING

The Tape Drive does not contain any operator serviceable parts. To prevent electrical shock, refer all service activities to service-trained personnel. Any servicing, adjustment, maintenance, or repair of this product must be performed only by service-trained personnel.

Adjustments described in this manual may be performed with power supplied to the product

while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside this product may still be charged after the product has been disconnected from the main power source.

To avoid a fire hazard, fuses with the proper current rating and of the specified type (normal blow, time delay, etc.) must be used for replacement. To install or remove a fuse, first disconnect the power cord from the device. Then, using a small flat-bladed screw driver, turn the fuseholder cap counterclockwise until the cap releases. Install either end of a properly rated fuse into the cap. Next, insert the fuse and fuseholder cap into the fuseholder by pressing the cap inward and then turning it clockwise until it locks in place.

6-2. ELECTROSTATIC DISCHARGE CONSIDERATIONS

CAUTION

The field replaceable assemblies (FRAs) in the Tape Drive contain electrostatic-sensitive devices. Take appropriate precautions when removing the FRAs from the Tape Drive. Use of an anti-static pad and wrist strap is required. (These items are contained in the anti-static workstation, part number 9300-0749, normally found in the Customer Engineer Toolkit.)

Immediately after removal, store the FRAs in anti-static, conductive plastic bags.

Do not turn the AC LINE switch on or off when the system is transferring data on the Hewlett-Packard Interface Bus (HP-IB).

Do not cycle the AC LINE switch on and off unnecessarily.

6-3. REQUIRED TOOLS/EQUIPMENT

To repair the unit you need the Customer Engineer toolkit and the TORX kit. In addition, the following tools are needed:

Ball driver (8710-1570)
Box wrench, ratchet (8710-0805)
Belt setting tool (35401-60030)
Door alignment tool (35401-20067)

The HP 85 Service System is also required for detailed troubleshooting.

6-4. REPAIR ENVIRONMENT

The Tape Drive does not need to be repaired in clean room conditions and may be disassembled in the normal operating environment. The conditions there must comply, however, with both the operational and non-operational environmental limits of the Tape Drive. These are to be found in Section 2.

Attention must also be paid to the sensitivity of the Tape Drive to electrostatic discharge and the unit should be placed upon the anti-static mat while being worked on. The wrist strap connected to this mat should also be worn.

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                         ┌──────────────┐
                         │  Microswitch │
                         │     PCA      │
                         │ Section 6-22 │
                         └──────────────┘

                         ┌──────────────┐          ┌──────────────┐   ┌──────────────┐
                         │    EPROM     │          │    Drive     │   │     RWS      │
                         │     Kit      │          │  Mechanism   │──▶│     PCA      │
                         │ Section 6-13 │          │ Section 6-16 │   │ Section 6-21 │
                         └──────────────┘          └──────────────┘   └──────────────┘

                         ┌──────────────┐  ┌──────────────┐   ┌──────────────┐
                         │     HDC      │  │     MDC      │   │    Eject     │
                         │     PCA      │─▶│     PCA      │   │   Solenoid   │
                         │ Section 6-11 │  │ Section 6-14 │   │ Section 6-17 │
                         └──────────────┘  └──────────────┘   └──────────────┘

                         ┌──────────────┐                     ┌──────────────┐
                         │     DDC      │                     │     Fan      │
                         │Microprocessor│                     │ Section 6-18 │
                         │ Section 6-19 │                     └──────────────┘
                         └──────────────┘

┌──────────────┐  ┌──────────────┐  ┌──────────────┐
│ Preparation  │  │     Top      │  │     DDC      │
│ for Service  │─▶│    Shroud    │─▶│     PCA      │
│ Section 6-5  │  │ Section 6-6  │  │ Section 6-15 │
└──────────────┘  └──────────────┘  └──────────────┘

                         ┌──────────────┐
                         │    Power     │
                         │    Supply    │
                         │     Unit     │
                         │ Section 6-8  │
                         └──────────────┘

                         ┌──────────────┐
                         │  Door Lock   │
                         │   Bracket    │
                         │    Assy.     │
                         │ Section 6-10 │
                         └──────────────┘

                         ┌──────────────┐  ┌──────────────┐
                         │    Front     │  │    Front     │
                         │    Panel     │─▶│  Panel PCA   │
                         │    Assy.     │  │ Section 6-12 │
                         │ Section 6-9  │  └──────────────┘
                         └──────────────┘                    ┌──────────────┐
                                                             │  Autochanger │
                         ┌──────────────┐                    │  Mechanism   │
                         │     Door     │                    │ Section 6-20 │
                         │ Section 6-7  │                    └──────────────┘
                         └──────────────┘
```

Figure 6-1. Order of Disassembly

6-5. DISASSEMBLY AND REASSEMBLY

PREPARATION FOR SERVICE

Before starting any disassembly of the Tape Drive, the following steps should be taken to prepare it for service:

1) Set the AC LINE switch to the "off" (push-button out) position. Disconnect the power cord from the AC LINE socket on the rear of the Tape Drive.

2) Disconnect the HP-IB cable assembly from the connector on the rear panel.

3) Place the Tape Drive on the anti-static mat and connect the wrist strap to the pad. When the top shroud is removed (see section 6-6), ground the frame of the Tape Drive to the mat.

CAUTION

Ensure that the anti-static wrist strap is attached to your wrist before removing or replacing any components in the Tape Drive.

Removal and replacement instructions for FRAs and parts in the Tape Drive are provided in the following sections. Numbers in parentheses refer to index numbers in table 9-1 and figures 9-1 and 9-2. Unless otherwise specified, replacement is the reverse of the removal procedure.

NOTE

All TORX screws with captive washers must be fully tightened during reassemb-

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ly. Tightness can be assessed by checking that the washer is completely flattened, and the effort required to rotate the screw has increased dramatically.

CAUTION

Do not lift the Tape Drive by either of the bars across the top of the unit when the shroud is off. Damage may result to the autochanger mechanism or the door latch mechanism.

WARNING

In extreme cases, jolting the unit while lifting it by one these bars may cause the bar to collapse, resulting in personal injury.

When moving the autochanger mechanism by hand, apply force gently and steadily at the correct positions. Vertically, apply force to the center of the platform (below where the cartridge lies on it). Horizontally, apply force to the thick part of the horizontal carriage near the horizontal shafts.

Failure to comply with this may result in permanent deformation of mechanism components.

WARNING

Before attempting to move the autochanger mechanism manually, disconnect the autochanger cable from socket J4 on the MDC PCA (see section 6-14). This will prevent damage to the MDC board.

6-6. TOP SHROUD
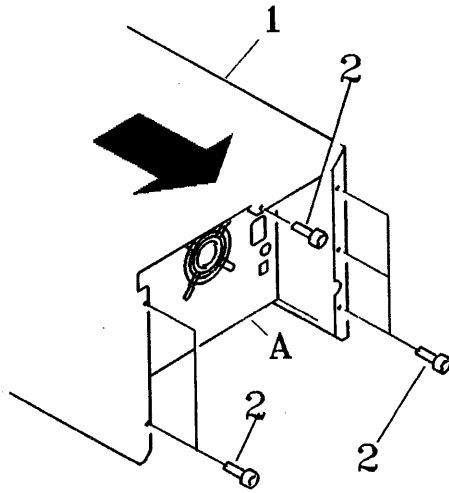
To remove the top shroud (1) proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Power-on the unit and open the front door by pressing the eject button. This step is not essential (you may not be able to power it up if there is a PSU fault), but will assist by giving access to the front of the shroud.

3) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

4) Remove the six T10 screws (2) which secure the top shroud to the chassis assembly.

5) Carefully slide the top shroud towards the rear of the drive. When the top shroud is clear of the front panels, gently pull the bottom of the sides apart (to clear screw heads on the chassis) and lift the shroud off the chassis.

6) Ground the chassis to the anti-static mat before removing any FRAs from the drive.

6-7. DOOR
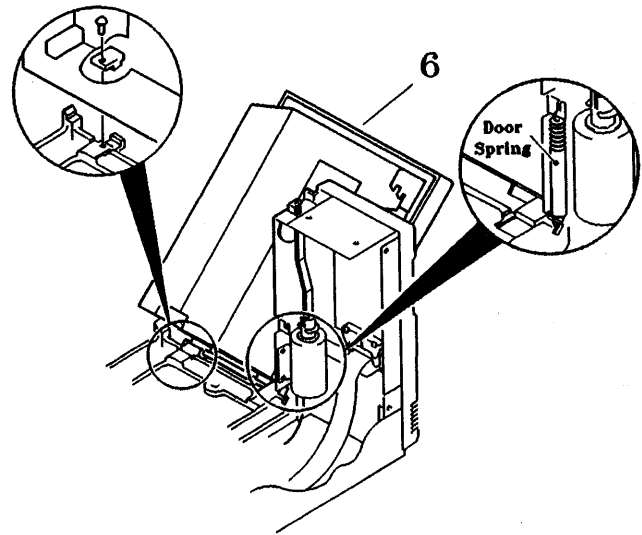
NOTE

For details of the door assembly on earlier models of the HP 35401A, refer to chapter 11 - Product History.

To remove the door (6) from the Tape Drive, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (refer to section 6-6).

4) Open the door (6) manually, by operating the door latch mechanism.

5) Remove the cartridge magazine (8), if one is loaded into the door.

6) Disconnect the governor arm (30) from the door, and push the governor arm assembly to the top of the slide housing. This will hold the ESD shield out of the way of the door.

7) Using a small pair of pliers, unhook the top of door-spring from the notch on the front

panel, and then unhook the bottom of the door-spring from the spring bracket on the door. Keep the spring for future use.

8) Support the door, and unscrew the two screws (7) securing the door hinges.

9) Remove the door by swinging the spring bracket clear of the front panel, then lifting the door out, bottom first.

Replacement is the reversal of the removal procedure, but take care to refit the door-spring with the heatshrink towards the bottom.

After replacing the door, perform the alignment procedure outlined below.

DOOR ALIGNMENT

To align the door, proceed as follows:

1) Loosen all nine screws securing the door lock bracket assembly (16), but do not remove.

2) Loosen the three screws securing the right hand panel (28), but do not remove.

3) Loosen the two screws holding the top of the front panel assembly (13) to the door lock bracket, and the two screws holding the front panel assembly to the side panel.

4) Loosen the screw holding the inside of the front panel to the stiffener bracket, and the two nuts securing the bracket to the chassis.

5) Loosen the screws securing the AC LINE switch to the side of the chassis.

6) Close the door.

7) Pull the front panel assembly to the left and tighten the two top screws.

8) Push back the retainer plate by pushing the nylon ferrule downwards, and hold the plate in position using a 1.5 mm Allen key. This should be inserted from the front of the mechanism, as shown in Figure 6-2.

9) Insert the door alignment tool over the door latch pin (see Figure 6-3).
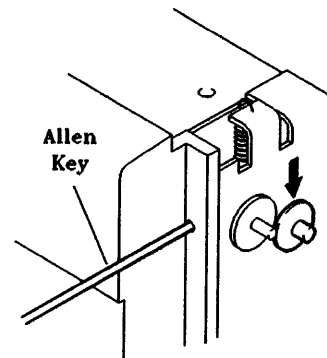
Fig 6-2. Retainer Plate & Nylon Ferrule
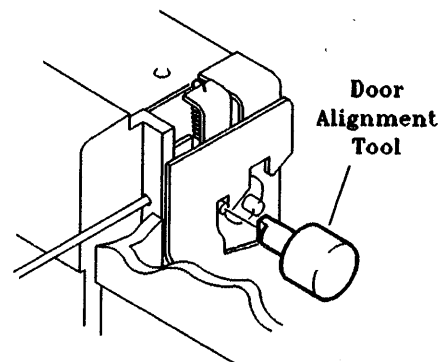
Fig 6-3. Door alignment Tool

10) Tighten all the screws in the right-hand side of the chassis.

11) Adjust the vertical position of the front panel assembly so that the door alignment tool fits snugly over the latch pin. (Ensure the bottom edge of the front panel cover is located inside the lip of the chassis).

12) Tighten all the screws on the left-hand side of the chassis, including those securing the AC LINE switch.

13) Pull the stiffener bracket to its extreme left position, and tighten the two nuts securing the bracket to the chassis.

14) Tighten the screw securing the inside of the front panel assembly to the stiffener bracket.

15) Remove the alignment tool and the Allen key, and check the action of the door mechanism.

16) Tighten the screw securing the right-hand panel from the inside. (Open the door to gain access).

17) Re-insert the Allen key, as in step 7, and insert the alignment tool again. If the alignment tool does not fit snugly, repeat the alignment procedure from the beginning.

DOOR ALIGNMENT CHECKS

After the top shroud has been replaced, the following tests should be carried out to check that the door assembly is aligned correctly:

- Ensure the door will unlatch and open freely with a full caddy of eight 600ft tapes.

- Ensure the door will unlatch and open freely with an empty caddy.

- Check for smooth and repeatable operation of the main AC LINE switch.

If any of these tests fail, repeat the alignment procedure from the beginning.

6-8. POWER SUPPLY UNIT (A10)

To remove the power supply unit (9) from the Tape Drive, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (refer to section 6-6.) and work from the left side of the unit.

4) Remove the T10 screw attaching the Earth bonding strap to the removable power supply access plate.

5) Remove the eight T10 screws attaching the access plate to the side of the chassis.

6) Remove the T15 screw attaching the access plate to the rear of the chassis.

7) Remove the two T10 screws attaching the AC LINE switch bracket to the side panel of the chassis.

8) Unscrew the T10 screw attaching the middle of the Bowden cable to a stand-off pillar on the side panel.

9) Pull out the access plate enough to allow you to disconnect the power cable assembly (57) and the fan cable from the PSU PCA.
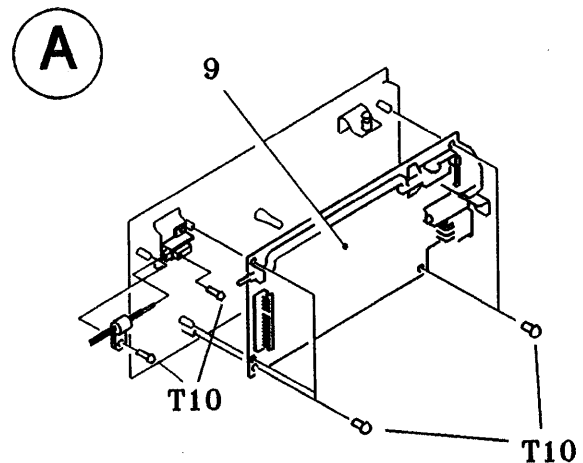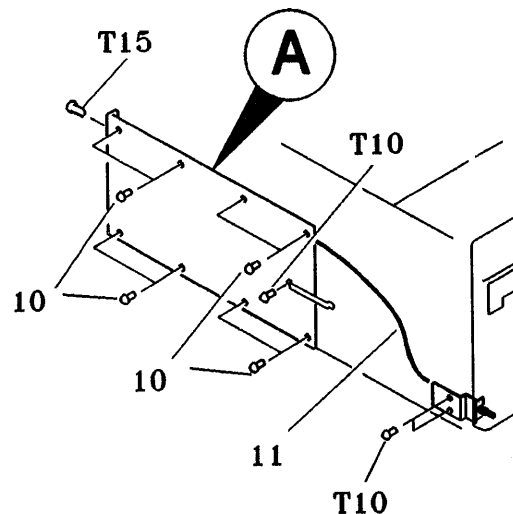
10) Pull out the access plate, rear first, and feed the front panel switch and Bowden cable assembly over the vertical motor and out through the hole in the side panel left by the access plate.

11) The power supply assembly can now be removed from the access plate by first releasing the Earth bonding screw from the AC LINE socket.

12) Next unscrew the four T10 screws attaching the corners of the PCA to stand-offs on the access plate.

13) Remove the T10 screw from the ground connection on the PCA.

14) Slacken the T10 screw attaching the switch extension rod (black plastic rod) to the Bowden cable assembly. Now the PSU PCA is only attached to the access plate by a plastic stand-off in the middle of the PCA.

15) Remove the PCA by lifting it off the plastic stand-off and withdrawing the switch extension rod.

When replacing the PCA with a new one, it must be prepared by removing the plastic high voltage guard from beneath the PCA. This guard is not necessary in this application and its removal provides a mounting hole for the plastic stand-off. Also, the return spring on the PCA mounted AC LINE switch must be removed. The action of this spring is performed by a similar spring on the front panel AC LINE switch.

The replacement procedure is the opposite of the removal procedure. Remember to attach the power cable assembly and fan cable prior to reattaching the access plate.

When the power supply assembly is replaced it may be found that the switch mechanism no longer works. Adjustments may be made to the amount of Bowden cable inside the brass ferrule at the power supply end until the switch functions correctly.

6-9. FRONT PANEL


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NOTE
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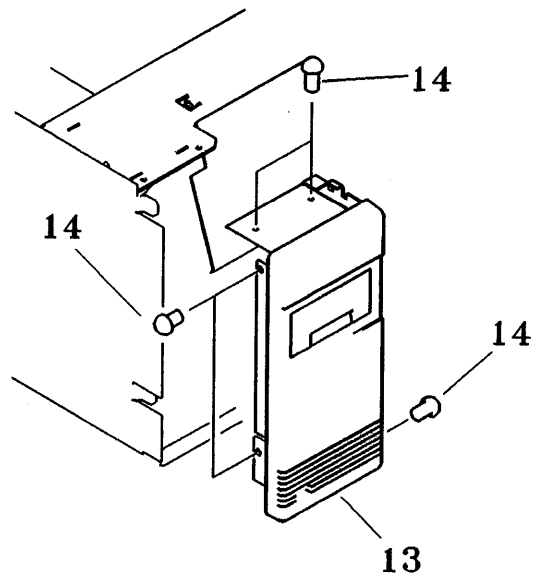
For details of the front panel on earlier models of the HP 35401A, refer to chapter 11 - Product History.

To remove the front panel (13) from the Tape Drive, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (refer to section 6-6).

4) Open the door manually, by operating the door latch mechanism, and remove the cartridge magazine if one is present.

5) Remove the door (refer to section 6-7).

6) Remove the two T10 screws attaching the top of the front panel to the door lock bracket, and the screw holding the inside of the front panel to the stiffener bracket.

7) Remove the two T10 screws attaching the side of the front panel to the side panel.

8) Push in the AC LINE switch and slacken its two mounting screws on the side panel.

9) Lift out the front panel, disconnecting the cable from the front panel PCA (26), and the solenoid from the microswitch PCA (52).

Replacement is the reverse of removal, but be sure to perform the door alignment procedure before tightening any of the screws. (see section 6-7).

6-10. DOOR LOCK BRACKET ASSEMBLY


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NOTE
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For details of the door latch mechanism on earlier models of the HP 35401A, refer to chapter 11 - Product History.

To remove the door lock bracket assembly (16) from the Tape Drive, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (refer to section 6-6).

4) Remove the door (refer to section 6-7).

5) Remove the front panel (refer to section 6-9).

6) Unscrew the three screws attaching the right hand panel to the side panel. There are two screws outside, and one inside. Remove the right hand panel.

7) Unscrew the nine T10 screws attaching the door lock bracket to the side panels.

8) Withdraw the door lock bracket assembly rearwards and upwards, taking care not to damage the ESD shield, or the governor arm assembly.

9) Slide the governor arm assembly (30) out of the slider housing, noting that the slider falls free. Retrieve the slider.

Replacement is the reverse of removal, but remember to perform the door alignment procedure before tightening any of the screws (refer to section 6-7).

6-11. HDC PCA
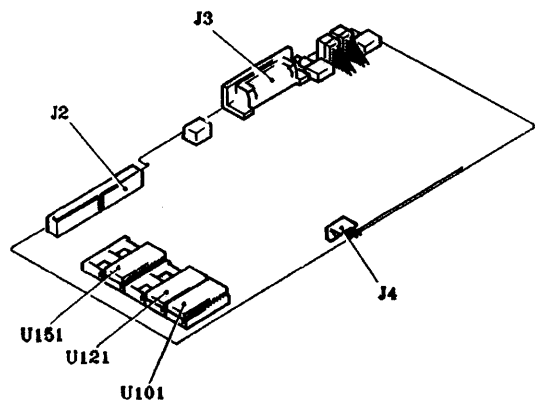
To remove the Host Dependent Controller PCA (19) from the Tape Drive, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (refer to section 6-6).

4) Unplug the power lead connector from socket J4 on the HDC PCA.

5) Unplug the HDC/MDC/DDC cable from socket J2 on the HDC PCA.

6) Ensure that the horizontal carriage assembly is below the level of the HDC PCA. If not, gently lower it by hand.

7) Unscrew and remove the two 9/32 AF screwed spacers attaching the HP-IB connector to the rear panel.

8) Withdraw the PCA forwards and upwards and place it on the anti-static mat or in an anti-static bag.

6-12.   FRONT PANEL PCA (A11)

To remove the front panel PCA (26) from the Tape Drive, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (referring to section 6-6).

4) Remove the front panel (referring to section 6-9).

5) The PCA can now be detached from the front panel by unscrewing three attaching T8 self-tapping screws (27). Retain the eject button, which is held in place by the PCA.

Replacement is the reverse of removal, but remember to perform the door alignment procedure before tightening any of the screws (refer to section 6-7).

6-13.   HDC/DDC EPROM KIT
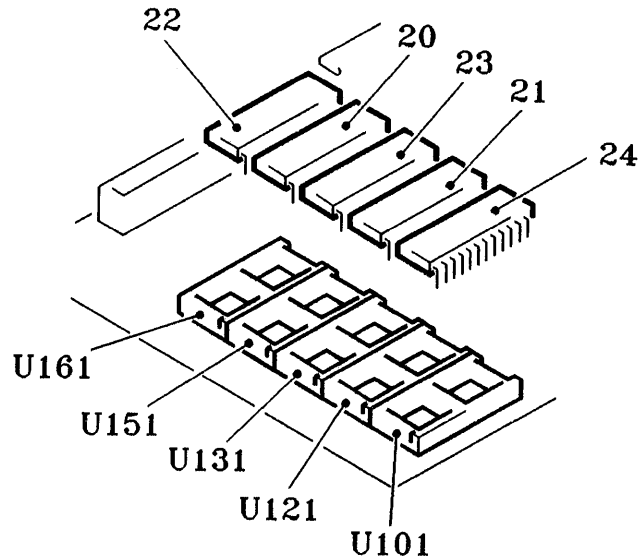
To remove the EPROMs (20-24) from the HDC PCA, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (refer to section 6-6).

4) Remove the HDC PCA (see section 6-11).

5) Remove the single EXEC EPROM (24) from the 28-pin socket U101 on the HDC PCA. Place the EPROM on a piece of anti-static foam or in an anti-static bag.

6) Remove the two mechanism EPROMs (22, 23) from their sockets U161 and U131 on the HDC PCA.

7) Remove the two DDC EPROMs (20, 21) from their sockets U151 and U121 on the HDC PCA.

8) Place all the EPROMS on a piece of anti-static foam.

Replacement is the opposite of the removal procedure. Take care to ensure that the EPROMs are replaced in the right sockets and are the correct way round, with their indent towards the outside of the PCA. Check that all IC legs are installed in the socket.

4) Remove the HDC PCA, referring to section 6-11, but now make sure that the horizontal carriage assembly is below the level of the MDC PCA.

5) Unplug the HDC/MDC/DDC cable from socket J1 on the MDC PCA.

6) Unplug the MDC/front panel cable from socket J2 on the MDC PCA.

7) Unplug the MDC power cable and eject solenoid cable from socket J3 on the MDC PCA.

8) Unplug the MDC/autochanger cable from socket J4 on the MDC PCA.

9) Remove the T10 screw attaching the MDC PCA to the rear panel and withdraw the MDC PCA from the unit.

6-14. MDC PCA (U1 A1)
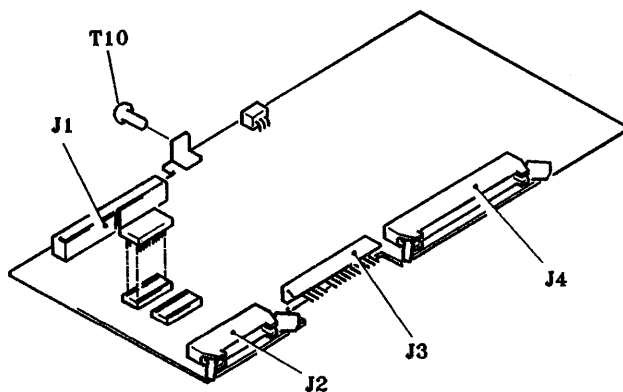
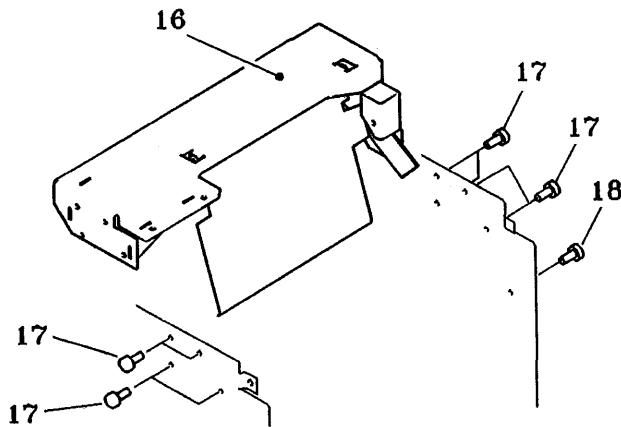To remove the Mechanism Dependent Controller PCA (33) from the Tape Drive, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (referring to section 6-6).

6-15. DDC PCA (U0 A2)
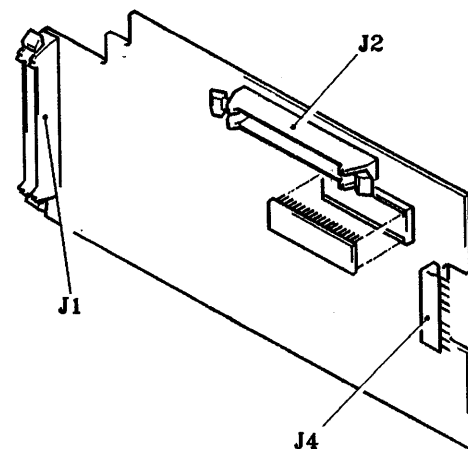
To remove the Device Dependent Controller PCA (35) from the unit, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (refer to section 6-6).

4) Remove the HDC PCA (see section 6-11).

5) Remove the MDC PCA (see section 6-14).

6) Unplug the DDC/drive mechanism cable from socket J2 on the DDC PCA.

7) Unplug the HDC/MDC/DDC cable from socket J1 on the DDC PCA.

8) Unplug the DDC power cable from socket J4 on the DDC PCA.

9) Unscrew the two T10 screws attaching the PCA support bracket to the side panel and remove the bracket.

10) The DDC PCA can now be lifted out of the unit.

6-16.   DRIVE MECHANISM (U0 A1)

To remove the drive mechanism assembly (37)
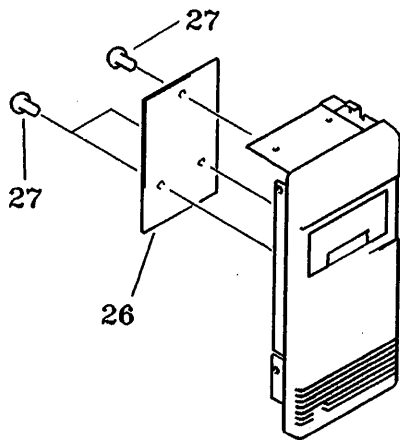
from the Tape Drive, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (refer to section 6-6).

4) Remove the HDC PCA (see section 6-11).

5) Remove the MDC PCA (see section 6-14).

6) Remove the locking pin (41) from the eject solenoid (40) and disengage the eject lever. Take care not to bend the lever.

7) Unplug the DDC/drive mechanism cable from socket J2 on the DDC PCA.

8) Turn the unit over and rest it on one side ensuring that it does not rest on either of the front panel assemblies.

9) Make sure that the unit remains on the anti-static mat, as this also helps to prevent damaging the surface of the table on which you are working.

10) Supporting the drive mechanism with one hand, remove the two T10 screws (38) and two T10 screws (39) attaching it to the base.

NOTE

Some units may have spacers in between the drive mechanism and the base casting. These must be replaced on re-assembly. Units with base castings of REV T onwards do not require spacers, and two of the four screws securing the drive mechanism are shorter (see chapter 11 - Product History).

1) Put the unit back on its base and lift the drive mechanism off the autochanger assembly (47). This enables you to remove the drive mechanism power cable from socket J8 on the Read/Write/Servo PCA.

2) Unplug the cartridge sensor (cartridge in / write protect) cable from socket J6 on the RWS PCA.

3) Lift the drive mechanism out of the unit and place it on the anti-static mat. The DDC/drive mechanism cable can now be unplugged from socket J7 on the Read/Write/Servo PCA.

If the drive mechanism has failed, it should be replaced by an exchange assembly 09144-69501. This is a bare mechanism (common to an HP 9144A Tape Drive) to which parts must be added from the assembly being replaced. The procedure for converting the replacement drive mechanism is as follows:

1) Begin by removing the RWS PCA from the faulty drive mechanism, as detailed in section 6-21 (paragraphs 10 to 15).

2) If the RWS PCA was mounted on four stand-off pillars, unscrew the pillars and discard them. These are not needed on the replacement mechanism.

3) Refer to the figure below and prepare the replacement drive mechanism by pulling off the eject pushbutton (A).
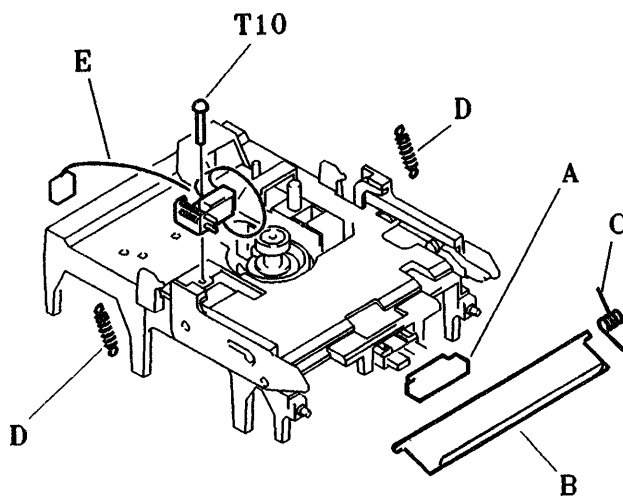
4) Remove the front door flap (B) and spring

(C) by spreading the cartridge guides.

5) Remove the two coil springs (D) from the eject mechanism.

6) Remove the cartridge sensor microswitches (E).

7) Remove the microswitch cable from the cable clip under the mechanism.

8) Now refer to the next figure, and continue constructing the replacement drive mechanism.
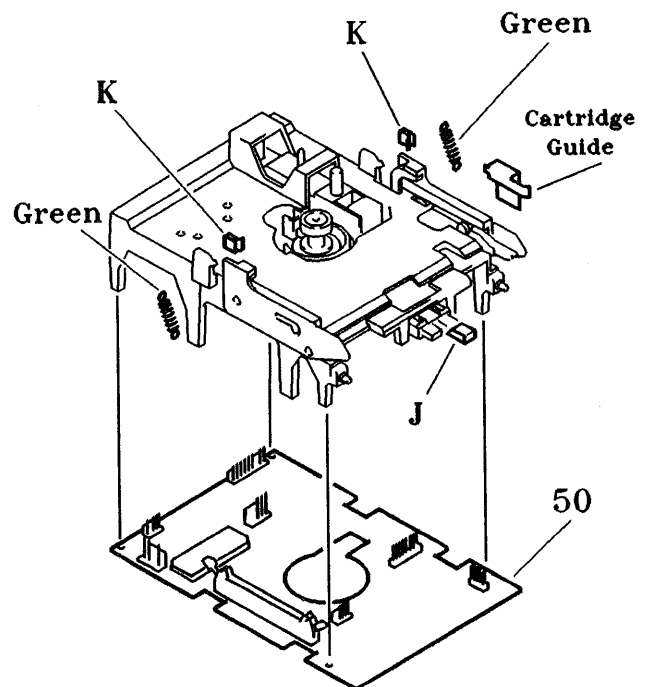
┌─────────────┐
│ **NOTE** │
└─────────────┘

The springs and clips referred to in this section are contained in a Fastener Kit (part no. 35401-60016), together with various screws, retainers etc.

1) Remove the eject mechanism coil springs from the faulty mechanism and fit them to the replacement mechanism. These springs are green and have less tension.

2) Remove the spring clip (J) from above the eject pushbutton on the faulty mechanism and fit it to the replacement. This clip prevents the eject mechanism from latching.

3) Remove the two spring clips (K) from the cartridge guides on the faulty mechanism. Fit them to the replacement so that they prevent the eject arms from entering the slots in the cartridge guides.

4) Loosen the screw holding the eject solenoid lever, and remove the lever from the eject push-button on the faulty mechanism. Attach it to the replacement mechanism.

5) Attach the RWS PCA to the replacement mechanism and follow the steps given in section 6-21 (in reverse order) to reassemble the Tape Drive.

6-17.   EJECT SOLENOID
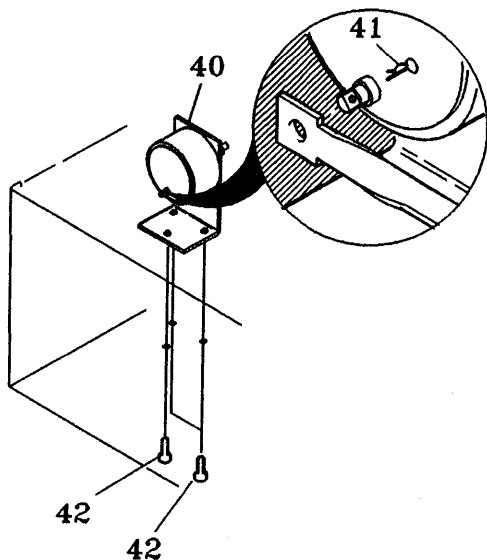
NOTE

For details of the eject solenoid on earlier models of the HP 35401A, refer to chapter 11 - Product History.

To remove the eject solenoid (40) from the unit, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (refer to section 6-6).

4) Remove the HDC PCA (see section 6-11).

5) Remove the MDC PCA (see section 6-14).

6) Remove the locking pin (41) from the eject solenoid and lift off the eject lever.

7) Turn the unit over and rest it on one side ensuring that it does not rest on either of the front panel assemblies.

8) Make sure that the unit remains on the anti-static mat, as this also helps to prevent damaging the surface of the table on which you are working.

9) While supporting the eject solenoid with one hand, remove the three T10 screws attaching it to the base.

10) Remove the eject solenoid complete with its bracket.

CAUTION

When replacing the solenoid, take care not to overtighten the screws.

6-18. FAN

To remove the fan (43) from the unit, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.
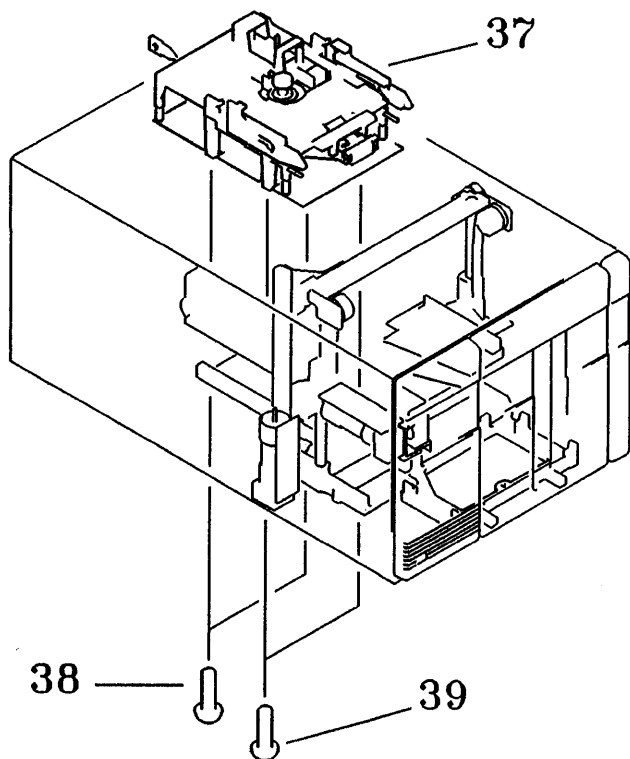
3) Remove the top shroud (refer to section 6-6).

4) Remove the HDC PCA (see section 6-11).

5) Remove the MDC PCA (see section 6-14).

6) Slacken the cable clamps through which the fan cable passes by pressing down the tab on each clamp.

7) Unplug the fan cable from socket J2 on the power supply PCA.

8) Release the fan cable from the cable clamps.

9) Remove the four T20 self-tapping screws attaching the fan to the rear panel.

10) Lift out the fan from the unit.

When replacing the fan with a new one, remove the fan guard from the old fan and fit it to the new one, so that the fan remains guarded on both sides.

6-19. MICROPROCESSOR KIT
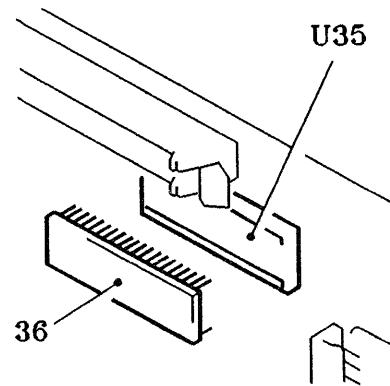
To remove the Microprocessor (36) from the DDC, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (referring to section 6-6).

4) Remove the HDC PCA (referring to section 6-11).

5) Remove the MDC PCA (see section 6-14).

6) Remove the DDC PCA (referring to section 6-15).

7) Remove the Microprocessor (36) from its socket U35 on the DDC PCA (35). Place the Microprocessor on a piece of anti-static foam.

Replacement is the opposite of the removal procedure. Take care to ensure that the Microprocessor is replaced in the right socket and is the correct way round, with its indent towards the outside of the PCA. Check that all IC legs are installed in the socket.

6-20. AUTOCHANGER MECHANISM (U1 A6)
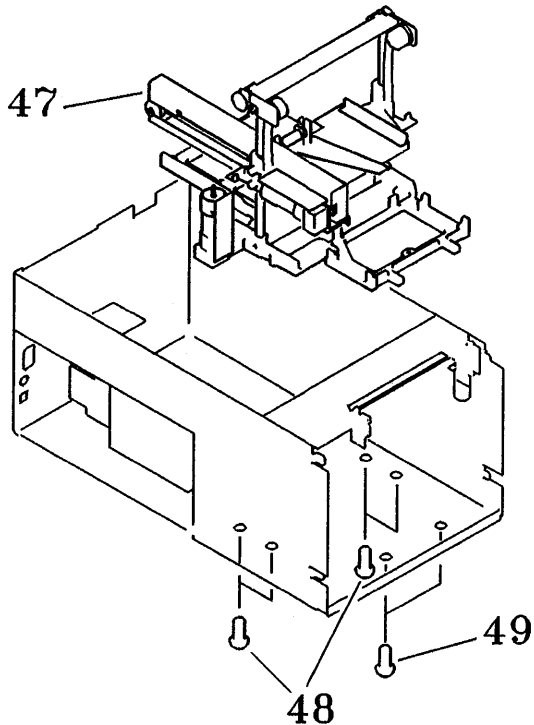
Before removing the autochanger mechanism (47) from the unit, confirm that it is faulty by comparing it with a new mechanism. (Much time could be saved by doing this). A method is given for this in section 8-6.

To remove the autochanger mechanism (47) from the unit, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (referring to section 6-6).

4) Remove the door (referring to section 6-7).

5) Remove the front panel (referring to section 6-9).

6) Remove the HDC PCA (referring to section 6-11).

7) Remove the MDC PCA (referring to section 6-14).

8) Remove the DDC PCA (referring to section 6-15).

9) Remove the drive mechanism (referring to section 6-16).

10) Unplug the brown flexible PCA (U1 A5), on the horizontal carriage assembly, from the socket mounted on top of the power supply.

11) Unplug the cable from the socket on the vertical motor PCA.

12) Unplug the ribbon cable from the socket on the microswitch PCA. (See illustration, section 6-22).

13) Gently lower the horizontal carriage assembly to the bottom of its travel, if it is not already there.

14) Turn the unit over and rest it on one side.

15) Make sure that the unit remains on the anti-static mat, as this also helps to prevent damaging the surface of the table on which you are working.

16) While supporting the autochanger mechanism with one hand, remove the six T10 screws attaching it to the base of the chassis.

17) Put the unit back on its base and carefully lift out the autochanger mechanism, lifting the rear of the mechanism first. Be careful not to catch any cables with the mechanism, especially the Bowden cable, which is close to the vertical motor.

Replacement is the reverse of removal, but be sure to perform the door alignment procedure before tightening any of the screws. (see section 6-7).

6-21. READ/WRITE/SERVO PCA (U0 A3,A7)

To remove the Read/Write/Servo PCA (50) from the unit, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (referring to section 6-6).

4) Remove the door (referring to section 6-7).

5) Remove the front panel (referring to section 6-9).

6) Remove the HDC PCA (referring to section 6-11).

7) Remove the MDC PCA (see section 6-14).

8) Remove the DDC PCA (see section 6-15).

9) Remove the drive mechanism (see section 6-16).

10) Unplug the optical sensor cable from socket J5 on the RWS PCA.

11) Unplug the stepper motor cable from socket J1 on the RWS PCA.

12) Unplug the capstan motor cable from socket J4 on the RWS PCA.

13) Unplug the write head cable from socket J3 on the RWS PCA.

14) Unplug the read head cable from socket J2 on the RWS PCA.

15) Put the drive mechanism on its side on the anti-static mat and remove the four T10 screws (51) attaching the PCA to the drive mechanism chassis.
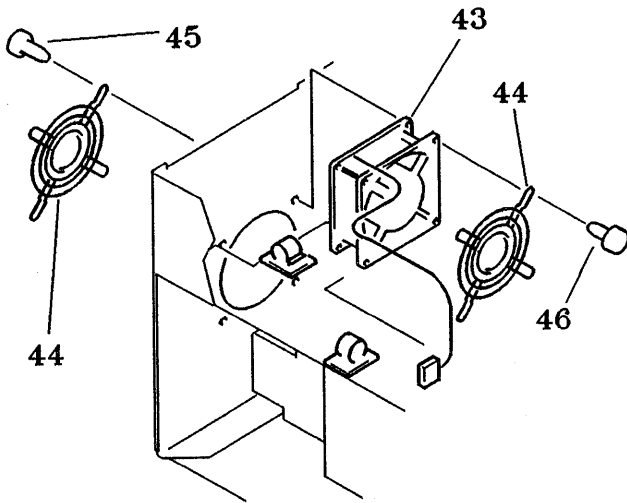
6-22. MICROSWITCH PCA (U1 A4)
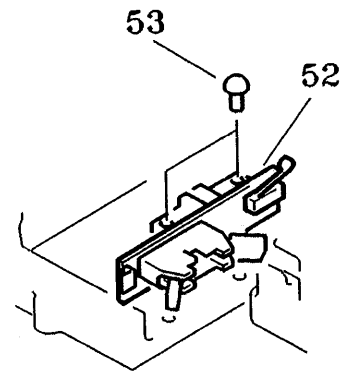
To remove the microswitch PCA (52) from the unit, proceed as follows:

1) Perform the preparation for service procedure outlined in section 6-5.

2) Ensure that the power cord is disconnected from the AC LINE socket on the rear panel.

3) Remove the top shroud (refer to section 6-6).

4) Remove the door (see section 6-7).

5) Remove the front panel (see section 6-9).

6) Remove the HDC PCA (see section 6-11).

7) Remove the MDC PCA (see section 6-14).

8) Remove the DDC PCA (see section 6-15).

9) Remove the drive mechanism (see section 6-16).

10) Remove the autochanger mechanism, referring to section 6-20.

11) With the autochanger mechanism out of the unit, raise the horizontal carriage assembly to the top of its travel.

12) Using the ratchet box wrench (8710-0805) with a T10 driver inserted, undo the two screws (53) holding the microswitch PCA bracket. The PCA and bracket can now be lifted clear of the mechanism.

Replacement is the reverse of removal. After reassembly, switch on the unit and check that it performs the self-test successfully. If the unit fails, and self-test error **8D** is displayed, the position of the microswitch PCA on the bracket may need further adjustment.

Adjustments

The only adjustments to be made in the Tape Drive concern the autochanger mechanism drive belts. The horizontal belt tension is adjustable, whereas the vertical drive belts have self-adjusting tensioners.

The vertical drive belts, however, have to be checked for position. If either belt slips over the toothed pulley at the bottom of the mechanism, the result is that the platform assembly is no longer parallel with the mechanism.

7-1. SAFETY CONSIDERATIONS

GENERAL - This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

SAFETY SYMBOLS

⚠ Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect the product against damage.

⚡ Indicates hazardous voltages.

⏚ Indicates earth (ground) terminal.

WARNING

The WARNING sign denotes a hazard. It calls attention to a procedure or practice that, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operating procedure or practice that, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

SAFETY EARTH GROUND - This is a safety class I product and is provided with a protective earthing terminal. An uninterruptible safety earth ground must be provided from the main power source to the product input wiring terminals, power cord, or supplied power cord set. Whenever it is likely that the protection has been impaired, the product must be made inoperative and be secured against any unintended operation.

BEFORE APPLYING POWER - Verify that the product is configured to match the available main power source according to the input power configuration instructions provided in this manual.

If this product is to be operated with an autotransformer make sure that the common terminal is connected to the earth terminal of the main power source.

SERVICING

WARNING

Any servicing, adjustment, maintenance, or repair of this product must be performed only by service-trained personnel.

Adjustments described in this manual may be performed with power supplied to the product while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.

Capacitors inside this product may still be charged after the product has been disconnected from the main power source.

To avoid a fire hazard, fuses with the proper current rating and of the specified type (normal blow, time delay, etc.) must be used for replacement. To install or remove a fuse, first disconnect the power cord from the device. Then, using a small flat-bladed screw driver, turn the fuseholder cap counterclockwise until the cap releases. Install either end of a properly rated fuse into the cap. Next, insert the fuse and fuseholder cap into the fuseholder by pressing the cap inward and then turning it clockwise until it locks in place.

7-2. REQUIRED TOOLS/EQUIPMENT

In addition to the Customer Engineer toolkit and the TORX kit, a drive-belt tension-checking tool (35401-60030) is needed to make the required adjustments.

7-3. PREPARATION FOR ADJUSTMENTS

Before making any adjustments in the Tape Drive, take the following steps to prepare it for service:

1) Set the AC line switch to the "off" (pushbutton out) position. Disconnect the power cord from the AC line socket on the rear of the Tape Drive.

2) Disconnect the HP-IB cable assembly from the connector on the rear panel.

3) Place the Tape Drive on the anti-static mat and connect the wrist strap to the pad. When the top shroud is removed (see section 6-6), ground the frame of the Tape Drive to the mat.

CAUTION

Ensure that the anti-static wrist strap is attached to your wrist before removing or replacing any components in the

Tape Drive.

7-4. SETTING HORIZONTAL BELT TENSION

To check or adjust the horizontal drive belt tension you must proceed through the preparation section (7-3) and remove the top shroud (section 6-6).

The horizontal carriage assembly should be positioned at the middle or top of its travel and at the forward limit of its travel. if it is not there, gently move it by hand to the correct position.

CAUTION

Gently apply force to the center of the platform to move it up or down. Parts of the mechanism could be permanently deformed if force is applied elsewhere.

Take care not to open the door with the horizontal carriage assembly forward and near the bottom of its travel. The door would damage the arm on the assembly.

Gently move the flexible PCA away from covering the holes in the horizontal sensor bar.

The belt tension may be checked by placing the tool (35401-60030) through the hole in the horizontal sensor bar, as shown in Figure 7-1. (Near the middle of the belt length). If the tension is correct, a single groove will show above the sliding collar on the horizontal sensor bar. If the belt is too tight, then two grooves will show. If the belt is too slack, then no grooves will show.

If the tension is not correct, it should be adjusted using a Pozidrive screwdriver, as shown in Figure 7-1. Slacken the belt first by unscrewing the Pozidrive screw and pressing down on the belt. Then tighten the belt until the belt tension tool shows just one groove.

NOTE

Remove the tool and exercise the mechanism by performing a mechanism self-test. This will even-out the tension in the belt. Now check the belt tension using the tool and readjust if necessary.

Tool
(35401-60030)

Pozi Driver
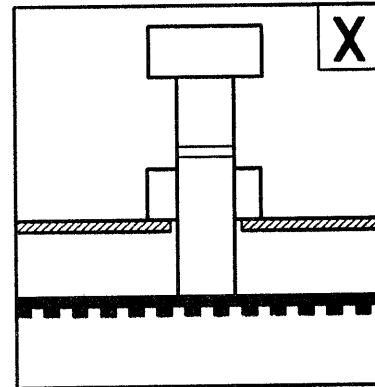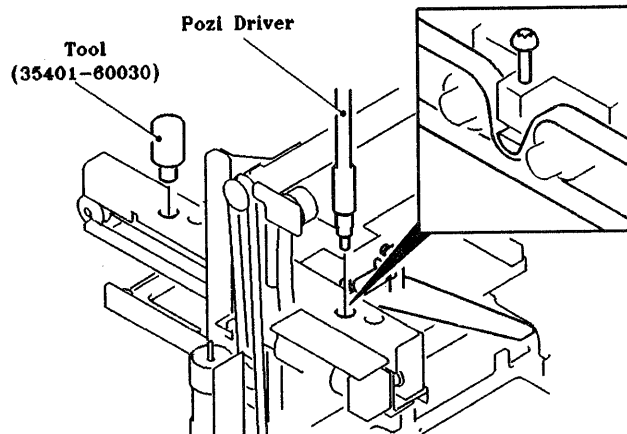
Belt too tight

Figure 7-1. Belt Tension Adjustment
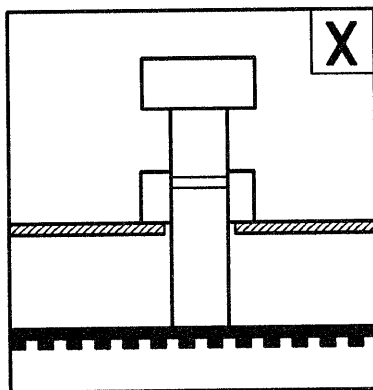
Belt too slack
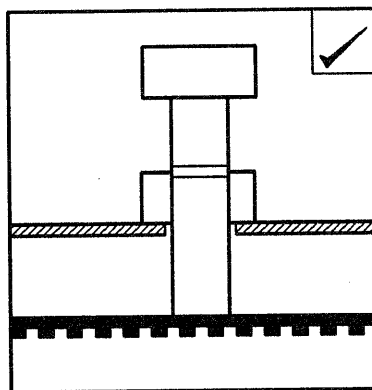
7-5. SETTING VERTICAL BELT POSITION

If either of the vertical drive belts slips over the toothed pulleys, the platform assembly will no longer be parallel with the tape mechanism. (This can occur if the platform is moved too fast or too hard at one side by hand). This makes vertical movement of the platform noticeably stiff and can cause loading problems.

A baseplate from a discarded cartridge (or a full cartridge, if you don't have a baseplate) can be used to check whether the platform assembly is parallel with the mechanism, as follows:

1) Perform the preparation for adjustment procedure outlined in section 7-3.

2) Disconnect the autochanger cable from socket J4 on the MDC PCA (see section 6-14).

3) Gently move the horizontal carriage to the home position.

4) Slide the baseplate part way onto the platform (if a full cartridge is used, lift the Cartridge Under Arm).

5) Starting with the platform slightly above vertical home, lower it gradually until the baseplate is close to the two machined lugs on the base casting (see Figure 7-2).

Tension correct
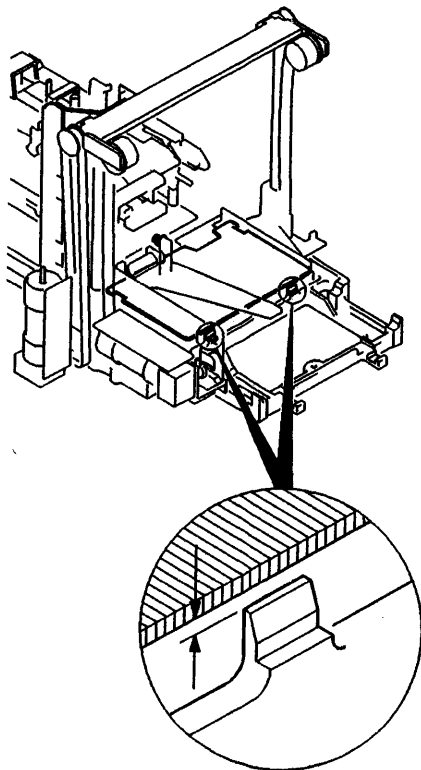
Figure 7-2. Checking the Platform Assembly

The gaps between the baseplate and the lugs should be the same on each side. If not, remove the cartridge baseplate and perform the platform levelling procedure as follows:

1) With a flat-bladed screwdriver, completely slacken one of the belt tensioners and slip the belt over the teeth on the bottom pulley.

2) Re-tighten the belt tensioner and use the cartridge baseplate again to see if the platform assembly is now level. If not, repeat this procedure until the assembly is level.

3) Check that the carriage now moves freely vertically.

4) Power up the drive and check that the mechanism functions correctly during self-test.

NOTE

Some toothed belts have marks which can assist in the levelling procedure (see Figure 7-3).

Platform Levelling Marks
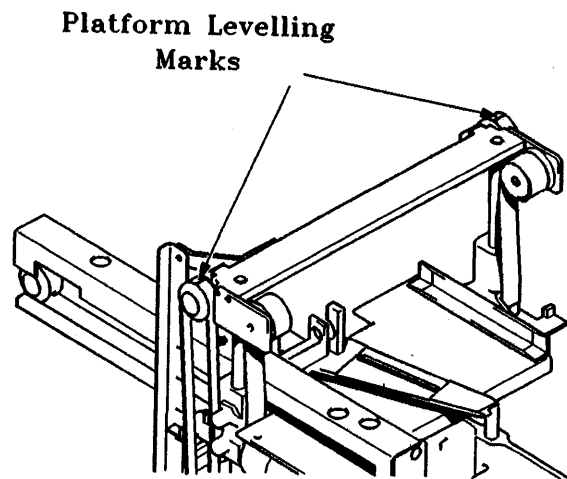
Figure 7-3. Platform Levelling

With the horizontal carriage at the lower limit of its travel, these marks can be seen near the top bar and should be level.

If not, use the marks as a guideline when adjusting the toothed belts, but remember to use the cartridge baseplate as a final check, as outlined earlier.

Troubleshooting and Diagnostics

This section provides service information to help you mend a faulty Tape Drive. Fault finding is quickly achieved by using the comprehensive self-test and diagnostic facilities built into the unit.

8-1. TROUBLESHOOTING STRATEGY

The HP 35401A is repaired to the Field Replaceable Assembly (FRA) level. A combination of exchange and non-exchange parts from the CSD exchange program are used to achieve this.

To aid troubleshooting, the Tape Drive has self-test capabilities and diagnostic routines which may be initiated at power-on, by the operator or through the host. These self-tests are described in detail in section 3-11. They provide an indication of the failed FRA(s), which can then be removed and replaced.

8-2. MINIMUM CONFIGURATION

The minimum configuration for host-initiated diagnostics comprises the Tape Drive linked to its HP 3000 or HP 9000 host for online or offline diagnostics. Alternatively, the existing host may be replaced by an HP 85 and diagnostics can then be performed using the CS/80 External Exerciser tape. If neither of these hosts are available for performing diagnostics then the Tape Drive's own internal diagnostics may be used (see section 3-11.).

8-3. TROUBLESHOOTING PROCEDURES

When troubleshooting the Tape Drive, the first thing to consider is whether the fault is repeatable or intermittent. This can be determined to some extent by repeating the self-test procedures several times. A repeatable fault usually causes the same self-test result to be presented each time the self-test is performed. By contrast, an intermittent fault occurring at random intervals may not always cause a self-test failure.

In the case of a repeatable fault, the self-test will identify the the failing FRA with a 95% certainty. In the event that more than one FRA is listed as the possible cause of the failure, replace the FRAs, one at a time, in the order given in the self-test display.

NOTE

Cable faults (such as an open-circuit conductor or a loose connector) may present a multiple FRA failure message. The FRAs listed will be the FRAs at either end of the defective cable.

All cabling should therefore be checked before replacing any FRAs.

Testing circuitry with a meter or oscilloscope should be restricted to checking the operation of the power supply. All other circuits are adequately tested by the system diagnostics and self-tests.

Test points are available on the PSU PCA next to the output connector J2. (see Figure 5-3, sheet 1). These should be checked with a digital voltmeter to confirm the correct voltages compared with Table 8-1. They should then be checked with an oscilloscope to determine the peak-to-peak ripple voltage. sp2

Test Point	Specification	Ripple (P-P)
+5V	+5± 150mV	50mV
+12V	+12 ± 360mV	100mV
-12V	-12 ± 600mV	100mV
+12VP	+12 ± 1V	100mV
PVAL	3.5V min	-

Table 8-1. Power Supply Voltages
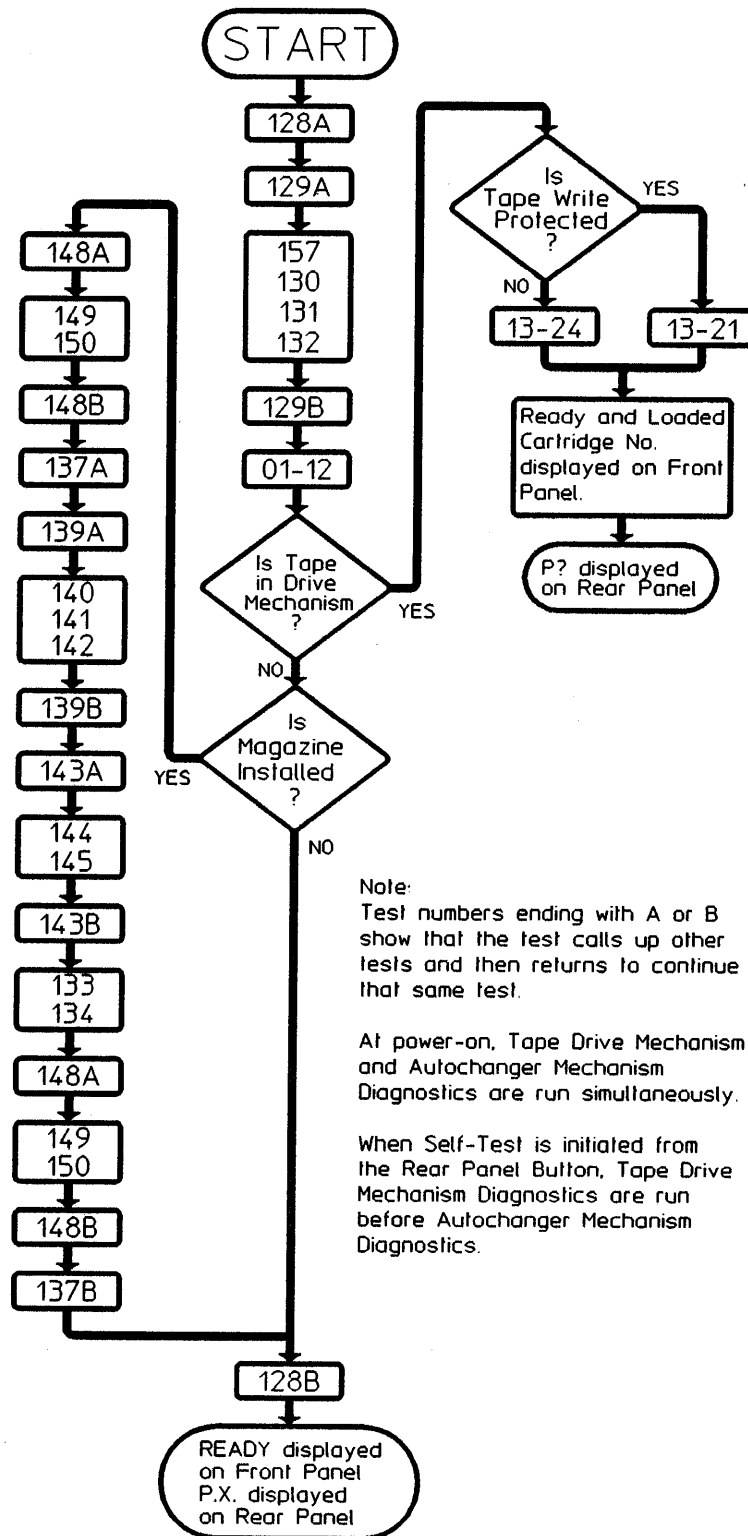
Figure 8-1. Self-Test Sequence Flowchart
(See Table 8-2. for a description of individual tests)

8-4.   ERROR CODES

As a result of self-tests the following codes may be displayed by the self-test displays on the rear panel.

The Units which may be faulty are given by the following displays:

U0 Unit 0, the Drive Mechanism, DDC & RWS PCAs

U1 Unit 1, The Autochanger Mechanism & MDC PCA

U2 Unit 2, the Internal Controller (HDC PCA)

For Unit 0, the Drive Mechanism, the Field Replaceable Assemblies that may be shown as faulty are:

A0 Not Discernible - An assembly failed and the test showed that it was good

A1 Drive Mechanism (including Spindle Motor and Head Stepper Motor)

A2 Device Dependent Controller (DDC)

A3 Read/Write Circuitry (R/W) on RWS PCA

A4 Probably a dirty tape head

A5 Host Dependent Controller (HDC)

A7 Servo Circuitry (S) on RWS PCA

A8 Head Stepper Motor (Replace Drive Mechanism)

A9 Spindle Motor and Optical Sensor (Replace Drive Mechanism)

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NOTE
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There is no error code **A6**

The Power Supply is faulty if either of the full stops (i.e., ⊔) are not illuminated.

For Unit 1, the Autochanger Mechanism, the FRAs that may be shown as faulty are:

A1 MDC PCA

A2 Vertical Motor

A3 Horizontal Motor

A4 Micro-switch PCA

A5 Flexible PCA

A6 Mechanism

A7 Horizontal Carriage Assembly

A8 Cabling (HDC/MDC/DDC DC-IB)

If any of these faults are displayed on the self-test displays, confirmation may be obtained by connecting an exchange autochanger mechanism in place of the original. (See section 8-6). This should save you some time.

If there is a Unit 2 failure in the Internal Controller (on the HDC), the error code sequence shown on the rear panel differs from the Unit 0 or Unit 1 failure sequence (see section 3-11).

Since there is a problem with the controller (which also generates the self-test sequence) only the failing controller test number is displayed.

The following controller faults may be displayed:

01 Kernel RAM failed. The processor cannot find enough working RAM to start running the program. Replace HDC PCA.

02 HDC Checksum failed. The ROM checksum did not work. Check for faulty ROMs.

03 RAM Test. The processor has now tested the whole RAM and found a fault. Replace HDC PCA.

04 DMA Test. DMA or Data Bus to processor fault. Short circuits on DMA Data Bus also cause LED segments to remain on all the time. Replace HDC PCA.

05 Timer Test. Fault in timer on DMA Controller. Replace HDC PCA.

06 HP-IB Test. Fault on HP-IB Controller or Interface. Replace HDC PCA.

07 Configuration Test. Wrong unit code for the DDC or Processor has failed. Replace HDC PCA.

08 Configuration Test. Indicates MDC or DDC failure.

If the front panel **Fault** display is illuminated, but the test results give a Pass Condition, either there is a system error, or the tape cartridge is faulty. Loading another cartridge and repeating the test would help to establish whether it was a faulty cartridge.

Next in the self-test sequence the individual failing tests may be indicated. The following tables give the test numbers with a brief description of each test and the MSFRAs.

Table 8-2 shows the test errors which may be displayed as a result of initiating a self-test. Table 8-3 shows the errors which may be displayed at any time while the Tape Drive is in use, as the result of a fault.

Table 8-2. Diagnostic/Self-Test Errors (TERRORS)

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
		WARNING: Ensure that mechanism path is clear before performing movement tests	
		UNIT 0 TESTS	
00	00	Complete test of Tape Drive	
01	01	HDC-DDC interface. Read Servo Status	DDC, HDC
02	02	DDC Circuitry	
03	03	a) Microcomputer test	DDC
04	04	b) Read/Write loopback	DDC
05	05	HDC-DDC Read/Write loopback.	DDC, HDC
06	06	HDC-DDC-Servo Interface	RWS, DDC, HDC
07	07	Servo Circuitry	
08	08	a) Microcomputer	RWS
09	09	b) Capstan Motor Drive Circuit	RWS, Drive Mechanism
10	0A	c) Tachometer	RWS, Drive Mechanism
11	0B	d) Capstan Motor	Drive Mechanism, RWS
12	0C	e) Head Stepper Circuit	RWS, Drive Mechanism
13	0D	Test the read portion of the R/W Circuitry.	RWS, DDC
		Start by executing a Put Gaps on Tape command. This will assume unit works and a Key Found signal can be generated. A failure of this command will cause the test to continue through the read tests, trying to diagnose what caused the failure. If the read tests all pass, the testing will halt and the test number shown will be the failing test.	

Table 8-2. Diagnostic/Self-Test Errors (TERRORS) continued

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
14	0E	With Read Gain set to minimum and Channel 0 positioned on the tape, enable Read with Read Head 0 and check for Overthreshold not being set.	RWS, DDC, HDC
15	0F	With Read Gain set to minimum and Channel 0 positioned on the tape, enable Read with Write Head 0 and check for Overthreshold not being set.	RWS, DDC, HDC
16	10	With Read Gain set to a maximum and Channel 0 positioned on the tape, enable Read with Read Head 0 and check for overthreshold being set.	RWS, DDC
17	11	With Read Gain set to maximum and Channel 0 positioned on the tape, enable Read with Write Head 0 and check for Overthreshold being set.	RWS, DDC, HDC
18	12	With Read Gain set to a minimum and Channel 1 positioned on the tape, enable Read with Read Head 1 and check for Overthreshold not being set.	RWS, DDC, HDC
19	13	With Read Gain set to a minimum and Channel 1 positioned on the tape, enable Read with Write Head 1 and check for Overthreshold not being set.	RWS, DDC, HDC
20	14	With Read Gain set to a maximum and Channel 1 positioned on the tape, enable Read with Read Head 1 and check for Overthreshold being set.	RWS, DDC
21	15	With Read Gain set to maximum and Channel 1 positioned on the tape, enable Read with Write Head 1 and check for Overthreshold being set.	RWS, DDC
22	16	Test the Write portion of the R/W Circuitry.	RWS
23	17	After the edge of tape has been found and the tape wound to BOT, execute a Locate and Write to track 0, Key 4 with Channel 0. Read back the written data and verify it is the same data that was written. If not, return an error.	RWS, DDC, Drive Mechanism
24	18	Execute a Locate and Write to track 7, Key 5 with Channel 1. Read back the written data and verify it is the same data that was written. If not, return an error.	RWS, DDC, Drive Mechanism

Table 8-2. Diagnostic/Self-Test Errors (TERRORS) continued

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
		UNIT 1 TESTS	
128	80	Test entire autochanger mechanism subsystem. There is an initial check of the MDC. If it passes, some sensors are checked to see if a mechanism diagnostic is allowed. It is run if the Vertical Home sensor is active; the cartridge-under-arm (CUA) and Write-Protect sensors show no cartridge (cleaning or normal) is under the arm; and the Magazine sensor is active (there is a magazine present). If these conditions are all true then the mechanism diagnostic (No 137) is executed. If no magazine is loaded then no mechanism diagnostics are executed.	N/A
129	81	MDC PCA Test all but motor drivers and controllers. No mechanism movement. DC-IB, NOVRAM and one channel of the 8253 timer IC are tested. This test calls tests No 157, 130, 131, 132, exiting at the first failure.	MDC
130	82	Data / Control Interface Bus (DC-IB) A loopback register is provided in the MDC, so that the last value written to the MDC can be read back. This register is exercised with a series of data patterns. The test passes if no integrity errors are encountered.	MDC, HDC, DC-IB Cable
131	83	NOVRAM Power interruption during this test will leave the NOVRAM corrupted for the next power-on. If a magazine is loaded then no test is performed, and the test always passes. If the sensor detects no magazine present, then a superficial non-volatility test is performed. The mechanism logs are not tested, but can be by using the Clear Logs Utility (see section 10).	MDC, DC-IB Cable

Table 8-2. Diagnostic/Self-Test Errors (TERRORS) continued

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
132	84	8253 Timer IC Functional check of third channel of timer. Also measures period of count provided by on-board oscillator by comparison with HDC clock. It calibrates the counter from this clock to allow for component tolerances.	N/A
133	85	Eject Solenoid Visual check: solenoid activated and deactivated after half a second.	N/A
134	86	Arm Solenoid Visual check: solenoid activated and deactivated after half a second.	N/A
137	89	Mechanism WARNING: Ensure the mechanism path is clear before running this diagnostic. Starts with vertical axis check (No 139). If this passes, it moves horizontal carriage assembly to a height suitable for horizontal axis check (No 143). If this also passes, then the eject solenoid (No 133) and arm solenoid (No 134) checks are performed. Finally, the mechanism is moved to the "home" position. Testing is aborted when the first failure is detected.	N/A
138	8A	Half Mechanism Test WARNING: Ensure the mechanism path is clear before running this diagnostic. This test performs as complete a check of the mechanism as is possible allowing for the door being open (and a magazine loaded). It is called during a complete self-test when the magazine is absent. Vertically it performs the same functions as Test 137, but horizontally the test is abbreviated.	N/A

Table 8-2. Diagnostic/Self-Test Errors (TERRORS) continued

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
139	8B	Vertical Axis Movement WARNING: Ensure the mechanism path is clear before running this diagnostic. This test executes the vertical motor (No 140), vertical sensors (No 141) and vertical travel (No 142) tests to check all FRAs associated with vertical movement.	N/A
140	8C	Vertical Motor Vertical motor is powered-up. Vertical counter channel and vertical slot and home sensors are examined for evidence of vertical movement If no evidence is found, then the horizontal axis is tested in the same way to see if the fault is unique to either motor/encoder or the MDC or cable connecting them.	Vertical Motor, MDC
141	8D	Vertical Sensors WARNING: Ensure the mechanism path is clear before running this diagnostic. By moving the vertical motor, the test checks that the vertical home and vertical slot sensors change state as the vertical movement is attempted. It checks that the vertical slot sensor becomes active at the correct heights above the vertical home sensor.	Autochanger Mechanism, Vertical Motor, Microswitch PCA
142	8E	Vertical Travel WARNING: Ensure the mechanism path is clear before running this diagnostic. Platform moved from top to bottom of vertical axis to check that it is the correct length. It checks that the mechanism path is unobstructed and that there is little or no backlash in the vertical gearbox.	Autochanger Mechanism, Vertical Motor

Table 8-2. Diagnostic/Self-Test Errors (TERRORS) continued

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
143	8F	Horizontal Axis Movement WARNING: Ensure the mechanism path is clear before running this diagnostic. This test executes the horizontal motor (No 144) and horizontal sensor (No 145) tests, to check all FRAs associated with horizontal movement. Testing is aborted when the first failure is detected.	N/A
144	90	Horizontal Motor Horizontal motor is powered-up. Counter channel and horizontal B and C sensors are examined for evidence of horizontal movement. If no evidence is found, then the vertical axis is similarly tested to see if the fault is unique to either motor/encoder or is caused by the MDC or connecting cable.	Horizontal Motor, MDC
145	91	Horizontal Sensors WARNING: Ensure the mechanism path is clear before running this diagnostic. By moving the horizontal motor, the test checks that the horizontal B or C sensors change state as axis movement is performed. It then checks that the correct sequence of sensor states occurs as the arm moves along the horizontal axis.	Horizontal Carriage
148	94	Find Home At power-on this test is used to move the mechanism to the horizontal home position. It calls the horizontal home test (No 149), followed by the vertical home test (No 150).	N/A
149	95	Find Horizontal Home The mechanism is moved to home to prepare for a mechanism diagnostic (half or full).	Autochanger Mechanism, Horizontal Motor

Table 8-2. Diagnostic/Self-Test Errors (TERRORS) continued

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
150	96	Find Vertical Home The mechanism is moved to vertical home position to prepare for a mechanism diagnostic (half or full).	Autochanger Mechanism, Microswitch PCA
157	9D	Front Panel Display Activate each LED segment on front panel for visual check. Starts with all LEDS illuminated then all LEDs off. Then LEDs activated in sequence: READY, UNLOAD, FAULT, PROTECT, LOAD and BUSY. Then the segments of the seven-segment display are illuminated in sequence.	Front Panel PCA

UNIT 2 TESTS

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
01	01	Kernel RAM test This RAM is tested first and is then used for the remainder of the HDC tests. The first 1K of RAM is tested during this test.	HDC PCA
02	02	HDC Checksum test Performs a checksum on the Executive EPROM.	HDC PCA
03	03	RAM test Tests the rest of the RAM not tested in the Kernel RAM test.	HDC PCA
04	04	DMA test Checks input and output paths of the DMA circuitry.	HDC PCA
05	05	Timer test Checks the on-board HDC timer (period = 1.024 msec)	HDC PCA

Table 8-2. Diagnostic/Self-Test Errors (TERRORS) continued

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
06	06	HP-IB Interface test	HDC PCA
		Performs a check on the 8291 HP-IB interface IC.	
07	07	DDC Checksum test	HDC PCA
		This test fails if either of the Unit code checksums does not agree with their expected values.	
08	08	Configuration test	DDC ROMS on HDC, U121 and U151
		This test fails if the wrong Unit code for the DDC is installed.	
136	88	Processor test	HDC PCA
		If this test fails, the rear display remains at 88. No external command or operation can be interpreted if the Processor has failed.	

Table 8-3. Run-Time Drive Errors (DERRORS).

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
16	10	Success	None
17	11	Vertical motor jammed or counter stopped	Vertical motor, cables
18	12	Horizontal motor jammed or counter stopped	Horizontal motor, cables
19	13	Vertical motor did not stop at the end of its travel	Belt tension, motor
20	14	Horizontal motor did not stop at the end of its travel	Belt tension, motor
21	15	Invalid sensor state - vertical, HB, HC, or CUA sensors in wrong state	Failed sensors, cables
22	16	Faulty count	Slack mechanism or gearbox
23	17	Not used	None
24	18	Not used	None
25	19	Magazine not present	No magazine, door open, sensor failed
26	1A	Load timed-out. Tape drive mechanism took too long to load cartridge.	Cabling, MDC
27	1B	Not used	None
28	1C	Not used	None
29	1D	Clear received from host	None
30	1E	Cartridge not loaded in drive mechanism, when attempt is made to activate "cartridge present" sensor	CUA sensors, cartridge removed illegally
31	1F	Unload failed	MDC

Table 8-3. Run-Time Drive Errors (DERRORS) continued.

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
32	20	Cleaning cartridge found during preload	None
33	21	Invalid parameter specified in load or unload	None
34	22	Vertical slot not reached	Jammed mechanism, failed sensor, blocked slot, cable, MDC
35	23	Vertical slot passed	Slack mechanism or gearbox, failed sensor, blocked slot, cable, MDC
36	24	Faulty vertical count	Slack mechanism or gearbox
37	25	Faulty horizontal count	Slack mechanism or gearbox
38	26	Unable to load. Tape mechanism diagnostics have failed.	
39	27	Cleaning cycle time-out. Cleaning cycle did not complete.	
40 ↓↓	28 ↓↓	Not used	None
48	30	Not used	None
49	31	HB sensor invalid	Sensor, cable, MDC
50	32	HC sensor invalid	Sensor, cable, MDC
51	33	HB and HC sensors invalid	Sensors, cables, MDC
52	34	VH sensor invalid	Sensor, cable, MDC
53	35	VH and HB sensors invalid	Sensors, cables, MDC
54	36	VH and HC sensors invalid	Sensors, cables, MDC

Table 8-3. Run-Time Drive Errors (DERRORS) continued.

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
55	37	VH, HB and HC sensors invalid	Sensors, cables, MDC
56	38	CUA sensor invalid	Sensor, cable, MDC
57	39	CUA and HB sensors invalid	Sensors, cables, MDC
58	3A	CUA and HC sensors invalid	Sensors, cables, MDC
59	3B	CUA, HB and HC sensors invalid	Sensors, cables, MDC
60	3C	CUA and VH sensors invalid	Sensors, cables, MDC
61	3D	CUA, VH and HB sensors invalid	Sensors, cables, MDC
62	3E	CUA, VH and HC sensors invalid	Sensors, cables, MDC
63	3F	CUA, VH, HB and HC sensors invalid	Sensors, cables, MDC
177	B1	Recoverable dual errors (one byte) Two frames were bad (CRC error or missing) which were recoverable through XOR circuitry. (Marginal or recoverable)	None
178	B2	Single frame error (one byte) Only one frame with bad CRC or missing. (Marginal or recoverable)	None
179	B3	Unrecoverable data (one byte) Combination of frame CRC errors or missing frames such that data could not be recovered through XOR circuitry. (Marginal, recoverable or unrecoverable)	None

Table 8-3. Run-Time Drive Errors (DERRORS) continued.

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
180	B4	DMA handshake error (one byte) Overflow or underflow has occurred between HDC and DDC. (Marginal, recoverable or unrecoverable)	HDC, DDC
181	B5	DMA failure (one byte) Not enough frames detected during read or read-while-write. (Marginal recoverable, or unrecoverable)	HDC, DDC
185	B9	Key error (one byte) One key past target, keys past target, bad key CRC, time-out of key sync, wrong key sent or verify failed. This error occurs during transfer, not seek to target or seek to perform retries. (Marginal, recoverable, unrecoverable, or latency induced)	DDC
186	BA	Seek error (one byte) Seek to target required retries or failed because of time-out or keys past target. (Unit fault)	DDC
187	BB	Seek to a jump spare (one byte) A latency was induced due to seeking to a jump spare during transaction (Latency induced)	DDC
190	BE	Reposition failure (one byte) Reposition of tape to next target address after tape access command required retries or failed. (Unit fault)	DDC

Table 8-3. Run-Time Drive Errors (DERRORS) continued.

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
193	C1	Log overflow (two bytes) Log indicated in postbyte overflowed. (Possible loss of entries) 0 = Manufacturer's block 1 = Sparing table 2 = Error rate test log 3 = Runtime error log 4 = Use log (Maintenance track overflow)	Tape Drive Subsystem: DDC RWS Drive Mechanism
194	C2	Unable to read log (two bytes) Log indicated in postbyte could not be read in multiple retries. (For sparing table, this could mean that it was never written or errors preclude it from being written. For other logs, if log was never written this error will not occur. Log will be returned as empty.) Postbyte log codes are defined above. (Unrecoverable data, uninitialized media, unit fault)	Uninitialized cartridge, Tape Drive Subsystem: DDC RWS Drive Mechanism
195	C3	Unable to write log (two bytes) Log indicated in postbyte could not be written on any track in multiple retries. Postbyte log codes are defined above. (Unrecoverable data)	
196	C4	Log only written on one track (two bytes) Log indicated in postbyte could only be written on one track rather than the usual two. Postbyte log codes are defined above. (Unrecoverable data)	

Table 8-3. Run-Time Drive Errors (DERRORS) continued.

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
200	C8	Servo error (two bytes)	

200 / C8 — Servo error (two bytes)

Command to servo processor was not successfully executed. Postbyte contains status returned by servo processor:

00H = Power on state (servo processor is reset)
FFH = Busy/Active
1(T)H = Rewind/T = track
2(T)H = Forward/T = track
3(T)H = Stopped/T = track
40H = Invalid command
41H = Loss of speed control
44H = Cannot find edge of tape
48H = Pre-pos gaps, no keys
50H = Cannot calibrate speed
61H = Unspool likely, no keys found
64H = EOT active
68H = BOT active
(Unit fault)

206 / CE — Load error (two bytes)

This cartridge failed the load sequence. Failure is recorded in postbyte:

1 = Load diagnostics failed
2 = Seek to EOT failed
3 = Speed calibration failed
4 = Gain set failed
5 = Seek to BOT failed
6 = Edge find failed
(Unit fault)

207 / CF — Unload error (two bytes)

This cartridge did not successfully complete the normal unload sequence (logs may not have been updated). Failure is recorded in postbyte:

1 = Diagnostic result indicated a hardware failure so normal unload was not attempted.

2 = Seek to EOT failed
(Unit fault)

Table 8-3. Run-Time Drive Errors (DERRORS) continued.

NUMBER		CAUSE or Test Description	SUSPECT HARDWARE
DEC	HEX		
209	D1	Not certified This cartridge is not certified. (Uninitialized media)	None
210	D2	Certify command failed Attempt to certify a cartridge failed. Possible reasons are: 1 Requires >80% of the spares to be used up. 2 Can't write spares table to tape. 3 Error rate test failed due to log overflow or seek failure. 4 Transfer canceled 5 Certify specified with 0 loops. (Uninitialized media)	
216	D8	Hardware fail (one byte) Attempt to access the tape (with a non-diagnostic command) when previous diagnostic command, power-on or load diagnostics indicated a hardware failure. (Unit fault)	
217	D9	Write circuit failure (one byte) Attempt to perform a write command when write circuitry has failed power-on or load diagnostics or has failed a diagnostic command. (Unit fault)	
223	DF	No buffers in system (one byte) No buffers are available to complete transaction. (Controller fault)	

8-5. INITIATING DIAGNOSTICS FROM A HOST COMPUTER

The test philosophy is that the Host executes a Transparent Loopback test (Read and Write) to verify functionality of the HP-IB interface and a large portion of the HDC board. If this test is unsuccessful, the host computer knows that the Most Suspected Field Replaceable Assembly (MSFRA) is the HDC circuitry.

Having completed the Loopback test, the host computer instructs the HDC to Initiate Diagnostics. The parameters passed with the command tells the HDC whether to start the diagnostic at the top of the hierarchical chart, or at some lower level, and the number of times to repeat the test.

The HDC controls all levels of Diagnostic Testing. This means that the diagnostic code residing on the HDC is sent memos to execute diagnostic commands. The diagnostic code then instructs the DDC to execute its diagnostics. The diagnostic code then instructs the Servo circuitry to execute its diagnostics. Then, by using both the DDC and the Servo, the diagnostic code executes a test of the Read/Write circuitry. This must be done since there is no self-test hardware on the R/W circuitry.

If the command is to test from the beginning, the diagnostic code issues commands in a sequential order until either the test is completed or a failure is discovered. The diagnostic code then terminates the testing and updates the MSFRA and the failing test number which are located in the Request Status summary and the back panel displays.

If the command is to execute a specific test, the diagnostic code sends the appropriate processor (e.g., DDC or RWS assembly) the command to execute the specific test. The HDC does not fail to send the message because it thinks that there is a failure higher up than the unit to be tested. For example, the diagnostic code sends a command to the DDC which tests the Read/Write circuitry even if the DDC appears to be bad.

TEST DESCRIPTIONS

HDC/DDC INTERFACE

The HDC/DDC Interface test consists of a loopback test. The diagnostic code sends the DDC a Loopback Command with an accompanying 4-bits

(nibble). The DDC reads this nibble, inverts it (ones complement), duplicates it into an upper nibble, and sends it back to the diagnostic code. This is done for 8 bytes. The diagnostic code decides if the correct data (the entire byte) is received and if not, declares that the DDC is faulty, with the HDC as the alternate MSFRA.

DEVICE-DEPENDENT CONTROLLER

The testing for the DDC is the self-test that is executed after every power-on. This tests >95% of the circuitry on the DDC and the results are completely independent from other circuitry, with the exception of the HDC and power supply.

This test includes testing out the microcomputer and the write and read circuitry, via internal loopback. The test stops short of sending signals to or receiving signals from the Read/Write circuitry. If self-test fails, the DDC sends a Failing Response to the diagnostic code which causes the MSFRA to be the DDC.

If the DDC passes the self-test, it sends a Passing Response to the diagnostic code.

HDC/DDC/SERVO INTERFACE

The HDC/DDC/Servo Interface test consists of a loopback test. The diagnostic code sends the Servo a Loopback Command with an accompanying byte. The Servo reads this byte, inverts it (ones complement), and sends it back to the diagnostic code. This is done for 14 bytes. The diagnostic code decides if the correct data is received and if not, declares that the Servo is faulty, with the DDC and HDC as the alternate MSFRAs.

SERVO CIRCUITRY

The testing of the Servo circuitry tests >95% of the circuitry. The microcomputer and associated digital circuitry is tested.

The spindle motor electronics and optical sensor electronics are tested for functionality. The motor and optical sensor are then tested for functionality.

The testing for the head stepper is to determine if voltage is being sent to the motor. If there is voltage, the Servo assumes the motor works.

NOTE

Other testing (i.e., determining if a signal from the head disappears when the gap moves off the tape) is needed to verify that the head does indeed move because the head is run open loop.

READ/WRITE CIRCUITRY

The testing of the Read/Write circuitry depends on the Servo circuitry being functional. The test first tests out the read channel. It accomplishes this using the adjustable gain of the read amplifier and the Overthreshold circuitry. This checks out the functionality of the heads, pre-amps, multiplexer, and part of the secondary amplifier. A failure on one of these, but not all, is probably indicative of a damaged or dirty Head. Otherwise the failure is on the Read/Write circuitry.

If the read channel is operational, the write channel is checked. This is done by creating one block of random data, writing the data to a scratch block of the tape, reading it back, and verifying that the read data was identical to the written data. In the event of a failure this is done repetitively on different tracks to ensure that the tape is not at fault. This is done using both head channels.

AVAILABLE TESTS

The discrete unit tests are accessible to the Host via CS/80 Commands. These tests are defined as shown in Table 8-2.

8-6. USING THE SERVICE CABLE ASSEMBLY

The service cable assembly (35401-61602) can be used to verify an autochanger mechanism fault, without having to remove the suspect unit:

1) Refer to sections 6-1 to 6-6 and remove the top shroud.

2) Place a new mechanism next to the Tape Drive.

3) Remove the cable from connector J4 on the MDC PCA and plug in the service cable.

4) Connect the 20-way socket to the flexible PCA on the new mechanism.

5) Connect the 14-way connector to the microswitch PCA and the 10-way connector to the vertical motor PCA.

6) Leave the 5-way connector unattached.

7) Power-up the unit and see if the fault has now gone.

Replaceable Parts

This section provides listings of all field-replaceable parts and an illustrated parts breakdown for the subsystem, as well as replaceable parts ordering information.

9-1. REPLACEABLE PARTS INFORMATION

Replaceable parts for the subsystem are listed in disassembly order in table 9-2 and illustrated in figure 9-1. In the table, attaching parts are listed immediately after the item they attach. Items in the DESCRIPTION column are indented to indicate relationship to the next higher assembly. In addition, the symbol "---X---" follows the last attaching part for that item. Indentation of the items in the tables is as follows:

Major Assembly
*Replaceable Assembly
*Attaching Parts for Replaceable Assembly
**Subassembly or Component Part
**Attaching parts for Subassembly or Component Part

The replaceable parts listings provide the following information for each part:

- FIG. & INDEX NO. The figure and index number which indicates where the replaceable part is illustrated.

- HP PART NO. The Hewlett-Packard part number for each replaceable part.

- DESCRIPTION. A description of each replaceable part. Refer to table 9-5 for an explanation of abbreviations used in the description column.

- MFR CODE. The 5-digit code that denotes a typical manufacturer of a part. Refer to table 9-1 for a list of manufacturers who correspond to the codes.

- MFR PART NO. The manufacturer's part number of each replaceable part.

- UNITS PER ASSY. The total quantity of each part used in the major assembly.

The MFR CODE and MFR PART NO. for common hardware items are listed as 00000 and OBD (order by description) respectively, because these items can usually be purchased locally.

9-2. ORDERING INFORMATION

To order replaceable parts for the subsystem, address the order to your local Hewlett-Packard Sales and Support Office. Sales and Support Offices are listed at the back of this manual. Specify the following information for each part ordered:

- Model and full serial number.

- Hewlett-Packard part number.

- Complete description for each part as provided in the replaceable parts listings. Refer to the appropriate part of section 11 if you can't find the part listed in table 9-2.

9-3. ILLUSTRATED PARTS BREAKOUT

See figure 9-1 for an exploded view of the HP 35401A subsystem.

9-4. EXCHANGE ASSEMBLIES

The following assemblies are included in the current exchange program:

09144-69501 DRIVE MECHANISM
09144-69518 RWS PCA
09144-69512 DDC PCA
07940-69195 HDC PCA
35401-69000 AUTOCHANGER MECH.

9-5. FIELD REPLACEABLE PARTS LIST

A list of Field Replaceable Parts is given in Table 9-2.

9-6. CODED LIST OF MANUFACTURERS

A list of manufacturers is given in table 9-1.

Table 9-1. Coded List of Manufacturers

Code No.	Manufacturer	Address
28480	Hewlett-Packard Co.	Palo Alto, CA

These code numbers are taken from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1, and H4-2, and their supplements.

9-7. ABBREVIATIONS LIST

A list of abbreviations is given in Table 9-3.

For Detail A
See Sheet 2

For Detail B
See Sheet 3
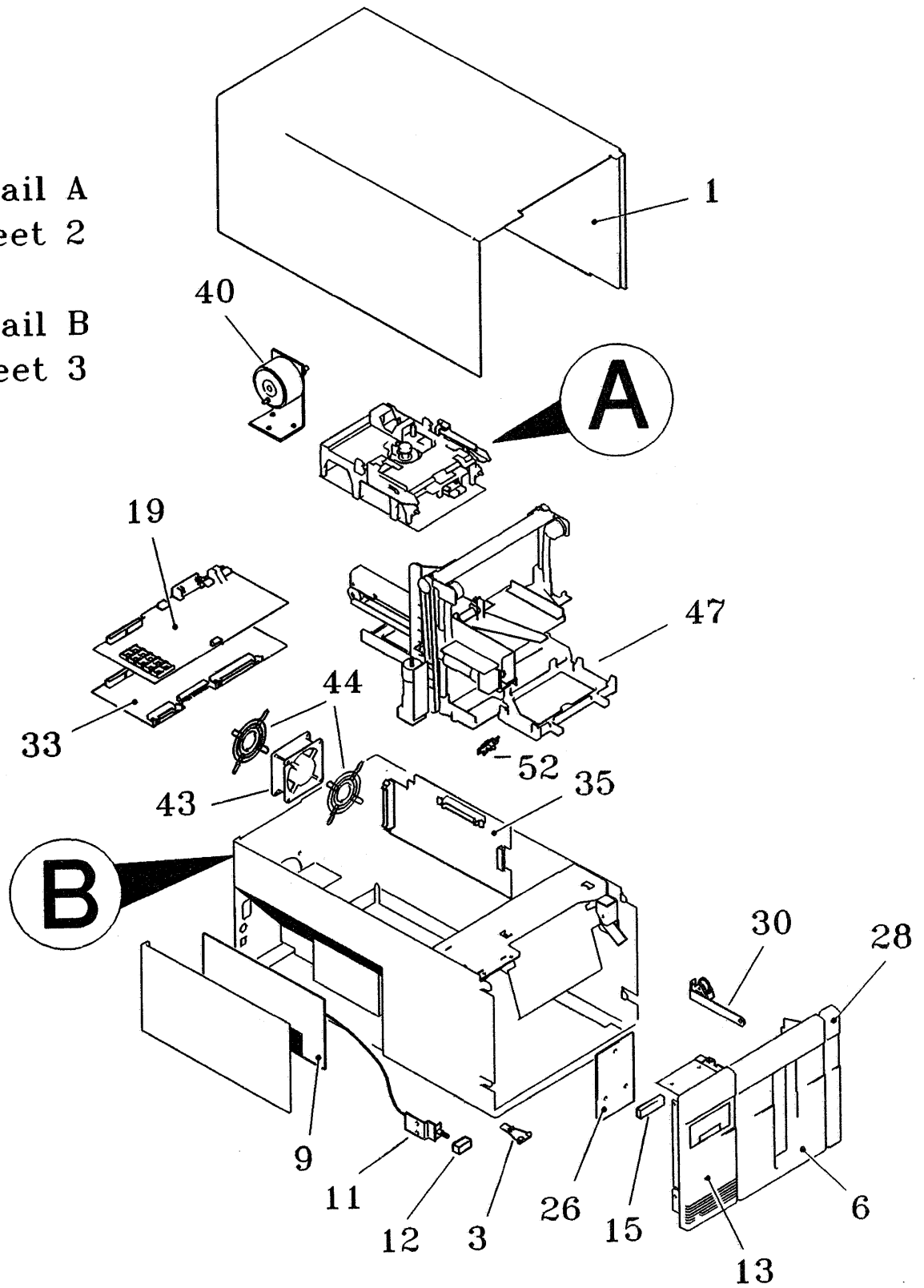
Figure 9-1. HP 35401A Exploded View (sheet 1 of 3)
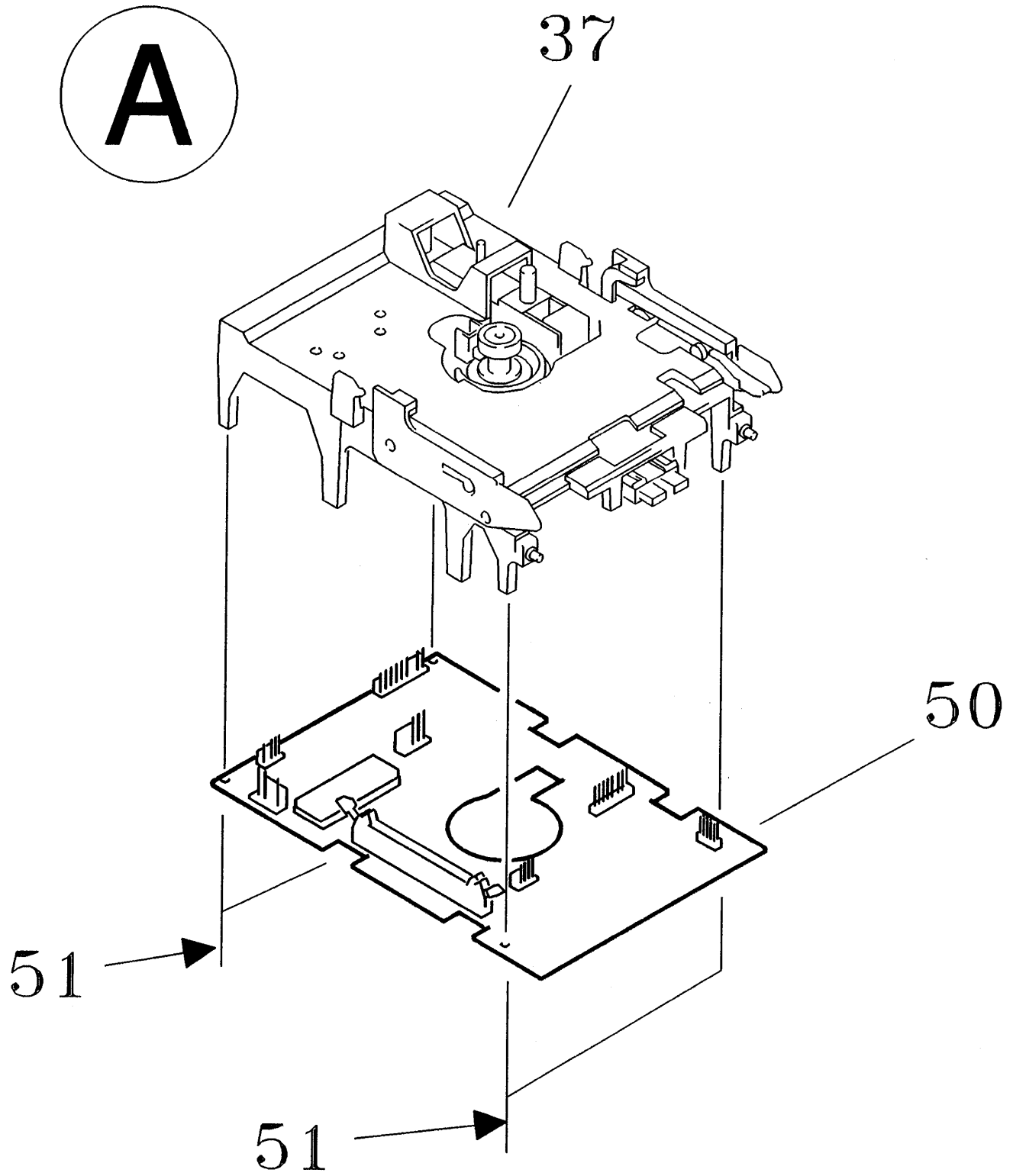
Figure 9-2. HP 35401A Exploded View (sheet 2 of 3)
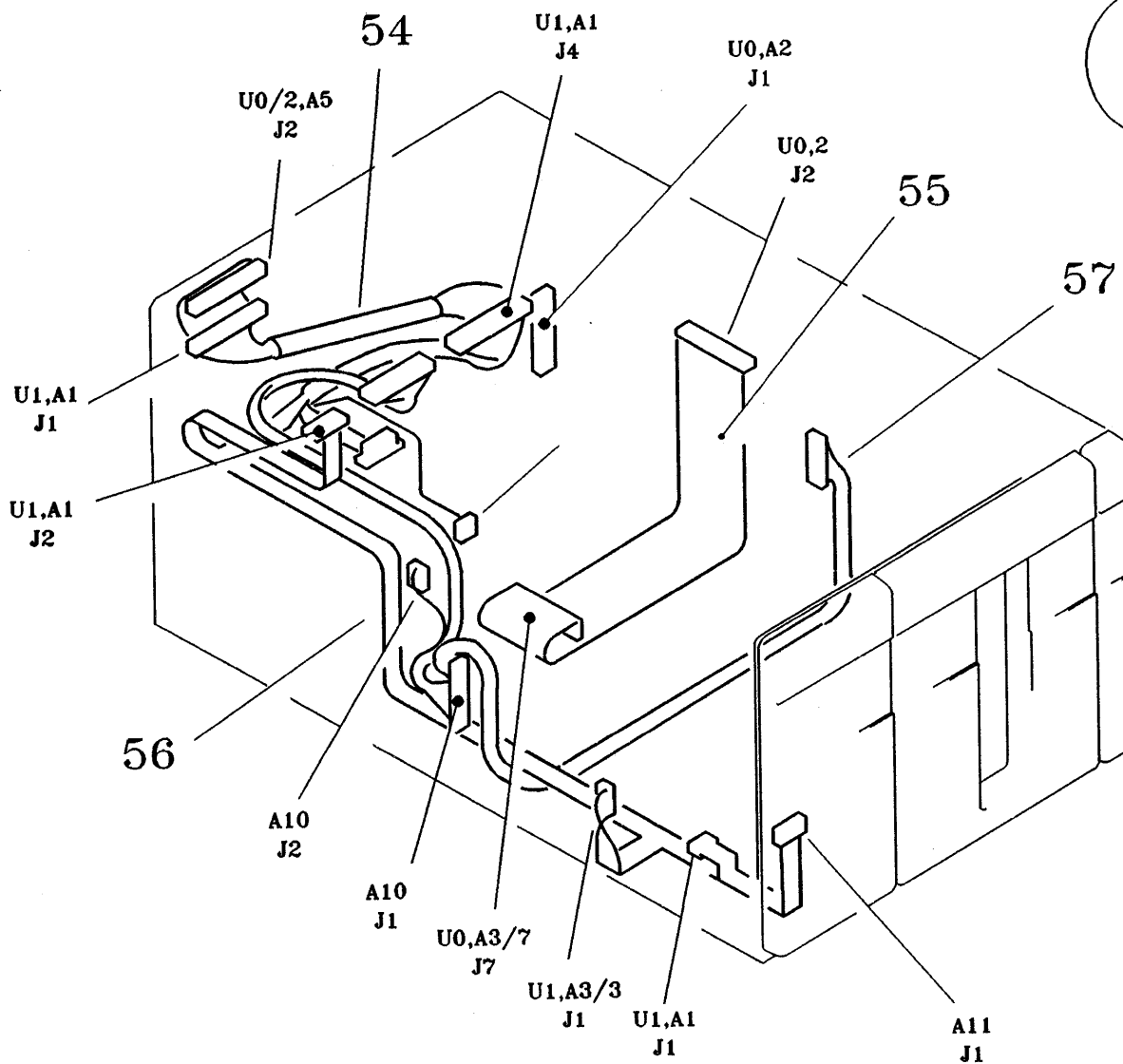
Figure 9-3. HP 35401A Cabling Layout (sheet 3 of 3)

Table 9-2. Replaceable Parts

FIG.& INDEX NO.	HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.	UNITS PER ASSY
	35401A	1/4 INCH CARTRIDGE TAPE DRIVE	28480	35401A	REF
1	35401-60020	*TOP SHROUD	28480	35401-60020	1
		(Attaching Parts)			
2	0515-0372	*SCREW, machine, pnh, T10, M3.0 by 0.5, 8mm long, w/scw	28480	0515-0372	6
		- - - X - - -			
3	09121-48303	**FRONT FOOT	28480	09121-48303	2
		- - - X - - -			
4	35401-60097	**MOTOR PCA	28480	35401-60097	2
		(Attaching Parts)			
5	0515-0430	**SCREW, machine, pnh, T10, M3.0 by 0.5 6mm long, w/scw	00000	OBD	3
		- - - X - - -			
6	35401-60034	*DOOR ASSEMBLY	28480	35401-60034	1
		(Attaching Parts)			
7	0515-0374	*SCREW, machine, pnh, T10, M3.0 by 0.5 10mm long, w/scw	00000	OBD	2
		- - - X - - -			
8	35401-40000	*CARTRIDGE MAGAZINE	28480	35401-40000	1
		- - - X - - -			
9	09133-67120	*PSU ASSEMBLY A10	28480	09133-67120	1
		(Attaching Parts)			
10	0515-0430	*SCREW, machine, pnh, T10, M3.0 by 0.5 6mm long, w/scw	00000	OBD	8
		- - - X - - -			
11	35401-67200	**BOWDEN CABLE ASSEMBLY KIT	28480	35401-67200	1
		- - - X - - -			
12	5041-1203	**KEY CAP, WHITE (for AC line switch)	28480	5041-1203	1
		- - - X - - -			
13	35401-60032	*FRONT PANEL ASSEMBLY	28480	35401-60032	1
		(Attaching Parts)			
14	0515-0372	*SCREW, machine, pnh, T10, M3.0 by 0.5 8mm long, w/scw	00000	OBD	5
15	35401-40004	**EJECT PUSH-BUTTON	28480	35401-40004	1
		- - - X - - -			
16	35401-60033	*DOOR LOCK BRACKET ASSEMBLY	28480	35401-60033	1
		(Attaching parts)			
17	0515-0372	*SCREW, machine, pnh, T10, M3.0 by 0.5 8mm long, w/scw	00000	OBD	8
18	0515-0374	*SCREW, machine, pnh, T10, M3.0 by 0.5 10mm long w/scw	00000	OBD	1
		- - - X - - -			

Table 9-2. Replaceable Parts (continued)

FIG.& INDEX NO.	HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.	UNITS PER ASSY
19	07940-60195	*HOST DEPENDENT CONTROLLER PCA U0 U2 A5	28480	07940-60195	1
		(Attaching Parts)			
20	09144-893XX	*EPROM, DDC (U151)	28480	09144-893XX	1
21	09144-895XX	*EPROM, DDC (U121)	28480	09144-895XX	1
22	35401-895XX	*EPROM, MDC (U161)	28480	35401-895XX	1
23	35401-896XX	*EPROM, MDC (U131)	28480	35401-896XX	1
24	35401-897XX	*EPROM, EXEC (U101)	28480	35401-897XX	1
20-21	09144-103XX	**ROM KIT (2 X DDC ROMs)	28480	09144-103XX	1
22-24	35401-103XX	**ROM KIT (2 X MDC & 1 X EXEC ROM)	28480	35401-103XX	1
25	0380-0644	*STAND-OFF, HEX, 6-32, 0.327in long	00000	OBD	2
		- - - X - - -			
26	35401-60093	*FRONT PANEL PCA A11	28480	35401-60093	1
		(Attaching Parts)			
27	0624-0512	*SCREW, tapping, pnh, T9, 4-20, 0.375in	00000	OBD	3
		- - - X - - -			
28	35401-60035	*END PANEL ASSY	28480	35401-60035	1
		(Attaching Parts)			
29	0515-0372	*SCREW, machine, pnh, T10, M3.0 by 0.5 8mm long, w/scw	00000	OBD	3
		- - - X - - -			
30	35401-60031	*GOVERNOR ARM ASSEMBLY KIT	28480	35401-60031	1
		(Attaching Parts)			
31	35401-80078	*CIRCLIP	28480	35401-80078	1
32	35401-20062	*BUSH	28480	35401-20062	1
		- - - X - - -			
33	35401-60091	*MDC PCA U1 A1	28480	35401-60091	1
		(Attaching Parts)			
34	0515-0430	*SCREW, machine, pnh, T10, M3.0 by 0.5 6mm long, w/scw	00000	OBD	1
		- - - X - - -			
35	09144-66512	*DDC PCA U0 A2	28480	09144-66512	1
36	09144-10355	*DDC PROCESSOR (U35)	28480	09144-10355	1
		- - - X - - -			
37	09144-67501	*DRIVE MECHANISM ASSEMBLY U0 A1	28480	09144-67501	1
		(Attaching Parts)			
38	0515-1349	*SCREW, machine, pnh, T10, M3.0 by 0.5 30mm long, w/scw	00000	OBD	2
39	0515-0665	*SCREW, machine, pnh, T10, M3.0 by 0.5 14mm long, w/scw	00000	OBD	2
		- - - X - - -			
40	35401-80064	*EJECT SOLENOID	28480	35401-80064	1
		(Attaching Parts)			
41	35401-80063	*PIN, SELF-LOCKING	28480	35401-80063	1
42	0515-0665	*SCREW, machine, pnh, T10, M3.0 by 0.5 14mm long w/scw	00000	OBD	3
42a	2190-0464	*WASHER	00000	OBD	3
		- - - X - - -			

Table 9-2. Replaceable Parts (continued)

FIG.& INDEX NO.	HP PART NO.	DESCRIPTION	MFR CODE	MFR PART NO.	UNITS PER ASSY
43	35401-68503	*FAN (including cable and connector)	28480	35401-68503	1
44	07941-00026	**FAN GRILLE	28480	07941-00026	2
		(Attaching Parts)			
45	0624-0661	**SCREW, tapping, pnh, T20, 10-14 0.625in long	00000	OBD	4
46	0624-0696	**SCREW, tapping, pnh, T20, 10-14 0.468in long	00000	OBD	4
		- - - X - - -			
47	35401-60000	*AUTOCHANGER ASSEMBLY (complete) U1 A6	28480	35401-60000	1
		(Attaching Parts)			
48	0515-0372	*SCREW, machine, pnh, T10, M3.0 by 0.5 8mm long, w/scw	00000	OBD	4
49	0515-0430	*SCREW, machine, pnh, T10, M3.0 by 0.5 6mm long, w/scw	00000	OBD	2
		- - - X - - -			
50	09144-66518	**READ/WRITE /SERVO PCA U0 A3,A7	28480	09144-66518	1
		(Attaching Parts)			
51	0515-0104	**SCREW, machine, pnh, pozi, M3.0 by 0.5 8mm long	00000	OBD	4
		- - - X - - -			
52	35401-60094	**MICROSWITCH PCA U1 A4	28480	35401-60094	1
		(Attaching Parts)			
53	0515-0430	**SCREW, machine, pnh, T10, M3.0 by 0.5 6mm long	00000	OBD	2
		- - - X - - -			
54	35401-61601	*CABLE, HDC/MDC/DDC	28480	35401-61601	1
55	35401-61607	*CABLE, DRIVE MECHANISM/DDC	28480	35401-61607	1
56	35401-61600	*CABLE, MDC/FRONT PANEL	28480	35401-61600	1
57	35401-61603	*CABLE ASSEMBLY, POWER	28480	35401-61603	1
58	8120-1351	*CORDSET BS1363/CEE	28480	8120-1351	1
59	8120-1369	*CORDSET ASC112/CEE	28480	8120-1369	1
60	8120-1689	*CORDSET GMBH/CEE	28480	8120-1689	1
61	8120-1378	*CABLE ASSEMBLY 18 AWG	28480	8120-1378	1
62	8120-1575	*CABLE ASSEMBLY 18 AWG	28480	8120-1575	1
63	8120-4753	*CABLE ASSEMBLY 16 AWG	28480	8120-4753	1
64	8120-2104	*CORDSET SEV/CEE	28480	8120-2104	1
65	8120-2956	*CORDSET MDPP/CEE	28480	8120-2956	1
66	8120-1860	*CORDSET CEE/CEE 5 foot	28480	8120-1860	1
67	8120-4211	*CABLE ASSEMBLY	28480	8120-4211	1
68	9211-5381	*PACKING OUTER BOX	28480	9211-5381	1
69	35401-80095	*FOAM END CAP	28480	35401-80095	1
70	9211-5379	*ACCESSORY BOX	28480	9211-5379	1
71	9222-1244	*PLASTIC BAG	28480	9222-1244	1
72	35401-80043	*MAGAZINE FOAM BLOCK	28480	35401-80043	1
73	35401-80069	*DOOR OPENER TAB	28480	35401-80069	1
74	35401-80058	*SPRING CLIP	28480	35401-80058	2
	35401-60016	*FASTENER KIT	28480	35401-60016	1

Table 9-3. Abbreviations

A	= ampere(s)	ID	= inside diameter	qty	= quantity
AC	= alternating current	in.	= inch, inches		
AR	= as required	incand	= incandescent	rdh	= round head
assy	= assembly	incl	= include(s)	rect	= rectifier
		intl	= internal	ref	= reference
brkt	= bracket	I/O	= input/output	rf	= radio frequency
				rfi	= radio frequency interference
c	= centi (10^{-2})	k	= kilo (10^3), kilohm	rh	= right hand
C	= Celsius, centigrade	kg	= kilogram	rpm	= revolutions per minute
cer	= ceramic	lb	= pound	rwv	= reverse working voltage
cm	= centimeter	LED	= light-emitting diode		
comp	= composition				
conn	= connector	lh	= left hand	sb	= slow blow
				SCR	= semiconductor-controlled rectifier
d	= deci (10^{-1})	M	= mega (10^6), megohm		
DC	= direct current				
deg	= degree(s)	m	= milli (10^{-3})	scw	= square cone washer
dia	= diameter	mach	= machine		
dpdt	= double-pole, double-throw	mb	= medium blow	Se	= selenium
		met oxd	= metal oxide	Si	= silicon
dpst	= double-pole, single throw	mfr	= manufacturer	slftpg	= self-tapping
		misc	= miscellaneous	spdt	= single-pole, double throw
		mm	= millimeter		
elctlt	= electrolytic	mtg	= mounting	spst	= single pole, single throw
encap	= encapsulated	My	= Mylar		
ext	= external			sst	= stainless steel
		n	= nano (10^{-9})	stl	= steel
F	= Fahrenheit, farad	n.c.	= normally closed	sw	= switch
fb	= fast blow	no.	= number		
fh	= flat head	NSR	= not separately replaceable	T	= TORX$^{(R)}$ screw
fig.	= figure	ntd	= no time delay	Ta	= tantalum
filh	= fillister head			tgl	= toggle
flm	= film	OBD	= order by description	thd	= thread
fw	= full wave			Ti	= titanium
fxd	= fixed	OD	= outside diameter	tol	= tolerance
G	= giga (10^9)	ovh	= oval head	U (u)	= micro (10^{-6})
Ge	= germanium	oxd	= oxide	V	= volt(s)
				var	= variable
H	= Henry, Henries	p	= pico (10^{-12})	Vdcw	= direct current working volts
hd	= head	PCA	= printed-circuit assembly		
hex	= hexagon, hexagonal	phh	= phillips head	W	= watt(s)
hlcl	= helical	pnh	= pan head	w/	= with
Hz	= Hertz	P/O	= part of	WIV	= inverse working volts
		pot	= potentiometer		
		pozi	= Pozidriv	ww	= wire-wound

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Reference Material

This section provides useful reference material including miscellaneous technical data which has been referred to in earlier sections.

10-1. OTHER MANUALS

There are a number of manuals written specifically for the HP 35401A Tape Drive. These are as follows:

35401-90902 User's Manual
35401-90903 Quick Reference Guide
35401-90904 Hardware Support Manual
35401-90905 CE Handbook
35401-90906 Unpacking Instructions
35401-90907 Installing the HP 35401A with HP 3000 series 37 systems
35401-90951 Applications Guide

35490-90901 Rack Mounting Kit Installation Instructions
35401-90918 Installing the HP 35401A with an HP 7936 or HP 7937 Disc Drive
35401-90921 CS80 Programmatic Support Manual

Other useful material may be found in the HP 9144A Service Manual (09144-90030).

10-2. RACK MOUNTING KIT INSTALLATION INSTRUCTIONS

These instructions provide information for the HP 35490A Rack Mounting Kit. This kit can be used for mounting the HP 35401A in an EIA 19-inch equipment rack.

KIT CONTENTS

ITEM	DESCRIPTION	HP PART NO.	QUANTITY
1	RACK ADAPTOR ASSEMBLY	35490-00001	1
2	STRUT LH, RH	35490-00002, 3	1 LH, 1 RH
3	STRAP	35490-80001	1
4	SCREW, M6 POZI	0515-1198	16
5	WASHER, FLAT M6	3050-1013	16
6	WASHER, LOCK HELI M6	2190-0676	16
7	NUT, SHEET METAL	35490-80002	8
8	PACKAGING	35490-80062	1
9	INSTALLATION INSTRUCTIONS	35490-90901	1

INSTALLATION

Only normal tools are required when installing the rack mounting kit.

Note: Numbers in brackets refer to items in the Kit Contents list and as shown in Figures 10-1 and 10-2.

Refer to Figure 10-1 and proceed as follows:

1) Unpack the kit and check the items against the contents list.

2) Remove the middle and rear two rubber feet from the module.

3) Attach the two struts (2) to the rack adaptor (1) using eight M6 screws (4) and washers (5) and (6).

4) Thread the strap (3) through the channel in the base of the rack adaptor (1).

5) Put the sheet metal nuts (7) into the rack, as shown in Figure 10-2.

6) Install the mounting kit into the 19-inch rack before attaching the module to it. It is helpful to tilt the mounting kit to one side when inserting it into the rack.

7) Attach the mounting kit to the rack using eight M6 screws (4) and washers (5) and (6).

8) Insert the module into the rack adaptor from the front, rear or from above. Engage the front feet in the slots in the front panel of the rack adaptor.

9) Tighten the strap (3) around the body of the module, ensuring that the buckle is to one side of the unit. The strap should be hand-tight and the buckle then fastened over-center.

10) Connect the HP-IB and power cords to the module, as normal.
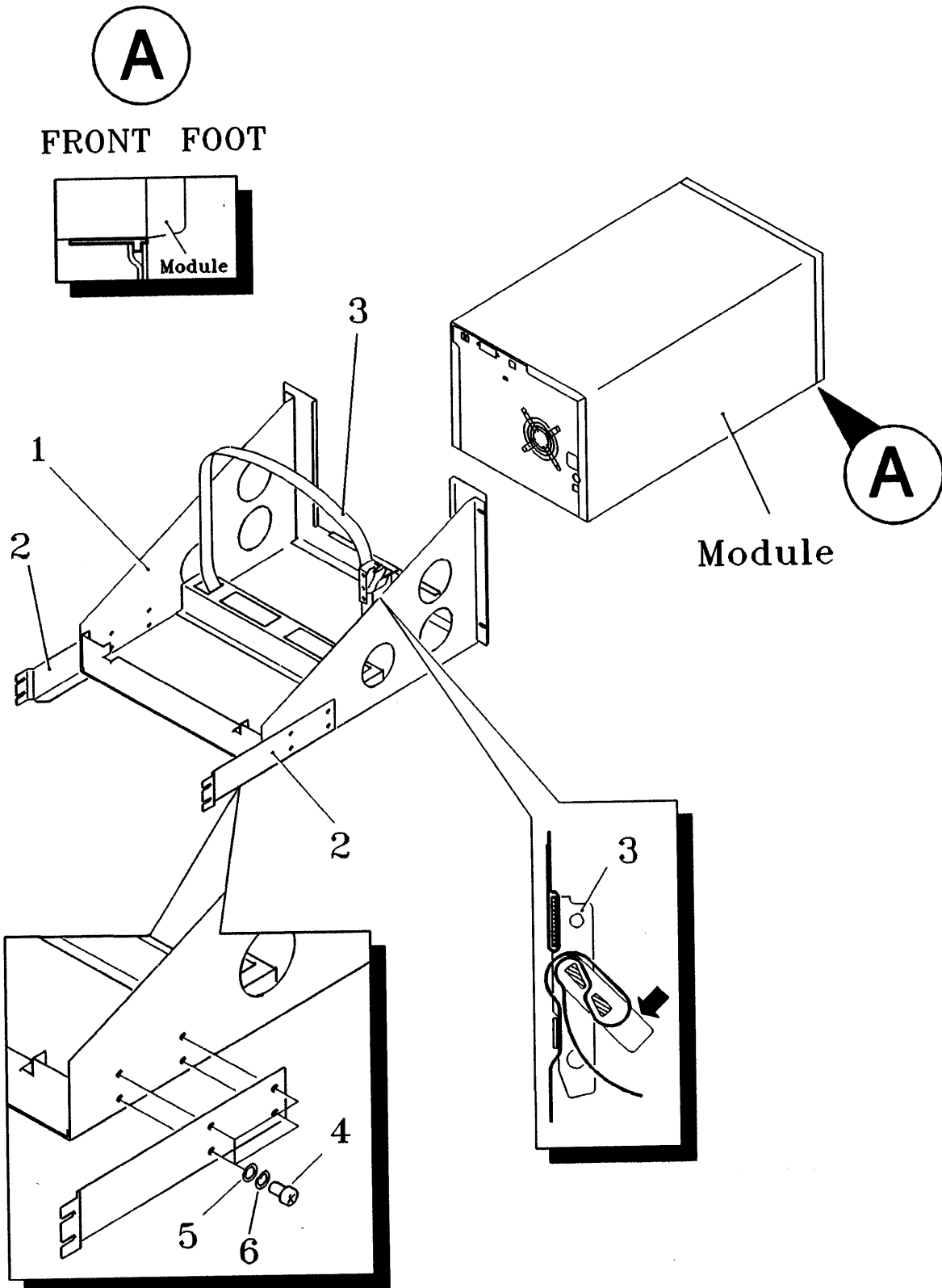
Figure 10-1. HP 35490A EIA Rack Adapter
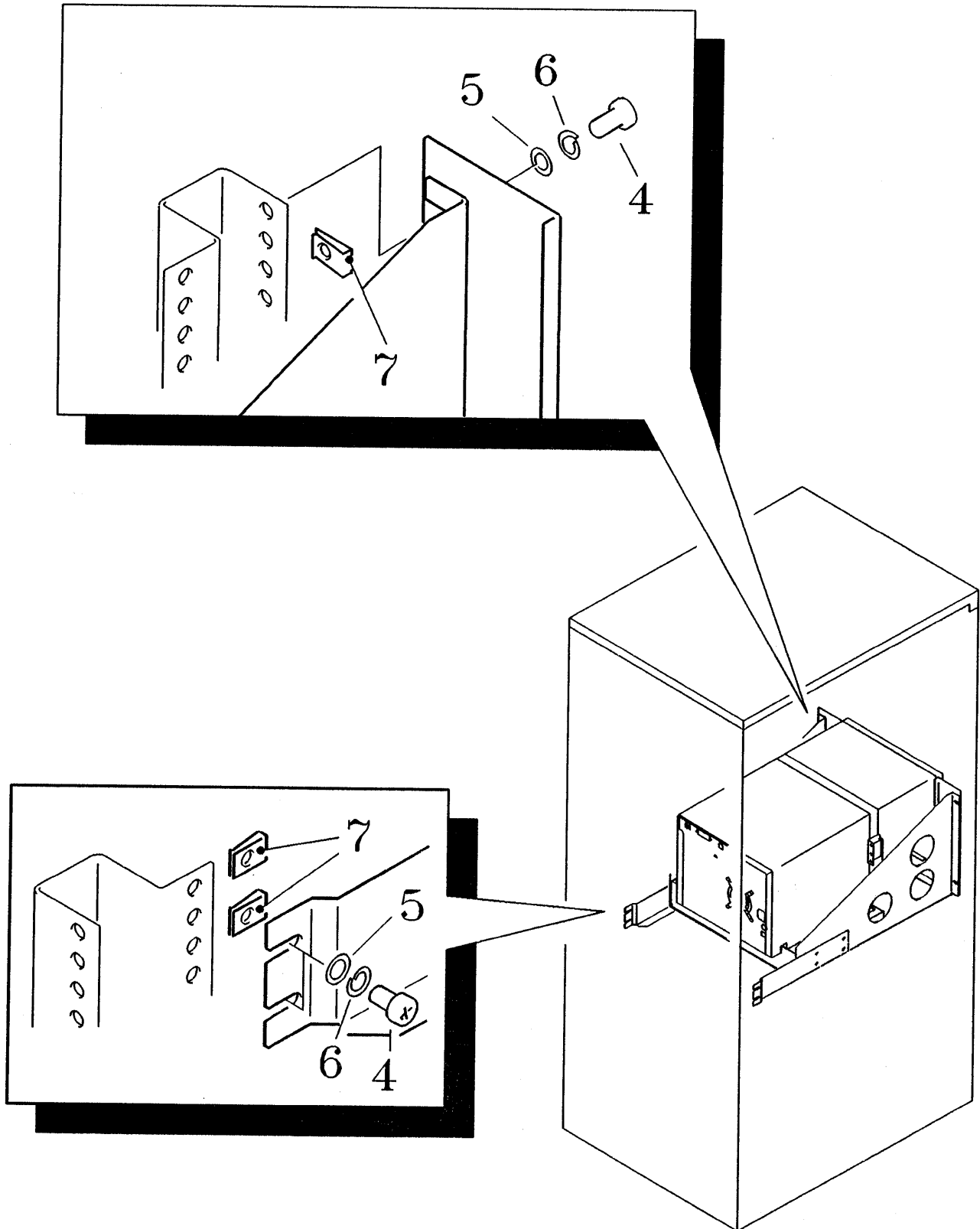
Figure 10-2. Rack Mounting Details

10-3. CHANNEL INTERFACE

The Tape Drive interface is through the Hewlett-Packard Interface Bus (HP-IB) hardware and the CS/80 Command Set, a set of commands formulated for mass storage devices. The following paragraphs discuss the types of CS/80 commands. Also provided is an overview of HP-IB. For full details of CS/80, refer to the *CS/80 Instruction Set Programming Manual*, part number 5955-3442.

10-4. CS/80 INSTRUCTION SET

The CS/80 Instruction Set increases the efficiency and speed of channel operations between tape memories and their associated host computers. Tables 10-1 to 10-4, Device Command Summary, provides a summary of all CS/80 instructions. The CS/80 Instruction Set also allows a host computer to access special utilities within the Tape Drive. Utilities are routines stored in firmware which allow error rate tests to be performed and the results of such tests to be examined or logged. Utilities are listed in table 10-5, Tape Drive Utilities. Refer to the *External Exerciser Reference Manual*, part number 5955-3462, for full details.

10-5. TRANSACTION STRUCTURE

A transaction is a logically complete operation between a system host computer and a peripheral device (the Tape Drive) over a given channel (HP-IB). Three phases may occur during each transaction: command, execute, and report. A transaction begins when a command is received by the Tape Drive, and ends when a reporting message indicating the status of the transaction is accepted by the host. Figure 10-3 illustrates the transaction structure, and shows the relationship between the Tape Drive operating states and the channel activity relative to each phase.

A unit is a separately addressable entity within a device (Tape Drive). A volume is a separately addressable portion of the storage media within a given unit.

TRANSACTION PHASE	CHANNEL ACTIVITY	UNIT OPERATING STATE
COMMAND	**2** COMMAND MESSAGE ⟶	**1** Command-Ready **3** Accept and validate command Note: Logical machine goes to report state **12** if command is invalid, or if host requests reporting message.
EXECUTION	**6** Execution Message Request (if applicable) **7** EXECUTION MESSAGE (if applicable)	**4** Begin execution of command **5** Request execution message (if applicable) **8** Complete execution of command (send data, receive data, or accomplish command action) **9** Compute transaction status
REPORTING	**11** Reporting Message request **12** REPORTING MESSAGE	**10** Request reporting message **13** Send one-byte report (QSTAT)

(1)   Logical Machine idle in command-ready state.

(2)   Host sends command message.

(3)   Logical Machine accepts and verifies command. If command is valid, Logical Machine moves to execution state. If not, Logical Machine moves to reporting state.

(4)   Unit begins execution of command.

(5,6)   If command involves data transfer, Logical Machine requests an execution message. If not, unit completes execution (6).

(7)   Execution message is established if command involves a data transfer.

(8)   Unit completes execution of command. If command involves data transfer, unit sends or receives data through channel module. If not, unit completes action called for in command message.

(9)   Logical Machine computes completion status of transaction. Pass/Fail status is set into QSTAT, complete status set into request status.

(10,11) Logical Machine requests reporting message.

(12)   Reporting message is established.

(13)   Logical Machine sends 1-byte reporting message (QSTAT) indicating Pass/Fail status of transaction. Host must send request command for complete status report (20 bytes).

Figure 10-3. Transaction Structure

10-6.   REAL-TIME COMMANDS

Real-time commands are optimized for execution time. These commands are used most often in host/device transactions. One or more complementary commands may precede a real-time command in order to modify the operation of that command. Real-time commands include: Locate and Read, Cold Load Read, Locate and Write, and Write File Mark.

10-7.   COMPLEMENTARY COMMANDS

Complementary commands are used to set or update programmable states in the Tape Drive. The programmable states define characteristics such as: set unit, set address, set block displacement, set return addressing mode, set length, set burst mode, set release, set status mask, set volume, set retry time, no op and set device specific options. These commands may be included within Real-Time, General Purpose, or Diagnostic command messages, or they may stand alone. When complementary commands are embedded within another command, the parameters or conditions established by those complementary commands are altered only for the duration of the current command. A stand-alone complementary command, however, sets the parameters or conditions until the same stand-alone complementary command alters the set value or until power-on or a CLEAR occurs. Power-on resets all complementary commands to their default values. Therefore, at power-on, length defaults to equal the entire tape, if one is loaded. A stand-alone Set Length command may give it a "set" value of 1 kbyte to be used for an entire sequence of transactions, although some special case commands could temporarily override this value with an embedded complementary command to set a "current" value of 256 bytes (for 1 frame).

10-8.   GENERAL PURPOSE COMMANDS

This command group includes commands which allow the host to determine device type and operating characteristics or to ascertain storage media integrity. These commands are not considered "real-time" commands and therefore should not be issued by the host unless it is willing to relinquish control of the drive for a varying period of time. General purpose commands are: Locate and Verify, Spare Block, Release, Release Denied, Describe, Extended Describe, Initialize Media, load and Unload.

10-9.   DIAGNOSTIC COMMANDS

Diagnostic commands are intended to assist the host in isolating problems in the device to the replaceable assembly level. Some commands allow protected access to variables or data maintained by the device (such as error information), while others cause tests to be performed within the device, or on a specific area of the storage media. Diagnostic commands may be modified by complementary commands. Initiate Diagnostic, Initiate Utility, and Request Status are all diagnostic commands.

10-10.   TRANSPARENT MESSAGES

Transparent commands compensate for different types of channels and differences in operating environments. Transparent commands are intercepted by the device firmware and modify the normal command-execution-reporting transaction sequence. Transparent commands are explained in the *CS/80 Instruction Set Programming Manual*, part number 5955-3442.

Table 10-1. Device Real-Time Command Summary

LOCATE AND READ

FUNCTION: Locates the data indicated by the target address and transmits the data to the host.

OPCODE: 0_{10} 00000000_2 000_8 00_{16}

FORMAT: No variables or parameters

COLD LOAD READ

FUNCTION: Used by the host to bootstrap itself into a higher operating environment from a more primitive state.

OPCODE: 10_{10} 00001010_2 012_8 $0A_{16}$

FORMAT: No variables or parameters

LOCATE AND WRITE

FUNCTION: Transfers data from the host for storage beginning at the address specified by the target address.

OPCODE: 2_{10} 00000010_2 002_8 02_{16}

FORMAT: No variables or parameters

WRITE FILE MARK

FUNCTION: Causes a file mark to be written at the current tape position or any position selected through the use of the Set Address command.

OPCODE: 73_{10} 01001001_2 111_8 49_{16}

FORMAT: No variables or parameters

Table 10-2. Device Complementary Command Summary

SET UNIT

FUNCTION: Used to specify a specific unit within the device.

OPCODE: 32_{10} 00100000_2 040_8 20_{16} unit 0
47_{10} 00101111_2 057_8 $2F_{16}$ unit 15 (controller)

FORMAT: <0010YYYY>

YYYY = unit number (1111 = device controller)

SET BLOCK ADDRESS

FUNCTION: Used to set the value of the target address and to define the addressing mode.

OPCODE: 16_{10} 00010000_2 020_8 10_{16}
17_{10} 00010001_2 021_8 11_{16}

FORMAT: <0001000T> < P1 > - - - - < P6 >

T = address mode (0 = single vector)
Single vector format: 6-byte binary number

SET BLOCK DISPLACEMENT

FUNCTION: Adjusts the target address by the number of blocks indicated by the parameter field.

OPCODE: 18_{10} 00010010_2 022_8 12_{16}

FORMAT: <00010010> < P1 > - - - - < P6 >

Parameter format: 6-byte, signed, two's complement,
binary number

Table 10-2. Device Complementary Command Summary (continued)

SET RETURN ADDRESSING MODE

FUNCTION: Specifies the address format (single or 3-vector) returned in the parameter field of the status message.

OPCODE: 72_{10} 01001000_2 110_8 48_{16}

FORMAT: <01001000> <00000TTT>

TTT = addressing mode
000 = single-vector
001 = 3-vector (this is ignored since the addressing mode
is single-vector, and single-vector behavior is maintained).

SET LENGTH

FUNCTION: Defines the number of bytes in a data transfer.

OPCODE: 24_{10} 00011000_2 030_8 18_{16}

FORMAT: <00011000> < P1 > - - - - < P4 >

Parameter format: 4-byte, unsigned, binary number

SET BURST MODE

FUNCTION: Activates and deactivates burst mode.

OPCODE: 60_{10} 00111100_2 074_8 $3C_{16}$
61_{10} 00111101_2 075_8 $3D_{16}$

FORMAT: <0011110T> < P1 >

T = 0 Only the last burst is tagged with the message terminator
(EOI on HP-IB)
T = 1 All bursts are tagged with the message terminator

P1 = Number of 256-byte segments in each burst (If P1=0, burst mode
is deactivated.)

Table 10-2. Device Complementary Command Summary (continued)

SET RELEASE

FUNCTION:	Defines how a device will respond to an internal release request.
OPCODE:	59_{10} 00111011_2 073_8 $3B_{16}$
FORMAT:	<00111011> <TZ000000>

T = 1 Suppress release timeout
Z = 1 Release automatically during idle time

SET STATUS MASK

FUNCTION:	Provides selective masking of error conditions reported in the status message.
OPCODE:	62_{10} 00111110_2 076_8 $3E_{16}$
FORMAT:	<00111110> < P1 > - - - - - - - < P8 >

The bit positions in the parameter bytes (P1-P8) correspond to the bit positions in the status message. Refer to paragraph 2-45 in the CS/80 Programming Manual.

1 = masked error

SET VOLUME

FUNCTION:	Selects a specific volume on the currently selected unit.
OPCODE:	64_{10} 01000000_2 100_8 40_{16}
FORMAT:	<01000YYY>

YYY = volume number (volume 0 only)

NO OP

FUNCTION:	Causes the device to disregard the message byte.
OPCODE:	52_{10} 00110100_2 064_8 34_{16}
FORMAT:	No variables or parameters

Table 10-2. Device Complementary Command Summary (continued)

SET RETRY TIME

FUNCTION: Sets maximum number of retries. Cannot exceed 10.

OPCODE: 58_{10} 00111010_2 072_8 $3A_{16}$

FORMAT: <00111010> < P1 > < P2 >

P1-P2 = Number of retries (16-bit binary number) See DESCRIBE.

SET DEVICE SPECIFIC OPTIONS

FUNCTION: The command can perform five tasks:

1. In sequential mode it can either load the next tape when one is unloaded, or it can enable a complete media unload.

2. It can enable or disable the tape drive's character count capability. This enables the drive to skip to the next data block when all user data in a given block has been sent.

3. It can enable or disable Auto Sparing.

4. It can choose either Jump or Skip Sparing.

5. It can enable tape streaming operation.

OPCODE: 56_{10} 00111000_2 070_8 38_{16}

FORMAT: <00111000> <M0001ASC>

M = 0: Cartridge unload mode (Sequential mode)
M = 1: Media unload mode (Sequential mode)

C = 0: Disable character count capability
C = 1: Enable character count capability

A = 0: Auto sparing disabled
A = 1: Auto sparing enabled

S = 0: Auto spare invokes Jump sparing
S = 1: Auto spare invokes Skip sparing

I = 0: Disable immediate report/command queueing
I = 1: Enable immediate report/command queueing.

The power-up and default value for the options byte is 00000000_2, that is all bits reset.

Table 10-3. Device General Purpose Command Summary

LOCATE AND VERIFY

FUNCTION: Instructs the device to perform an internal verification of a section of data to ensure that it can be read.

OPCODE: 4_{10} 00000100_2 004_8 04_{16}

FORMAT: No variables or parameters

SPARE BLOCK

FUNCTION: Gives the device permission to become temporarily busy while sparing the block indicated by the target address.

OPCODE: 6_{10} 00000110_2 006_8 06_{16}

FORMAT: <00000110> <00000S0T>$_{P1}$

P1 = sparing mode byte
S = 0 skip spare   S = 1 jump spare
T = 0 retain data   T = 1 do not retain data
T must equal 1 for tape operation
S must equal 0 for tape operation

RELEASE

FUNCTION: Releases the device.

OPCODE: 14_{10} 00001110_2 016_8 $0E_{16}$

FORMAT: No variables or parameters

RELEASE DENIED

FUNCTION: Prohibits the device from releasing itself.

OPCODE: 15_{10} 00001111_2 017_8 $0F_{16}$

FORMAT: No variables or parameters

Table 10-3. Device General Purpose Command Summary (continued)

DESCRIBE

FUNCTION: Directs the device to return information about the currently loaded cartridge. It gives a controller description, unit description and a volume description.

OPCODE: 53_{10} 00110101_2 065_8 35_{16}

FORMAT: All individual fields are 8-bit binary. Numbers are given in hexadecimal unless otherwise stated.

Controller Description Field (5 bytes)

C1, C2 = 80, 01 (Installed unit type: U0, U15)
C3, C4 = 03, E8 (maximum transfer rate is 1Mbyte per second)
C5   = 00

Unit Description Field (19 bytes)

U1 = 02 (Tape Drive)
U2 - U4 = 35, 40, 10 (Model No. is 35401)
U5, U6 = 04, 00 (1024 bytes per block)
U7 = 0B (11 blocks can be buffered - can vary)
U8 = 00 (burst mode not recommended)
U9, U10 = 75, 30 (30 000 microseconds block to block)
U11, U12 = 00, 23 (35 000 bytes per second ave. transfer rate)
U13, U14 = 00, 0A (Number of retries. Maximum is 10)
U15, U16 = 5D, C0 (24 000 milliseconds)
U17 = 00 (maximum interleave factor)
U18 = 00 (no fixed volumes)
U19 = 01 (removable volumes)

Volume Description Field (13 bytes)

V1 - V6 = all 00 (the tape drive does not support 3 vector addressing)
V7 - V12 = 00, 00, 00, 00, nn, nn Maximum block address (nn, nn) is either:

    FF, FF (65535 - 600 foot tape, no spares)
    FF, 7F (65407 - 600 foot tape with spares)

    3F, FF (16383 - 150 foot tape, no spares)
    3F, DF (16351 - 150 foot tape with spares)

    00, 00 (no tape loaded in drive)

V13 = 00 (current interleave is 0)

Table 10-3. Device General Purpose Command Summary (continued)

EXTENDED DESCRIBE

FUNCTION: In Selective mode only, information may be obtained about the cartridges which are in the magazine, not just the cartridge which may be loaded. The information is given in table form which includes the following: a controller description, a unit/volume description, and media information which can be loaded using the Load command. Each table is prefaced with a six byte table descriptor which provides such information as table type and length, record size and number, and header size. This information is followed by the header and the specified number of fixed length records.

OPCODE: 12_{10} 00001100_2 014_8 $0C_{16}$

FORMAT: <00001100> <TABLE> The first table returned in the Describe message is the controller description table which makes no use of the record capability and keeps all information in the header section. The format of this table is as follows:

TABLE DESCRIPTOR
Table length = 8
Table type = 3 (Controller description table)
Header size = 8 bytes (C1 - C8)
Record count = 0
Record size = 0

Header Format
C1, C2 = 80, 01 (Installed unit type: U0, U15)
C3, C4 = 03, E8 (maximum instantaneous transfer rate, kbyte/s)
C5 =80 (Describe extensions supported, single unit controller)
C6 = 00 (Not valid as not a multi-port controller)
C7 = 00 (Not valid as not a multi-port controller)
C8 = 00 (Padding)

Following the controller table is the Unit/Volume table (table type 4). There is only one unit, so the table is only returned once. The unit description is contained in the header of the table and the volume description is kept within the record field. The format of the table returned is as follows:

TABLE DESCRIPTOR
Table length = 32
Table type = 4 (unit/volume description table)
Header size = 18 bytes (U1 - U18)
Record count = 1
Record size = 14 bytes (V1 - V14)

Header Format
U1 = 00 (Unit number)
U2 = 02 (Tape device)
U3 - U5 = 35, 40, 10 (Model number 35401)

Table 10-3. Device General Purpose Command Summary (continued)

U6, U7 = 04, 00 (1024 bytes per block)
U8 = 0B (Number of bufferable blocks - can vary)
U9 = 00 (Burst mode not recommended)
U10, U11 = 75, 30 (30 000 microseconds block to block)
U12, U13 = 00, 23 (Average transfer rate = 35 000 byte/s)
U14, U15 = 00, 0A (Number of retries. Maximum is 10)
U16, U17 = 5D, C0 (Access time parameter is 240 seconds)
U18 = 00 (Maximum interleave factor)

Volume (Record) format (describes the currently loaded cartridge)
V1 - V6 = All 00 (the Tape Drive does not support 3 vector addressing)
V7 - V12 = See DESCRIBE, V7 - V12. (All 0s if no cartridge loaded)
V13 = 0 (Current interleave factor)
V14 = 1 (Removable media)

After the Unit/Volume Table comes the Available Volumes Table which has the
following format:

TABLE DESCRIPTOR
Table length = Variable (6 -14 bytes)
Table type = 6 (Available Volumes table)
Header size = 6 bytes (A1 - A6)
Record count = Variable (0 - 8 bytes)
Record size 0 1 (byte per cartridge) (R1 - R8)

Header Format
A1 = 0 (Unit number - only one unit for tape drive)
A2 = Load parameter to access currently loaded cartridge (0 - 8) (0 if no cartridge
loaded)
A3, A4 = 7, 00 (approximately 3 minutes load access time)
A5, A6 = 4, 60 (approximately 2 minutes unload access time)

Record format
R1 - R8 = 1 - 8 This field is repeated for every cartridge which is available and
gives the parameter which must be sent with the LOAD command to access all the
cartridges. Only one byte is returned per cartridge and gives the cartridge number.
If a cartridge is not present then its parameter is excluded. If no cartridges are
present (magazine empty or door open), then no records are returned. The cartridge
number for the currently loaded cartridge is returned as well as all the others.
Numbers are returned sequentially, beginning at the lowest.

The last table returned is the terminating table, which has the following format:

TABLE DESCRIPTOR
Table length = 0
Table type = FF (End of Describe)
Header size = 0
Record count = 0
Record size = 0

Table 10-3. Device General Purpose Command Summary (continued)

INITIALIZE MEDIA

FUNCTION: Initializes all the data fields of the currently selected unit.

OPCODE: 55_{10} 00110111_2 067_8 37_{16}

FORMAT: <00110111> <00000CWZ>$_{P1}$ < P2 >

P1 = initiate options byte

Options for tape media:
  CWZ = 000 Retain both factory (primary) and field (secondary) spares
  CWZ = 001 Retain factory spares only
  CWZ = 010 Retain no spares (for CE use only)

P2 = Block interleave byte

LOAD

FUNCTION: Loads a specified cartridge in Selective mode. It is not supported in Sequential mode.

OPCODE: 75_{10} 01001011_2 113_8 $4B_{16}$

FORMAT: <01001011> <No. of parameter bytes> <Parameter byte>

No. of parameter bytes = 1
Parameter byte = 1 to 8 only

UNLOAD

FUNCTION: Causes the drive mechanim to perform an unload sequence. The autochanger mechanism then replaces the unloaded cartridge back into the magazine. In selective mode the door is now unlatched and may be opened to remove the cartridge magazine by pressing the [EJECT] button.

In addition, in sequential mode only, one of two events now happens:

• the next cartridge is loaded, or if the unloaded cartridge was at the top of the magazine,

• the door is now unlatched and may be opened by pressing the [EJECT] button.

OPCODE: 74_{10} 01001010_2 112_8 $4A_{16}$

FORMAT: No variables or parameters

Table 10-4. Device Diagnostic Command Summary

INITIATE DIAGNOSTIC

FUNCTION: Directs the device to perform one internally defined diagnostic routine.

OPCODE: 51_{10} 00110011_2 063_8 33_{16}

FORMAT: <00110011> < P1 > < P2 > < P3 >

P1-P2 = loop parameter
P3 = diagnostic section number

INITIATE UTILITY

FUNCTION: Directs the device to perform one utility routine.

OPCODE: 48_{10} 00110000_2 060_8 30_{16}
  49_{10} 00110001_2 061_8 31_{16}
  50_{10} 00110010_2 062_8 32_{16}

FORMAT: <001100XX> < P1 > < n parameter bytes >

XX = execution message qualifier
  00 = no execution message
  01 = device will receive execution message
  10 = device will send execution message
P1 = utility number (device specific)
There can be up to 8 bytes in the parameter field. The number and content of these bytes is determined by P1.

Information about the individual Tape Drive Utilities is found in Table 10-5.

REQUEST STATUS

FUNCTION: Instructs the device to return (in an execution message) the status report.

OPCODE: 13_{10} 00001101_2 015_8 $0D_{16}$

FORMAT: No variables or parameters

Table 10-5. Tape Drive Utilities

Pattern Error Rate Test <C8> Hex

11001000	LOOP	TYPE	TEST AREA	DATA SOURCE
Micro-opcode	1 byte	1 byte	1 byte	1 byte

Parameter Definition:

LOOP ⇒ 0-255 = Loop Count

TYPE ⇒ 00 = Read Only ERT
01 = Write/Read ERT
02 = Certification (Read-while-write with bad blocks spared after test done)

TEST AREA ⇒ 00 = Use Current Address & Current Length (Logical)

X1 = Use Current and Next Track Test is performed starting on first block of track X and continues for the length of two tracks. If track 15 (F) is specified, test will be done on tracks 14 and 15. All blocks on two tracks are tested.

02 = Entire Tape (Physical)

DATA SOURCE ⇒ 0-255 Defines data source
00 = Use Internal Pattern Table (8 patterns corresponding to loop number modulo 8)
01 = Use User Defined Pattern (patterns received via the Receive User Pattern Utility)
02 = Use Random Data

The internal patterns, in order, are:

Pattern	Function
B6 6D DB	MFM DC offset
7F	Standing wave
77	Standing wave
55 49 3F	Frequency sweep
FF	Produces 2F in one phase
00	Produces 2F in other phase
55	Produces 1F in one phase
AA	Produces 1F in other phase

Table 10-5. Tape Drive Utilities (continued)

Read Error Summary <C1> Hex

The Tape Drive returns 64 bytes of 0s in response to this command because the drive mechanism does not support Error Summary Usage due to its comprehensive diagnostic capabilities.

Read Revisions Number <C3> Hex

This utility returns the firmware revision number to the Host. Four bytes of data are returned. The first byte is always 3, indicating that there are three bytes of data following. The second byte holds the revision number for the Executive ROM. The third byte holds the revision number for the Tape Drive Unit code and the fourth byte holds the number for the Drive Mechanism Unit code.

Bytes 2 and 3 are simple 8 bit numbers.

Byte 4 is of the form:
```
            bits 7-4 =Revision number
                 3-0 =Rework number
```

Read Drive Tables <C4> Hex

One of three drive tables is returned to the Host based on the micro-opcode which follows the utility opcode.

a. Manufacturer's block <0A> Hex

This table is written by 3M when the tape is formatted. It contains manufacturer's information about the tape. Unlike the other blocks on the tape it is written in the same direction on all tracks (moving towards EOT) between keys zero and one.

The format of the table is:

```
<cr><lf>DC6xxHC     xx = 00 for the long tape
                         15 for the short tape
<cr><lf>1024
<cr><lf>FORMAT () 1980, MINN. MINING & MFG.CO.
<cr><lf>xxxxxxnnnnnnnnnn
<cr><lf><esc>
```

<cr> represents a carriage return character
<lf> Line Feed
<esc> Escape
xxxxxx is the manufacturer's control code
nnnnnnnnnn is the Date code

The cartridge identification code (xxxxxxnnnnnnnnnn) contains both numeric and alphabetic characters and is unique for each cartridge.

Table 10-5. Tape Drive Utilities (continued)

b. Spares Table <08> Hex

The blocks which have been spared either by Certification, Autosparing or by the Host issuing a Spare Block command are returned. The format of the data is as follows :

```
Number of entries .......... 1 byte
Table record
      Key number ............. 2 bytes
      Track .................. 1 byte
      for each entry
```

Note that the table returned in response to this utility shows only bad blocks that have been spared out. It does not show blocks that have been reserved as spares.

c. Copy Start Address <0C> Hex

This table is 6 bytes of zeroes. (On cartridges recorded by a single controller on 7914 Drives the starting address for multiple tape backups is returned.)

If this command is sent to the Tape Drive, illegal parameter will be set in the Request status summary.

Read Error Log <C5> Hex

(also referred to as Runtime Error Log or just Runtime Log.)

This utility returns to the Host the Runtime Error Log, which is an accumulation of run-time errors detected by the drive since the last Clear Logs command. The format of the log is shown next.

```
Number of records ................. 1 byte
Number of uncorrectable errors .... 1 byte
Number of key errors .............. 1 byte
Type of certification ............. 1 byte

    0 - not certified
    1 - 3M certified
    2 - HP factory certified
    4 - 7914 Drives certified
    8 - Tape Drive/drive mechanism certified
```

Address entries - same format as the Error Rate Test Log.

Table 10-5. Tape Drive Utilities (continued)

Read Error Rate Test Log <C6> Hex

```
┌─────────────┐        ┌─────────────┐
│  11000110   │        │  00000000   │
└─────────────┘        └─────────────┘
 Micro-opcode          Parameter = 0
```

The ERT Data Error Log is the standard log for all errors found while executing the Pattern Error Rate Test. The log is composed of a header which contains the number of blocks accessed and error counts, and records which contain relevant addresses and error qualifiers. This log contains data and key errors, and is kept separate from the Runtime Error Log so that cumulative errors are not a concern during testing. Records are kept for permanent errors (correctable and uncorrectable) and key errors.

Log Format:

```
                LOG HEADER

    No. of records ............... 1 byte
    No. of blocks accessed ....... 4 bytes
    No. of permanent errors ...... 2 bytes
    No. of transient errors ...... 2 bytes
    No. of uncorrectable errors .. 1 byte
    No. of permanent key errors .. 1 byte
```

Address entries - 3 bytes for each of the records. Each entry is of the form:

```
    Logical address ............. 2 bytes (MSB,LSB)
    Error byte .................. 1 byte
                        <7 6 5 4 3 2 1 0 >
```

The Error byte is a bit-map with bits 0 - 5 corresponding to Frames 1-6. A **1** in any of these positions indicates that the frame had a CRC error. Bit 6 is set if the data is uncorrectable. Bit 7 is set if there was a Key error.

Read Use Log <C7> Hex

This utility returns the Use Log to the Host. This log is never cleared so that an accurate record of all tape usage is recorded here. Note that it is not possible to update this log if the tape is write-protected and thus all sessions may not be reflected in this log. Also if the tape drive receives a Clear command, all the accumulated data not written to the tape is lost.

The format of the Use Log appears next.

```
    Number of times tape was loaded .... 2 bytes
    Number of blocks accessed .......... 4 bytes
```

Table 10-5. Tape Drive Utilities (continued)

Clear Logs <CD> Hex

This utility clears the logs indicated by the parameter byte.

0 - Clear both the Error Rate AND the Runtime Error Log
1 - Clear ONLY the Error Rate Log

Preset Drive <CE> Hex

When the drive receives this utility, it updates the Runtime Error Log if it needs updating.

Receive User Pattern <D1> Hex

This utility allows the Host to send 64 bytes of data which are replicated 16 times (1k total) per block of data written to the tape. This utility is used in conjunction with the Pattern Error Rate Test.

Read Memory <30> Hex <Address MSB>

Returns 1024 bytes of data, to the Host, starting at memory address <MSB><00>.

Return Servo Status <36> Hex

The unit reads the current servo status from the Servo I/O port and returns this byte. The servo status is elaborated below.

Status	Description
1XH	Going reverse on track X
2XH	Going forward on track X
3XH	Stopped on track X
40H	Illegal command
41H	Tach/encoder error
42H	Current limit
44H	Edge find fault
48H	Key fault
50H	Speed calibration fault
64H	End of tape
68H	Beginning of tape

Table 10-5. Tape Drive Utilities (continued)

Set Amplifier gain <37> Hex

Allows the Host to set the gain of the Read channel amplifier. The parameter byte is the gain value in hexadecimal.

$$\boxed{\textbf{CAUTION}}$$

THIS COMMAND MAY HAVE CATASTROPHIC RESULTS.

Return Amplifier Gain <38> Hex

Returns 1 byte to the Host. This byte is the gain setting of the Read Amplifier (hexadecimal). The value returned is the value obtained using the lower write gap.

Send Servo Command <3A> <XX> Hex

This routine passes the Servo command to the Servo microprocessor.

A listing of the Servo commands is presented below. The commands are grouped according to their command type. The command abbreviation, hexadecimal code, and a description of each command are given.

Normal Operation Commands

Command Abbrv.	Hex Code	Description
REV/TRK	1/T	Move tape in the reverse direction on track T
FWD/TRK	2/T	Move tape in the forward direction on track T
STOP/TRK	3/T	Stop the tape on track T
SPD60	81	Set the tape speed to 60 ips
SPD90	82	Set the tape speed to 90 ips

Special Function Commands

Command Abbrv.	Hex Code	Description
SPDCAL	48	Calibrate tape speed to 60 ips
PREPOS	50	Pre-position both gaps on tape, approx. track 0
EDGE	60	Find edge of tape, put bottom gaps on track 0
UNLOCK	84	Unlock cartridge
STEPU	A/N	Step head up N steps
STEPD	B/N	Step head down N steps

Table 10-5. Tape Drive Utilities (continued)

Transparent Commands

Command Abbrv.	Hex Code	Description
INIT	00	Exit power on state
AC600	43	Set acceleration/deceleration rate to 600 ipsps
AC800	44	Set acceleration/deceleration
ESPOOL	45	Enable unspool detection
DSPOOL	46	Disable unspool detection

Utilities/Diagnostic Commands

Command Abbrv.	Hex Code	Description
RNS	C1	Return number of steps to edge of tape
SC0	C2	Select channel 0, override track based select
SC1	C3	Select channel 1, override track based select
LWH	C4.XX	Loopback diag.,set status to compl. of xx
TSM	C5	Test servo motor circuit
TST	C6	Test servo tach circuit
THS	C7	Test head stepper circuit
TMP	C8	Test microprocessor (6805)

Set Retry Mode <3B> <XX> Hex

Allows the Host to specify one of four Retry modes, where XX =

<00> 7914 Drives compatible - the Default Mode.
Retry blocks with two or more single permanent errors which cause the data to be un-recoverable until the data is recoverable, or the retry count expires. Retry bad keys as well. Perform auto-sparing as needed for writes based on the current options byte.

<01> Retry all write errors.
Retry blocks with one or more single permanent errors until the errors are no longer present or the retry count expires during writes ONLY. Retry bad keys also. Perform autosparing as needed for writes based on the current Options byte.

<02> Retry and spare write errors.
Retry all write errors with Auto-sparing invoked if the retry count expires.

<03> Diagnose errors.
Retry bad keys and any frame errors for reads AND writes until the errors go away OR the retry count expires.

Table 10-5. Tape Drive Utilities (continued)

Set trip point <3D> <Parameter> Hex

Uses the parameter to reset the time at which the distance from the edge is checked. The parameter will be the count of timer cycles needed to expire before performing the next edge check. Each timer cycle is approximately 65 seconds.

Return trip point <3E> Hex

Returns the current trip point value.

Perform Preload sequence <64> Hex

Perform the the Tape Drive Preload sequence. This utility returns two bytes of data. The first is the Cartridge Present byte, which is a bit-map of occupied slots in the magazine, with bit 0 (LSB) corresponding to cartridge 1, bit 1, cartridge 2 and so on. A **1** in any bit position indicates that the associated cartridge is in the magazine.

The second byte is the Write-protect byte, which is a bit-map of the protect status of each cartridge. Bits are mapped as above. A **1** in any bit position indicates that the associated cartridge is write-protected.

Load Cartridge <65> <cartridge number> Hex

Performs a full (including the drive mechanism) load of the specified cartridge number. The report is issued at the end of the the Drive Mechanism Load. This is functionally identical to the Load command, defined only in Selective mode, but is available in both modes of operation.

Unload Cartridge <66> <Slot number> Hex

Performs a full unload of the cartridge currently loaded and loads it into the magazine at the specified slot number. An error will occur if the slot is already occupied.

The report is issued at the end of the operation, i.e. when the cartridge has been replaced in the magazine. If no cartridge is loaded, then a report is issued immediately.

Table 10-5. Tape Drive Utilities (continued)

Read Status of Cartridges <69> Hex

Returns two bytes of information. The first shows which cartridges have failed during a load operation. The second shows which cartridges have exceeded their nominal use limit. Bit 0 (LSB) corresponds to cartridge 1, Bit 1 to cartridge 2 and so on. If a bit position contains a **1**, then the associated cartridge has a fault or warning.

Read Cartridge information <6A> Hex

Allows the user to read the information about cartridges present and their write-protect status (gathered with the last Preload) without performing a Preload.

Returns two bytes of data. The first is the Cartridge Present byte, which is a bit-map of occupied slots in the magazine, with bit 0 (LSB) corresponding to cartridge 1, bit 1, cartridge 2 and so on. A **1** in any bit position indicates that the associated cartridge is in the magazine.

The second byte is the Write-protect byte, which is a bit-map of the protect status of each cartridge. Bits are mapped as above. A **1** in any bit position indicates that the associated cartridge is write-protected.

This utility will return invalid data if a Preload has not been performed on the magazine which is in the Tape Drive.

Unload Backwards <6C> Hex

Available only in Sequential Mode.

It causes the current cartridge to be unloaded and replaced in the magazine. The next lowest cartridge (if available - the current cartridge could be the bottom one) is then loaded. If the next lowest cartridge is not available then the cartridge number display will show a 🛈 and the magazine may be removed by pressing the (EJECT) button.

If a new magazine is now loaded, the first cartridge to be loaded will be the lowest available cartridge. If you want to load the highest cartridge, then this must be selected by pressing (repeatedly) the (EJECT) button.

Table 10-5. Tape Drive Utilities (continued)

Read Use Logs <6E> Hex

Returns the contents of the Mechanism Use logs. These logs give an indication of the amount of use the Tape Drive has sustained since the logs were last cleared.

The format of the data returned is as follows :

```
Total Movement Time (in milli-secs) ...... 4 bytes
Total Operations ......................... 4 bytes
Total Unit Faults ........................ 4 bytes
Total Recovery Calls ..................... 2 bytes
Total Nested Faults ...................... 2 bytes
Total Cleaning Cycles Performed........... 2 bytes
Overflow byte ............................ 1 byte
Total Power Cycles........................ 2 bytes
TOTAL .................................... 21 bytes
```

The **Total Movement Time** is simply the time that the mechanism has been in operation since the last Clear Logs command was issued. Time is in milli-seconds, and a 32-bit result is returned (MS byte first), so the maximum movement time recordable is approximately 1190 hours.

The **Unit Faults field** shows the number of times that a unit fault has occurred (due to a mechanism problem).

An **Operation** is a term which is defined by the mechanism control software. In general it is a small section of a movement, and consists of movement in only one dimension. For example, operations are moving from the vertical "home" position to a specific cartridge position, and moving in the horizontal axis from the magazine to the "home" position.

The number of **Recovery Calls** gives an indication of how many jams the mechanism has been involved in. It is expected that recovery from most jams occurs transparently to the user. This field gives an indication of how many times the recovery routines have been invoked.

It is also possible under some circumstances to recover from a fault which is detected while recovering from another fault. The **Total Number of Nested Faults field** shows how many times such a situation has occurred.

The **Overflow byte** gives a bit-map of any fields which have overflowed during use.

The bits are mapped as follows :

```
Bit              Field overflowed if "1"

0 (LSB)          Movement time
1                Operations
2                Unit faults
3                Recovery calls
4                Nested faults
5                Cleaning cycles
6                Power cycles
```

Table 10-5. Tape Drive Utilities (continued)

Read Sensors and Quarry ID <70> Hex

Returns 2 bytes of data. The first is an image of the Main Sensors Port, and the second is the Quarry ID byte, which also contains the Field Mode bit and the Eject Button state.

The Sensors Port is mapped as follows :

Bit	Function
LSB **0**	Horizontal Movement sensor. Active when the mechanism is on the Drive Mechanism side.
1	Horizontal Movement sensor. Active when the mechanism is on the magazine side.
2	Vertical Home sensor. The Vertical sensor is active when the mechanism is at its lowest point. It is inactive otherwise.
3	Cartridge Under Arm detector. **1**=UARM, **0**=NOT UARM
4	Cartridge Write-protect detector. **0**=W PROT, **1**=W ENABLE
5	Magazine detector. Active when the magazine is loaded and the door is closed.
6	Operation mode. **1** corresponds to Selective mode and **0** to Sequential mode.
MSB **7**	Vertical Movement sensor. Inactive when the tray is at any of the cartridge positions or when it is level with the Drive Mechanism.

Except as stated, all sensors are active High (i.e. **1** when active).

The Quarry ID is contained in the lower six bits of the second byte, and is **110100** (LSB). Bit 6 of this byte is the Field mode and is **1** for Field mode and **0** for Factory mode. Bit 7 is the Eject Button and is **0** when the button has been pressed.

Table 10-5. Tape Drive Utilities (continued)

Read NOVRAM <71> Hex

Returns all 32 bytes of Non-volatile RAM, beginning with the least significant byte. These bytes contain the Mechanism Use Logs as detailed above, but in addition, have some details pertinent to the system operation of the Tape Drive. The relevant parameters are described below.

Address (Decimal)	Contents
00	Mode - **00** = Sequential **01** = Selective.
01	Current cartridge. Contains the number of the cartridge currently installed. Zero if none.
02	Mechanism Operation - **0** = Idle **2** = Loading **3** = Unloading **4** = Fault.
03	Object cartridge number. Valid only if Loading or Unloading.
04	Next cartridge. Used during Unload to remember which cartridge has been selected for the next load.
05	Unload Mode (valid only in Sequential mode and when unloading) - **0** = Cartridge **1** = Media **2** = Eject Button pressed.
06	Cartridge Present byte (bit-mapped) - bit 0 (LSB) corresponds to cartridge 1, etc.
07	Cartridge Protect byte - bit-mapped byte indicating which cartridges are write-protected. Bit 0 (LSB) = cartridge 1, etc.
08	Magazine initialized - **0** = Magazine not initialized **1** = Magazine initialized.
09	Fault Status byte - bit-map as above indicating cartridges which have faults (**1** indicates that the cartridge was not loadable).
10	Media Status byte - bit-map as above indicating which cartridges in the magazine have exceeded the media life limit.
11	Mechanism Logs Overflow byte - defined under utility number **<6E>**.

Table 10-5. Tape Drive Utilities (continued)

12-15   Total Mechanism Movement Time - defined under utility number **<6E>**.

16-19   Total Operations - defined under utility number **<6E>**.

20-23   Total Unit Faults - defined under utility number **<6E>**.

24-25   Total Recovery Calls - defined under utility number **<6E>**.

26-27   Total Nested Faults - defined under utility number **<6E>**.

28-29   Total Cleaning Cycles

30-31   Total Power Cycles

10-11.   HEWLETT-PACKARD INTERFACE BUS

The Hewlett-Packard Interface Bus (HP-IB) provides a standardized method of connecting separate devices (see figure 10-2). The HP-IB permits transfer of commands and data between the

components of a system on 16 signal lines. The interface functions for each system component are performed within the component so only passive cabling is needed to connect the system. The cable connects all controllers and other devices of the system in parallel.

Figure 10-4. Hewlett-Packard Interface Bus Signal Lines

The Hewlett-Packard Interface Bus (HP-IB) has certain rules which must be followed for successful installation of the Tape Drive. Cabling is limited to 1 meter per HP-IB load. Typically the Central Processing Unit (CPU) is 7 equivalent loads and the Tape Drive is 1 equivalent load.

The CPU adheres to an HP standard which allows 7 meters of HP-IB cable between the CPU and the nearest device connected to it and 1 meter of cable between each additional device. The maximum configuration is eight devices (not including CPU) per HP-IB channel or a maximum of 15 meters or 15 equivalent loads.

The eight Data I/O lines are reserved for the transfer of commands, data, and other messages in a byte-serial, bit-parallel manner. Data and message transfers are asynchronous, coordinated by three handshake lines: Data Valid (DAV-L), Not Ready For Data (NRFD-L), and Not Data Accepted (NDAC-L). The other five lines are for bus management.

Information is transmitted on the data lines under sequential control of the three handshake lines (DAV-L, NRFD-L and NDAC-L). No step in the sequence can be initiated until the previous step has been completed. Information transfer can proceed as fast as devices can respond, but no faster than allowed by the slowest device presently addressed. This permits several devices to receive the same message byte concurrently.

Devices connected to the bus may be talkers, listeners, or controllers (refer to table 10-6). The Controller-In-Charge (CIC) dictates the role of each of the other devices by setting the Attention (ATN-L) line low and sending talk or listen addresses on the data lines. Addresses are set for each device at the time of system configuration. While the ATN-L line is low, all devices must listen to the data lines. When the ATN-L line is high, devices that have been addressed will send or receive data; all others ignore the data lines. Several listeners can be active simultaneously but

only one talker can be active at a time. Whenever a talk address is put on the data lines (while ATN-L is low), all other talkers will be automatically unaddressed.

The Interface Clear (IFC-L) line places the interface system in a known quiescent state. The Remote Enable (REN-L) line is used to select be-

tween two sources of device programming data such as the front panel or the HP-IB. The End Or Identify (EOI-L) line is used to indicate the end of a multiple-byte transfer sequence. In addition, when a controller-in-charge sets both the ATN-L and EOI-L lines low, each device capable of a parallel poll responds on the DIO line assigned to it.

Table 10-6. HP-IB Definitions

HP-IB Term	Definition	Considerations
TALKER	Any device which sends information over the HP-IB.	There can be only one TALKER sending information over the HP-IB at a time.
LISTENER	Any device which receives information over the HP-IB. Some devices can function as LISTENERS or TALKERS.	In a parallel poll system, there can be up to 8 LISTENERS receiving information over the HP-IB at the same time.
CONTROLLER	Any device that has been programmed to manage data flow between the TALKER and the LISTENER(s) in addition to being a TALKER and a LISTENER.	The CONTROLLER manages data flow by addressing one device as a TALKER and one or more devices as LISTENERS. There can be only one active CONTROLLER on the HP-IB at any time. The active CONTROLLER is called the CONTROLLER-IN-CHARGE (CIC).
SYSTEM CONTROLLER	Any device that functions as a CONTROLLER and is able to gain absolute control of the HP-IB with the Interface Clear (IFC) signal.	There can be only one SYSTEM CONTROLLER connected to the HP-IB.

10-12. HP-IB COMMUNICATIONS

This section describes the formats and sequences for the HP-IB commands, messages and transactions that occur between the Controller-In-Charge (CIC) and the Tape Drive. The following list explains the terms used in this section.

COMMAND • A parcel of information transmitted over the channel (HP-IB) relating to a specific operation. Channel commands (usually a single

byte) are used to manage operations on the interface channel. Device commands (usually more than one byte) are used to control the operation and are contained within the text of a command message.

UNIVERSAL COMMAND • A channel command that causes all devices on the bus to perform a predetermined interface function. The format is ATN [P001CCCC] where P is a parity bit and CCCC is the command code.

PRIMARY COMMAND • The primary 1 command is a channel command that begins the

message sequence. It contains the command to listen or talk and the address of a particular device. The primary II command terminates the message with an unlisten or untalk command.

SECONDARY COMMAND • The secondary command sets up the action required of the Tape Drive in the text of the message.

TEXT • The text of the message can be 1 to n bytes depending on the required action. The required action can be to receive further qualifying information or instructions (such as a device command), to receive write data, to send read or status data, or to perform a specific operation such as a CLEAR.

MESSAGE • A unique sequence of command and text bytes transmitted over the channel during which the communication link between the devices (for example, CIC and the Tape Drive) remains unbroken.

COMMAND MESSAGE • A single message containing all the information required to address a device and initiate an operation, set up a programmable parameter, or set up an operation to be executed by an execution message.

EXECUTION MESSAGE • A single message containing all the information required to carry out an operation previously set up by a command message.

TRANSACTION • A complete process or operation carried out over the channel. Some transactions are completed with only a command/report message, and some require a command, execution, and a reporting message.

10-13. CHANNEL MANAGEMENT

The following techniques are used by the CIC to manage the HP-IB: Parallel Poll and Universal Device Clear.

10-14. PARALLEL POLL

The CIC conducts a parallel poll on the HP-IB by asserting ATN-L and EOI-L simultaneously. Each

device requiring service can then respond by asserting the DIO line corresponding to its address. The CIC then addresses only the device requiring service. If more than one device requires service, the CIC addresses the device with the highest priority (lowest address) first. Parallel Poll Enable (PPE) and Parallel Poll Disable (PPD) are internal states of the Tape Drive controller. PPE occurs when the Tape Drive requires service from the CIC. PPD is the opposite state and occurs whenever the Tape Drive is active (for example, busy executing a command) or idle. A Parallel Poll Response (PPR) from the Tape Drive will occur if the CIC asserts both ATN-L and EOI-L and if the Tape Drive is in the PPE state.

10-15. UNIVERSAL DEVICE CLEAR

A universal command is a channel command that causes all devices on the HP-IB to perform a predetermined interface function. Universal Device Clear erases information stored in the Tape Drive controller and places the Tape Drive in a known reset state. The format of the command is ATN [P0010100] where P is a parity bit.

10-16. MESSAGE STRUCTURE

Each message contains the following components (refer to table 10-7).

• Primary I Command
  (unidirectional from CIC to device)

• Secondary Command
  (unidirectional from CIC to device)

• Text (bi-directional)

• Primary II Command
  (unidirectional from CIC to device)

The CIC asserts ATN-L during primary and secondary commands to distinguish them from text information. The Tape Drive decodes the information contained in both the primary I and secondary commands to prepare for action specified in the text.

Table 10-7. HP-IB Message Structure

Header		Text	Trailer
Primary I	Secondary	Device Command or Data	Primary II
[ATN] [ONE BYTE] • Unidirectional *CIC to device • Begins message *Addresses device to LISTEN or TALK *Universal	[ATN] [ONE BYTE] • Unidirectional *CIC to device • Set up device for further action	• Bidirectional • Qualifying instructions to device • Write data to device • Read data to CIC • Status data to CIC	[ATN] [ONE BYTE] • Unidirectional *CIC to device • Terminates message • Unaddresses device *Unlisten *Untalk

10-17. MNEMONICS

Table 10-8 contains a summary of the signals used in the Tape Drive and shows where they may be measured.

Table 10-8. Mnemonics

MNEMONIC	SIGNAL	SOURCE		DESCRIPTION
ARMSOL	Activate Arm Solenoid	MDC pin 12	J4	Drives arm solenoid when low. (Voltage range 0-12V).
ATN-L	Attention	HDC pin 11	J3	HP-IB management interface line used to specify how information on bidirectional Data Bus DIO1-L through DIO8-L is to be interpreted and which device must respond to the information. When ATN-L is low, the DIO1 through DIO8 lines carry addresses or commands. When ATN-L is high, these lines carry data.
BOT	Beginning Of Tape	DDC pin 31	J2	Active high signal from DDC Read State Machine to tell Servo circuitry that the tape has reached BOT.
BUF LOAD	Stimulate drive mechanism-loaded sensor	MDC pin 4	J4	Simulates drive mechanism-loaded switch. Active low signal that indicates to the drive mechanism that a cartridge is loaded.
BUF PROT	Stimulate drive mechanism write-protect sensor	MDC pin 2	J4	Simulates drive mechanism write-protect microswitch. Active high when cartridge is protected.
BUSY	Activate BUSY LED	MDC pin 5	J2	When this line falls to about 10V, the BUSY LED is illuminated. (Voltage range 10-12V).
CADDY PRESENT	Indicates cartridge magazine in drive.	MDC pin 45	J4	Signal derived from microswitch on microswitch PCA indicating a magazine has been loaded and the door is shut. It is active low.
CART U ARM	Indicates cartridge under arm	MDC pin 7	J4	Signal derived from top microswitch under arm. Active low indicating cartridge under arm.
CHS	Channel Select	DDC pin 27	J2	Used to select the top or bottom read or write gaps in the read/write circuitry.

Table 10-8. Mnemonics (continued)

MNEMONIC	SIGNAL	SOURCE	DESCRIPTION
CSA0-H CSA5-H	Control/Status Address Bus bits 0 to 5	HDC J2 pins 16-18, 20-21, 23	DC-IB signals used to access the registers in the DDC which comprise the Control/Status Data Bus CSB0-H through CSB7-H.
CSB0-H CSB7-H	Control/Status Data Bus bits 0 to 7	HDC J2 pins 25-28, 30-33	DC-IB bidirectional 8-bit bus used to pass control and status data between the HDC, DDC and MDC.
CSRS-L	Control/Status Read Strobe	HDC J2 pin 13	DC-IB signal used to pass bytes from the DDC to the HDC over the Control/Status Data Bus CSB0-H through CSB7-H. The bytes are of a DDC-status nature since recording medium information is passed over the Read/Write Data Bus DATA0-H through DATA7-H. The read strobe generates a 500 nanosecond control/status bus read cycle.
CSWS-L	Control/Status Write Strobe	HDC J2 pin 14	DC-IB signal used to pass control bytes from the HDC to the DDC over the Control/Status Data Bus CSB0-H through CSB7-H.
DATA0-H DATA7-H	Read/Write Data Bus, bits 0 to 7	HDC J2 pins 35-38, 40-43	DC-IB bidirectional 8-bit bus used to pass read/write data between the HDC and DDC.
DAV-L	Data Valid	HDC J3 pin 6	HP-IB handshake line used to indicate availability and validity of information on Data I/O Bus DIO1-L through DIO8-L. DAV-L indicates to a receiving device that data is available.
DIO1-L DIO8-L	HP-IB Data I/O Bus, bits 1 to 8	HDC J3 pins 1-4, 13-16	HP-IB bidirectional data input/output (I/O) bus used for the transfer of data, commands and other messages between the host computer and the HDC. Transfer is bit parallel, byte serial.

Table 10-8. Mnemonics (continued)

MNEMONIC	SIGNAL	SOURCE		DESCRIPTION
DOORSOL	Activate Door Latch Solenoid	MDC pin 50	J4	Drives the door latch solenoid when low. (Voltage range 0-12V).
DRIN-L	Data Request In	MDC DDC pin 45	J1, J1	DC-1B tri-state DMA request line used to tranfer bytes over the Read/Write Data Bus DATA0-H through DATA7-H from the MDC or DDC to the HDC. The DDC is programmed via the Control/Status Data Bus CSB0-H through CSB7-H to drive a given request line.
DROUT-L	Data Request Out	HDC pin 46	J2	See DRIN-L above. This time bytes are passed from the HDC to the DDC and MDC.
DSIN-L DSOUT-L	Data Strobe In, Data Strobe Out	HDC pin 48	J2	DC-1B HDC-generated strobe lines which accomplish the transfer of data between the HDC and DDC over the Read/Write Data Bus DATA0-H through DATA7-H.
EJECT	Initiate Eject Sequence	Front Panel PCA pin 15		A push-button on the front panel grounds this line when pushed. It triggers the eject circuitry on the MDC. (Voltage range 0-5V).
EJECTLED	Activate the Eject Button LED on front panel	MDC pin 16	J2	When this line drops to about 10V, the Eject Button LED is illuminated.
EJECTSOL	Activate Eject Solenoid	MDC pin 2	J3	Drives the solenoid which unclamps the cartridge in the drive mechanism. The solenoid is activated when this line goes low. (Voltage range 0-12V).
EOI-L	End Or Identify	HDC pin 5	J3	HP-IB control signal used to indicate the end of multiple byte transfers or used with signal ATN-L to perform a parallel polling sequence.

Table 10-8. Mnemonics (continued)

MNEMONIC	SIGNAL	SOURCE	DESCRIPTION
EOT	End Of Tape	DDC J2 pin 33	Active high signal from the DDC read state machine to tell the Servo cir that the tape has reached EOT.
FAULT	Activate Fault LED on front panel	MDC J2 pin 2	When this line falls to about 10V, the FAULT LED on the front panel is illuminated. (Voltage range 9.5-12V).
GABLE	Gain Set Enable	DDC J2 pin 22	Set by the DDC (high) when requesting gain feedback from the Read/Write circuitry.
GNS-L	Gain Select	DDC J2 pin 47	This is the strobe line for latching data into the Read/Write circuitry from the Servo circuitry. This data travels on lines DB0 through DB7 and originates from the DDC. It is used to set the threshold levels in the Read/Write circuitry.
HENC	Horizontal motor optical encoder output	Motor PCA J1 pin 4	Signal derived from horizontal motor optical encoder. (Read at MDC J4 pin 15)
HENCLED	Horizontal motor LED drive	MDC J4 pin 18	Drive for infra-red LED in optical encoder on horizontal motor. Active when voltage is about 3.5V. (Voltage range 3.5-5V).
HLEDS	Horizontal Sensors LEDs drive	MDC J4 pin 9	Drive for infra-red LEDs in horizontal B and Horizontal C sensors. Active when voltage is about 3.5V. (Voltage range 3.5-5V).
HMOTOR1, HMOTOR2	Bidirectional horizontal motor control lines	MDC J4 pins 20, 16	Drive lines for horizontal motor. (Voltage range 0-12V).
HORIZB, HORIZC	Horizontal sensors	MDC J4 pins 11, 13	Sensor inputs indicating the position of the arm in the horizontal plane. (Voltage range 0-5V. 1=sensor active). B C 1 1 Fully in drive mechanism 1 0 Magazine side 0 1 Drive mechanism side 0 0 Home

Table 10-8. Mnemonics (continued)

MNEMONIC	SIGNAL	SOURCE	DESCRIPTION
ICSB0 to ICSB7	Internal Control/ Status Data Bus	MDC J1 pins 25-28, 30-33	Control/Status Data Bus linking HDC/MDC/DDC. See CSB0-H to CSB7-H.
IFC-L	Interface Clear	HDC pin 9 J3	HP-IB general management line used to set the interface in a known quiescent state.
KEYFND	Key Found	DDC pin 25 J2	Active low; the read state machine on the DDC tells the Servo circuitry that keys have been found on the tape. If no keys are found within 0.5 seconds, the capstan motor stops.
LOAD	Activate LOAD LED	MDC pin 4 J2	When this line falls to about 10V, the LOAD LED on the front panel is illuminated. (Voltage range 10-12V).
MPO-L	Master Power On	DDC pin 1 J1	A signal received from the DDC that the power supply is on and stable. Used to generate a system reset on the HDC.
NCART	Cartridge Present	RWS pin 37 J7	Active high when cartridge is in the drive mechanism.
NDAC-L	Not Data Accepted	HDC pin 8 J3	HP-IB handshake line used to indicate the acceptance of data by all devices.
NRFD-L	Not Ready For Data	HDC pin 7 J3	HP-IB handshake line used to indicate that all devices are, or are not, ready to accept data over the Data I/O Bus DIO1-H through DIO8-H.
OVERTH-H	Overthreshold	RWS pin 35 J7	Digital signal from Read/Write circuitry to DDC telling it that a signal read from tape is above the threshold level and hence is valid data.
PROT	Activate PROTECT LED	MDC pin 1 J2	When this line falls to about 10V the PROTECT LED is illuminated. (Voltage range 10-12V).

Table 10-8. Mnemonics (continued)

MNEMONIC	SIGNAL	SOURCE	DESCRIPTION
PVAL-H	Power Valid	PSU J2 pin 12	Indicates that power supply outputs are up to their proper values. This signal is used by the DDC to give an orderly power-up sequence. It is used by the MDC to update the NOVRAM when there is a power failure. It is used by the Read/Write circuitry to disable the write heads until power supply is established.
READY	Activate READY LED	MDC J2 pin 6	When this line falls to about 10V, the READY LED on the front panel is illuminated. (Voltage range 10-12V).
REN-L	Remote Enable	HDC J3 pin 17	HP-IB control line used in conjunction with other messages to select between two alternate sources of device programming data.
RESET-L	Reset	DDC J2 pin 19	Active low; resets the DDC and Servo microprocessors. High in normal operation and low at power-on or when PVAL is low.
RHWL	Read High Write Low	DDC J2 pin 29	Signal from DDC to Read/Write circuitry. When high, the read and write heads are connected to the read channel. The circuit can then read data from the tape. When low, the write heads are disconnected from the read channel and the read head amplifiers are disabled. The write heads are still connected to the write channel and data can be written.
SBC-L	Single Board Controller	DDC J1 pin 11	A signal which identifies the controller as being a single board controller (as opposed to being a dual board controller - a little-used signal).
SEL-L	Select	HDC J2 pin 22	DC-IB signal used to select either the DDC or MDC to respond to a given control/status bus operation. When low, SEL-L selects the DDC.

Table 10-8. Mnemonics (continued)

MNEMONIC	SIGNAL	SOURCE	DESCRIPTION
SERVO DATA0 SERVO DATA7	Servo Data Bus	DDC J2 pins 1, 3, 5, 7, 9, 11, 13, 15	Passes commands from the DDC to the Servo circuitry and returns status to the DDC.
SRQ-L	Service Request	HDC pin 10 J3	HP-IB general management line. SRQ-L is used by a device to indicate the need for service and to request an interrupt of the current activity.
SVR-L	Servo Read Low	DDC pin 45 J2	Active low signal which enables the servo output latch to drive the data bus.
SVW-L	Servo Write Low	DDC pin 43 J2	Active low signal which clocks servo commands into the servo input latch.
UNIT	Select unit	HDC pin 9 J2	Signal selects whether HDC communicates with DDC or MDC.
UNLOAD	Activate UNLOAD LED	MDC pin 3 J2	When this line falls to about 10V, the UNLOAD LED on the front panel is illuminated. (Voltage range 10-12V).
VENC	Vertical motor optical encoder output	MDC pin 30 J4	Signal derived from vertical motor optical encoder.
VENCLED	Vertical motor LED drive	MDC pin 32 J4	Drive for infra-red LED on vertical motor encoder. (Voltage range 3.5-5V).
VHLED	Activate Vertical Home sensor LED	MDC pin 42 J4	Drive for infra-red LED on Vertical Home sensor. (Voltage range 3.5-5V).
VHOME	Vertical Home	MDC pin 38 J4	Active low signal, indicating that the platform is at the bottom of its travel.
VMOTOR1 VMOTOR2	Vertical motor bidirectional drive	MDC pins 34, 28 J4	Drive lines for vertical motor. (Voltage range 0-12V).

Product History

11-1. OVERVIEW

This section describes the differences between earlier models of the HP 35401A and the latest version documented in the main body of this manual.

The main differences are:

- Two solenoids and a connecting bar were used to operate the door latch mechanism (see figure 11-1).

Figure 11-1. Door Latch with Connecting Bar

- In later models the connecting bar was removed, and the left-hand solenoid, although still fitted, was no longer mechanically connected to the door latch mechanism (see figure 11-2).

Figure 11-2. Modified Door Latch Mechanism

- The door, front panel and door latch assemblies have been redesigned. The door action is now damped using a mechanical speed governor assembly, instead of an air-filled dashpot (see service note 6). Figures 11-3 and 11-4 show the original front panel and door assemblies.

Figure 11-3. The Front Panel Assembly

Figure 11-4. Door Assembly

- Two red plastic clips were used to prevent the door from latching during shipment. These clips were replaced a single clip, and then by a door-puller tab. Section 11-3 gives details of how to unpack and repack models fitted with two red plastic clips.

- Changes have been made to the design of the bowden cable assembly to eliminate the risk of damage and improve the operation of the ON/OFF switch (see service notes 2 and 5).

- Packers can be provided to raise the tape drive mechanism and assist cartridge loading (see service note 5).

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    │    NOTE     │
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Models of the HP 35401A with base castings of REV T onwards do not require packers to raise the tape drive mechanism.

- The clip securing the flexible PCB has been redesigned to prevent the PCB catching on the autochanger mechanism (see service note 5).

- A new eject solenoid and self-locking pin have replaced the old eject solenoid, bracket

and collar (see service note 5). Figure 11-5 shows the original mechanism.

Fig 11-5. Eject Solenoid & Collar

- Metal clips have replaced the plastic retainers used to retain the selector arm lever in its channel.

11-2. REPLACEABLE PARTS

The replaceable parts which differ from the present version include:

35401-60004 Door Assembly
35401-60007 Door Latch Assembly
35401-60010 Eject Solenoid and Bracket
35401-60012 Front Panel Assembly
35401-60018 Bowden Cable Assembly
35401-40003 End Panel
35401-80044 Door Lock Clip
              (now a Door Opener Tab).

Parts which are no longer replaceable (as separate items) include:

35401-80024 Door Latch Solenoid
09144-65209 Capstan Motor and Tachometer
35401-60015 Vertical Spring and Drum Assembly
35401-20015 Eject Solenoid Collar
35401-60011 Horizontal Carriage Assembly
35401-80022 Horizontal Drive Belt
35401-80012 Vertical Drive Belt
35401-61000 Vertical Motor

35401-61000 Horizontal Motor
35401-80017 Huco Coupling

11-3. UNPACKING AND REPACKING

The cartridge magazine comes installed in the front door. The door is held shut by the packaging. Two red plastic clips on the top edge of the door prevent it from latching. Once the foam end-pieces have been removed, open the door and remove the plastic clips.

Pull out the cartridge magazine, noting the cord attached to its bottom. This cord is attached to a black, plastic coated transit clip which secures the autochanger mechanism. Pull the cord and detach the clip, freeing the mechanism. Detach the cord from the magazine and store it, in case the drive requires future shipping. Remove the foam block from the magazine. The Tape Drive is now fully unpacked.

If any items are incorrect or missing, please accompany all enquiries with the following information:

- Original order number or unit serial number
- Receiving address

If, for any reason, the Tape Drive is to be returned to Hewlett Packard it should be sent back in its original packaging.

REPACKING INSTRUCTIONS

8) Remove ALL cartridges from the magazine.

9) Identify the spring clip which holds the interior platform steady. In demo units there are two of these clips, coated in black plastic and with a length of cord attached. Later shipments will have a single wider clip, also with a length of cord attached.

10) Pass the cord through the magazine handle and feed the spring clip(s) through the loop in the cord. Pull tight, so that the clips are tied to the magazine by about 1/2 meter of cord.

11) Insert the foam block into the magazine.

12) Reach through the front door and fix the spring clip so that it clips the moveable platform (which has a Serial Number Label attached to it) to the frame at the bottom. Note that the platform must be in its lowest position.

13) Slide the magazine down through the front door, BUT DO NOT CLOSE THE DOOR. Ensure that the cord is NOT trapped under the magazine. This could cause the magazine to sit high and jam the door shut. If this happens, you can open the door by pushing down on the magazine and pulling the door open at the same time.

14) Slide the two red plastic clips onto the flanges at the top of the door on either side of the installed magazine. If fitted correctly, they will prevent the door from staying closed.

15) Place the drive in its plastic bag and fit the foam end pieces. These keep the door closed.

16) Lower the drive carefully into the box. Place the foam top piece on top. Place the accessories box in the depression in the top piece and close and seal the box.

11-4. DISASSEMBLY

Figure 11-6 shows the order of disassembly for earlier versions of the HP 35401A. When using this chart, refer to chapter 6 in the main body of this manual for appropriate safety warnings and cautions.
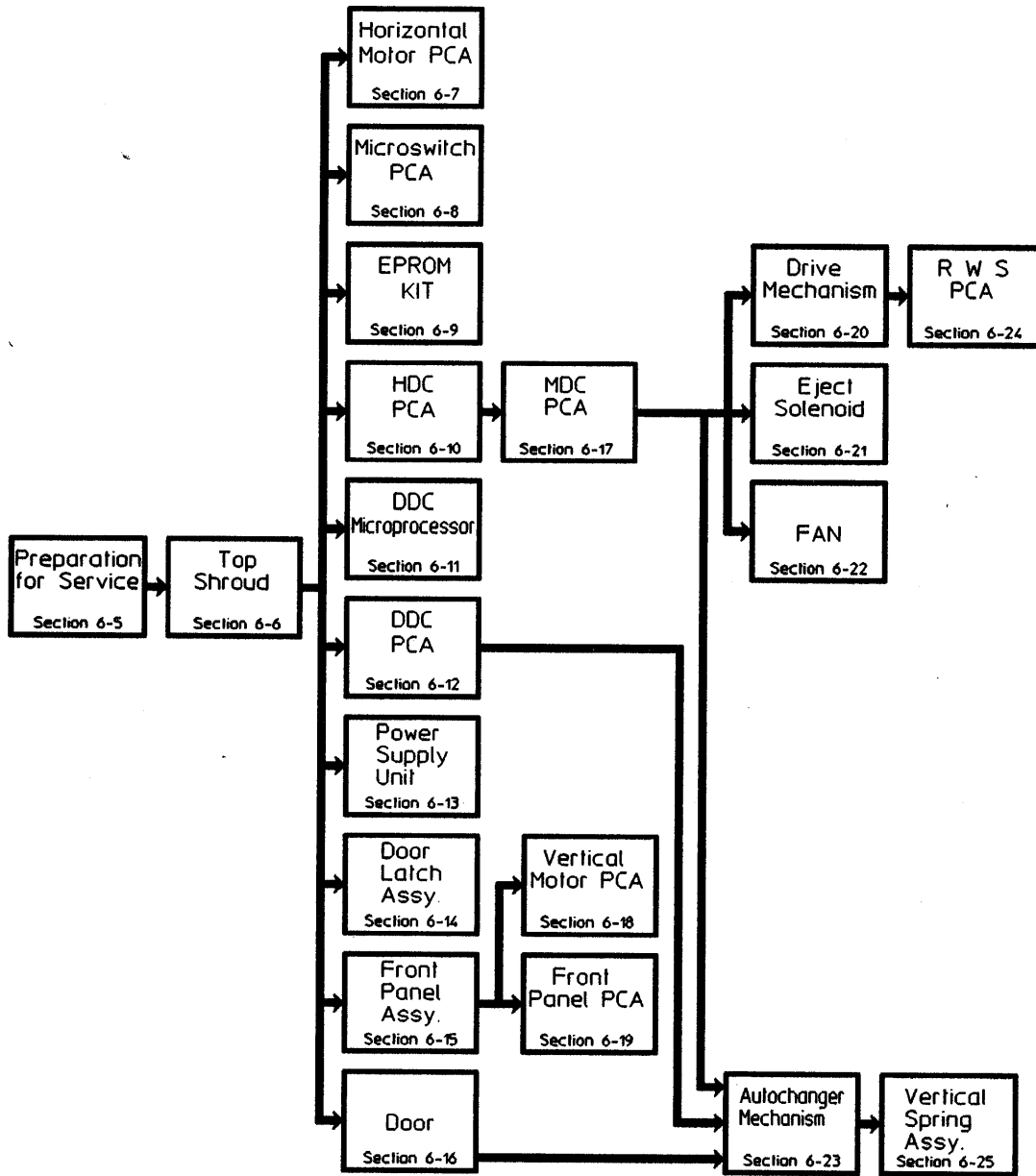
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                    ┌─────────────┐
                    │ Horizontal  │
                    │ Motor PCA   │
                    │             │
                    │ Section 6-7 │
                    └─────────────┘

                    ┌─────────────┐
                    │ Microswitch │
                    │    PCA      │
                    │             │
                    │ Section 6-8 │
                    └─────────────┘

                    ┌─────────────┐                ┌──────────────┐   ┌──────────────┐
                    │   EPROM     │                │   Drive      │   │   R W S      │
                    │    KIT      │                │  Mechanism   │   │    PCA       │
                    │             │                │              │   │              │
                    │ Section 6-9 │                │ Section 6-20 │   │ Section 6-24 │
                    └─────────────┘                └──────────────┘   └──────────────┘

                    ┌─────────────┐  ┌───────────┐ ┌──────────────┐
                    │    HDC      │  │   MDC     │ │   Eject      │
                    │    PCA      │→ │   PCA     │ │  Solenoid    │
                    │             │  │           │ │              │
                    │ Section 6-10│  │Section 6-17│ │ Section 6-21 │
                    └─────────────┘  └───────────┘ └──────────────┘

                    ┌─────────────┐                ┌──────────────┐
                    │    DDC      │                │     FAN      │
                    │Microprocessor│               │              │
                    │             │                │ Section 6-22 │
┌───────────┐ ┌──────┐│ Section 6-11│               └──────────────┘
│Preparation│ │ Top  ││
│for Service│→│Shroud││┌─────────────┐
│           │ │      │││    DDC      │
│Section 6-5│ │Section 6-6│   PCA     │
└───────────┘ └──────┘│ Section 6-12│
                    └─────────────┘

                    ┌─────────────┐
                    │   Power     │
                    │   Supply    │
                    │   Unit      │
                    │ Section 6-13│
                    └─────────────┘

                    ┌─────────────┐ ┌──────────────┐
                    │   Door      │ │  Vertical    │
                    │   Latch     │→│  Motor PCA   │
                    │   Assy.     │ │              │
                    │ Section 6-14│ │ Section 6-18 │
                    └─────────────┘ └──────────────┘

                    ┌─────────────┐ ┌──────────────┐
                    │   Front     │ │   Front      │
                    │   Panel     │→│  Panel PCA   │
                    │   Assy.     │ │              │
                    │ Section 6-15│ │ Section 6-19 │
                    └─────────────┘ └──────────────┘

                    ┌─────────────┐          ┌──────────────┐ ┌──────────────┐
                    │             │          │ Autochanger  │ │  Vertical    │
                    │   Door      │          │  Mechanism   │ │   Spring     │
                    │             │          │              │ │   Assy.      │
                    │ Section 6-16│          │ Section 6-23 │ │ Section 6-25 │
                    └─────────────┘          └──────────────┘ └──────────────┘
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Figure 11-6. Order of Disassembly

SERVICE NOTE 1

Dated: 12th April 1986

Units affected: All units prior to S/N prefix 2645E

New ROM Update Kit: P/N 35401-10302

Contains:
1 - EXEC EPROM
1 - 35401-89504 MDC EPROM (U161)
1 - 35401-89604 MDC EPROM (U131)

FIRMWARE UPDATE
(Required for HP3000 & HP9000 systems)

Purpose:

This service note documents a ROM firmware update to the HP 35401A which is required to support this product on the HP3000 and HP9000 Computers. Beginning with serial number prefix 2645E, the HP 35401A 1/4 inch cartridge autochanger will be produced with firmware which finalizes the support of the drive on the HP3000 and HP9000 computer systems.

Problem:

If an HP 35401A contains "old" firmware, the following might happen:

HP3000 Systems

1) The first tape of a HP3000 SYSDUMP or the last tape of a HP3000 STORE might be overwritten if a powerfail occurs while the tape is going through the unload sequence. In this instance, the tape would go through a load sequence when power is restored instead of completing the unload sequence.

As a consequence of this, the first tape of a SYSDUMP would be overwritten by data destined for the second tape, or the last tape of a STORE set would be overwritten by a further STORE process being started.

2) If a write-protected cartridge is detected during a multi-cartridge write operation, an error condition may occur which would display an "F" in the HP 35401A's front panel status display. This error will cause the tape operation to abort.

HP9000 Systems

1) On the HP9000/500 HP-UX systems the HP 35401A may appear to hang under the following condition. If a 600ft tape is unloaded, and the next tape is 150ft, then the front panel display will remain showing LOAD, READY and the number of the tape.

SERVICE NOTE 1 (continued)

Solution:

If an HP 35401A with a serial number prefix prior to 2645E is configured into an HP3000 or HP9000 system, then an upgrade to firmware is needed. An upgrade kit, part number 35401-10302 is available from CPE/PCE. It contains the Exec Eprom as well as the two MDC Eproms.

CPB (Div C600) will accept billings for 0.5 hour labor, travel and the cost of the upgrade kit. The Customer Service Order (CSO) must contain the system serial number.

SERVICE NOTE 2

Dated: 2nd June 1987

Units affected: All units

New Part Number: 35401-60018
Replaces Part Number: 35401-80038

ЗOWDEN CABLE/COUPLING ASSEMBLY

Purpose:

To inform the field of a design change.

Problem:

There is a risk of damaging the bowden cable assembly while changing the power supply in the field.

Solution:

The design of the bowden cable assembly has been improved to eliminate the risk of damage. Up to serial prefix number 2647E01650 it is strongly recommended that if the power supply is changed, the bowden cable is also replaced using P/N 35401-60018.

Action:

NOTE ON FITTING THE BOWDEN CABLE ASSEMBLY TO THE POWER SUPPLY

It is important that the screw clamping the plastic power switch extension shaft is only tightened to hand tight, otherwise the plastic can snap.

<div style="border:1px solid black">

SERVICE NOTE 3

Dated: 7th July 1987

Units affected: All units

DOOR LOCK MECHANISM

Purpose:

To inform the field of a design change.

Problem:

Unreliable door lock mechanism.

Solution:

The design of the door lock mechanism has been changed to improve reliability, simplify the manufacturing process and reduce the manufacturing cost. The new design mechanism is fitted to all drives from serial number 2706.
The new design mechanism is backwards compatible with the old door lock, and fitting is exactly the same. The old style mechanism locked the door on both sides, whereas the new mechanism locks on the right-hand side only. This eliminates the need for the left-hand lock lever and connecting bar. The two solenoids will still be fitted until manufacturing stocks are exhausted. The design change also eliminates the need for the left-hand door lock packing clip.

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SERVICE NOTE 4

Dated: 3rd June 1987

Units affected: All units

New Part Numbers:
09144-89324
09144-89524

Replaces Part Numbers:
09144-89209
09144-89519

FIRMWARE CHANGE TO REV 10

Purpose:

To inform the field of a design change.

Problem:

During the manufacturing process of the HP 9144A, it has been noticed that a tape will sometimes despool while being loaded into the mechanism. This problem is of no concern to the customer, after the tape has been successfully loaded.

Solution:

The problem has been fixed by changing the firmware code in the HDC. If this problem is seen in the field, the firmware should be updated to p/n 09144-89324 and 09144-89524. The new firmware has been incorporated into the drives with serial number prefix 2721E onwards, and these drives should not exhibit the problem of despooling.

We do not believe that this problem will be seen in the field, but if it is, please call Technical Marketing at CPB on 44 272 799910.

SERVICE NOTE 5

Dated: 10th November 1987

Units affected: All units

DESIGN CHANGES

Purpose:

To notify the field of 4 design changes that have been made to the HP 35401A tape drive. These changes are currently in production and can be made to all units existing in the field today.

Action:

1. BOWDEN CABLE CHANGE

New Kit Part Number: 35401-67200
Replaces Part Number: 35401-60018

Service Inventory: Return for Update

A change has been made to the way the Bowden cable, attaching the front panel switch to the PSU, is secured to the brackets at either end of the cable. This ensures that the ON/OFF switch operates successfully, without fouling on the front panel moulding.

Details for installing the new Bowden cable will be included with the parts in the kit.

2. RAISE TAPE MECHANISM

When loading a cartridge into the tape mechanism, there can be a problem with the cartridge base plate catching on the mechanism guides. This can be solved by raising the mechanism using "packers".

If you see this problem in the field, please contact CPB Technical Marketing (44 272 799910 or via the desk node CPB SUPPORT /HPC600/06) with details of the fault and your name and address. We will then send you the "packers" and details for installing them.

Please note that this item is not set up as a replaceable part and can only be obtained from CPB.

(For reference, the internal part number is 35401-00024).

SERVICE NOTE 5 (continued)

3. FLEXIBLE PCB RETAINING CLIP

The clip has been redesigned to ensure that the flexible PCB always springs in an upward direction to avoid it becoming trapped between the autochanger horizontal arm and the tape mechanism.

NOTE: This part is not a field replaceable item. This information is to inform the field that the clip design has changed from unit serial number prefix 2752, and that exchange autochangers also after this prefix will have the new design.

4. EJECT COLLAR

New Part Number:
35401-80063 PIN
35401-80064 EJECT SOLENOID

Replaces Part Number:
35401-20015 EJECT COLLAR
35401-60010 EJECT SOLENOID

Service Inventory: Return for Update

This change has been made to resolve the problem where the eject collars have fallen off and the unit has been unable to load cartridges into the tape mechanism. A new self-locking pin has been introduced, and hence a new eject solenoid has been introduced with a longer pin and countersunk hole to accomodate the pin.

This change has been performed on drives from serial number prefix 2748 or later.

SERVICE NOTE 6

Dated: 7th July 1988

Units affected: All units

NEW DOOR ASSEMBLY

Purpose:

To notify the field of the introduction of a new door assembly fitted to the HP 35401A. This is fitted to all units with a serial number prefix of 2818 or later.

The new door has undergone a design change for improved operation and reliability. A new form of damping is used, giving even damping over the opening range. The locking assembly is also changed to one of a positive lock.

Solution:

There are five major assemblies in the redesigned door assembly. These are available using the following part numbers.

Governor Arm Assembly	35401-60031
Control Panel Assembly	35401-60032
Door Lock Bracket Assembly	35401-60033
Door Assembly	35401-60034
Right Hand Panel Assembly	35401-60035

A kit of these parts will be available, along with the necessary fasteners, alignment tool and fitting instructions. This is for upgrade from the previous design. A service note will be issued when this kit is available.

SERVICE NOTE 7

Dated: 16th August 1988

Units affected: All units

FIRMWARE UPGRADE

Purpose:

To inform the field of a firmware upgrade on the HP 35401.

Problem:

With the introduction of the HP 9145 32-track 1/4-inch tape drive, a new 32-track XTD cartridge is to be used. These cartridges cannot be used in 16-track drives. This change ensures that the hardware fault flag is set in the drive if a 32-track cartridge load is attempted.

On less than 1% of 3000 systems booting with 1/4-inch tape, drive message sequence errors or watchdog timer errors have occurred. This can be overcome by reloading the tape. By implementing this firmware change, the transfer length is prevented from being altered during the freeload, thus eliminating the problem.

Solution:

All drives manufactured with a serial number prefix 2823E will have updated unit code firmware that resolves both the above problems. This firmware is located on the Host Dependent Controller PCA (HDC). The upgrade is available as follows:

35401-10303 MERLIN ROM KIT containing:

    35401-89505 EPROM REV E
    35401-89605 EPROM REV E
    35401-89701 EPROM REV A

This is an upgrade of the previous kit: 35401-10302.

Diagrams

All the diagrams in this manual are to be found distributed throughout the text, as near as possible to the relevant text.

HEWLETT PACKARD