P/N 07908-60340

TAPE MODULE

Series Code 2349

ER43 DH:C6/50A

HEWLETT-PACKARD CO.

NOTE: This page provides a running history of changes for a multi-page drawing which cannot conveniently be re-issued completely after each change. When making a change, list for each page all before-and-after numbers (within reason; use judgement, and use "extensive" revision note if loss of past history is tolerable, or retype complete page) and associate with each a symbol made up of the change letter and a serial subscript to appear here and on the page involved (there enclosed in a circle, triangle, or other attention-getting outline). (L430)

LTR	REVISIONS	DATE	INIT	MF
A	AS ISSUED PER PCO 48-6074	12/16/82	clr/ML	M

A	48-6074	clr/[illegible]	12-16-82	MODEL 7908	STK # 07908-60340
				HCD-75 DMI ERS	
				BY	DATE FEB 13, 1984
LT	P.C. #	APPR	DATE	APPD	SHEET # 1 OF 21
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HCD-75 DRIVE MODULE INTERFACE ERS
(07908-60140)

GENERAL DESCRIPTION

This document describes the HCD75 (3M Company Product No.) cartridge tape drive interface to our Controller. A brief description of the DC600HC preformatted cartridge used by the drive is also included.

The Controller referenced in this document consists of the following elements:

MICROPROCESSOR Assy
(or equivalent)

DMA Assy
(or equivalent)

TIB Assy

The cartridge is pre-recorded by a full width recording device which writes completely across the full one quarter inch width of the tape. The 600 foot tape length is divided into three areas. There is a unique "Beginning of Tape" (BOT) pattern area at the front of tape, a unique "End of Tape" (EOT) pattern area at the end of tape and a data area for user recording. The data area is divided into 4114 erased areas which are separated by identifying key marks. It is important that the BOT, EOT and short key recordings should not be erased in user recording. The 4114 erased areas between keys are each approximately 1.75 inches long. Four thousand ninety six of these areas can be recorded by the user on 16 tracks across the width of the tape. A movable write-read head on the drive will select the desired track. Fifteen areas are reserved for system diagnostics and usage.

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GENERAL DESCRIPTION (Continued)

Serpentive recording is used. This method writes and reads forward on even numbered tracks, and reverse on odd numbered tracks (the 1st track is 0). This method saves rewind times by using the 600 feet of recording area in a continuous flow.

The keys identify the record areas in ascending numerical order from BOT. Key zero is near BOT. Key 4112 is near EOT.

Nearly gapless recording can be employed by the user. Small gaps must be provided to inhibit the possibility of speed variations accidently erasing the keys. A read operation is always required before writing occurs. The recording zone must first be identified.

The drive module is cabled with a 50 pin flat cable. No termination resistors are used, but tri-state drivers will function well over a maximum 15-foot cable length. The Controller has all its drivers in the constant enable mode; the drive must not see the tri-state condition. It must see only one of the two T.T.L. levels.

After a power up reset, the drive will wait for cartridge insertion and then execute an automatic cartridge load sequence. This sequence starts at the end of tape area and takes about two minutes to execute. The purpose is to condition the cartridge, set the electronic gain control, and locate a positive reference for track location. After this sequence, the drive will "park" at BOT and wait for commands.

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HCD-75 DRIVE SPECIFICATIONS

MEDIA: DC600HC or DC615HC Data Cartridge

POWER SUPPLY: NOMINAL CURRENT (AMPS)

	IDLE	RUNNING	SURGE
+5VDC -2%/+5%	1.5	1.5	
+12VDC -5%/+10%	0.13	0.75*	3.5 (45 MS,@ 60 ips)
		1.0 *	3.5 (80 ms,@ 90 ips)
		1.0 STEPPING*	

* ADDITIVE DEPENDING UPON OPERATIONS

TYPICAL POWER: 9W IDLE

18W RUNNING

WEIGHT: 6 POUNDS

SERVO: 60 ips +/- 3% forward-reverse, 75 mS ramp.
90 ips +/- 3% forward-reverse, 100 mS ramp.

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HCD-75 DRIVE SPECIFICATIONS (Continued)

HEAD STEPPER:	0.00078 inch head movement per step. 19 steps per track, driven at 100 steps per second. 16 tracks on 1/4 inch tape.
HEAD:	Single track, ferrite construction.
RECORDING METHOD:	Serial M.F.M. 10,000 f.r.p.i. max at 60 i.p.s.
TRANSFER RATE:	60 K bits per second (exclusive of gaps).
CARTRIDGE INTERLOCK:	Locked when head is on tape. Released when head is at its lowest mechanical travel.

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HCD-75 DRIVE SPECIFICATIONS (Continued)

OPERATION ENVIRONMENT:

Temperature:	41 degrees Fahrenheit to 113 degrees Fahrenheit (5 degrees Centigrade to 45 degrees Centigrade)
Relative Humidity:	20% to 80% non-condensing
Max Wet Bulb Temp:	79 degrees Fahrenheit (26 degrees Centigrade)

STORAGE/TRANSPORTATION ENVIRONMENT:

Temperature:	-40 degrees Fahrenheit to 149 degrees Fahrenheit (-40 degrees Centigrade to 65 degrees Centigrade)

MEAN TIME BETWEEN FAILURE (M.T.B.F.):

Greater than 10,000 hours

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HCD-75 DRIVE SPECIFICATIONS (Continued)

NOMINAL LIFETIME:

Drive Motor:	Greater than 15,000-600 ft. cartridge cycles
Head:	Greater than 50,000,600 ft. cartridge cycles
Stepper Motor:	Greater than 15,000,000 steps.

MATING INTERFACE CONNECTOR:

3M 3425	Socket Connector (50 Contacts)
3M 3469/50	Flat Cable, 15 Ft. Max.

MATING POWER CONNECTOR:

MOLEX 09-50-3041, housing and three MOLEX 2 GL pins.

Minimum 16 GA. wire, 4 ft. max.

MATING INDICATOR CONNECTOR:

MOLEX 22-01-2085, housing and eight MOLEX 08-56-0110, pins

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HCD-75 DRIVE INTERFACE

COMMAND LINES CMD07 through CMD00

The eight command lines (07m.s.b.) convey the command which the selected drive is to execute. These lines are T.T.L. high true for a binary one. They must be stable on the leading edge of the minimum one microsecond long CSTROBE pulse.

CSTROBE Line

The command strobe line is a minimum one microsecond long T.T.L. positive going pulse which the Controller sends at command transfer. The command data shall be stable on the leading positive edge. The drive will accept the command on the negative going trailing edge.

CACKN Line

The command acknowledge is a positive going T.T.L. pulse which is used to synchronize command transfers. The leading positive edge of command acknowledge will occur on the trailing edge of command strobe. The Controller must wait for the trailing negative going edge of command acknowledge before sending the second byte of a command or before testing status of execution for the present command.

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HCD-75 DRIVE INTERFACE (Continued)

STATUS LINES ST07 through ST00

The eight status lines (07m.s.b.) convey primary and secondary status as well as memory read data from the selected drive. These lines are T.T.L. high true for a binary one.

Normally these lines have primary status in real time and ST07 is a 0. They can then be sensed at any time without acknowledge. If a drive fault condition occurs, secondary status will appear and ST07 will be a 1. Secondary status must be acknowledged. If data is requested, the lines must be sampled and acknowledged only after SSTROBE goes low.

STROBE Line

The status strobe line is a T.T.L. compatible level which is used as a drive busy flag. Status strobe must be low before a command will be accepted by a selected drive. When a command is transferred, status strobe will go high before the trailing edge of command acknowledge. Status strobe will remain high during execution of the command. Status strobe will return low only after command execution is over or when a drive fault has occurred during the execution of the command. For the four motion commands 31, 34, 37, 3A, execution is over after the drive has achieved the requested operating speed.

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HCD-75 DRIVE INTERFACE (Continued)

SACKN Line

The status acknowledge line ia a T.T.L. compatible pulse which is used by the Controller to acknowledge certain drive status transfers. When issued, it is a positive pulse of one microsecond minimum duration. The Controller need only acknowledge these status transfers:

a) Secondary status drive fault transfers as indicated by ST07 = 1.

b) Memory read data transfers upon completion of a 76 command.

It should be noted that drive fault conditions are not tested during (b) above so that ST07 = 1 will not be confused with secondary status. The drive will always revert back to primary status after acknowledge.

SELECT LINES SEL1 AND SEL0

The select lines (1m.s.b.) are T.T.L. high true for a binary one. They are used to select one of four drives for use. They must be stable for all data, status or command transfers. Only one drive at a time can be on the interface.

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HCD-75 DRIVE INTERFACE (Continued)

RESET LINE (Causes cartridge load sequence at all drives).

The Reset line is a T.T.L. compatible pulse which is controlled by the Controller. When issued, it must go high and remain high for one of two designated periods of time. The pulse must have clean T.T.L. compatible edges that do not ring. The trailing negative going edge will cause all drive units to initialize their programs. Communication is lost for 500 microseconds. The drives will once again be able to communicate after this time interval as signaled by SSTROBE going low. These reset pulse durations apply:

(a) During power interruption, reset must go high and remain high for at least 100 msec after power has once again stabilized.

(b) During power stable conditions, the Controller may choose to reset. The pulse must then remain high for 10 microseconds. If head reference has not been lost the drive will not execute the auto load sequence. Drive motion will stop, status will be cleared, and the drive will be receptive to commands.

READ DATA LINE

The read data line is a T.T.L. compatible signal line on which the selected drive places the same M.F.M. polarity signal on playback as was written on tape originally from the write data line. The use of this line is gated by drive select and by RW enable high.

RW ENABLE LINE

This line is a T.T.L. compatible signal line which the Controller places low to write and high to read data at the selected drive.

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HCD-75 DRIVE INTERFACE (Continued)

WRITE DATA LINE

The write data line is a T.T.L. compatible signal line on which the Controller places the M.F.M. write data pattern to be written at the selected drive.

DRIVE INTERFACE PIN ASSIGNMENTS

All odd pins 3 through 49 are ground.

1	CMD00	26	ST02
2	CMD01	28	ST01
4	CMD02	30	CSTROBE
6	CMD03	32	ST00
8	CMD04	34	SACKN
10	CMD05	36	RESET
12	CMD06	38	WRDATA
14	CMD07	40	SSTROBE
16	ST07	42	SEL1
18	ST06	44	SEL0
20	ST05	46	CACKN
22	ST04	48	RDDATA
24	ST03	50	RW ENAB

DRIVE POWER CONNECTOR PIN ASSIGNMENTS

1	+12V	3	KEY
2	GROUND	4	+5V

INDICATOR CONNECTOR PIN ASSIGNMENTS

1	+5V	5	CART IN AND LOCKED
2	FILE PROTECTED	6	DRIVE FAILURE
3	SPARE	7	CARTRIDGE FAILURE
4	DRIVE SELECTED	8	GROUND

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HCD-75 STATUS CODES

The HCD-75 presents two different groups of status codes, primary and secondary. Primary status is presented in real time as the drive is executing commands or is idle. Primary status indicates normal drive operating conditions and is always available on the status lines except for the times indicated below. Secondary status indicates drive or cartridge failure.

(a) Secondary status is placed on the status lines along with STTROBE low. Secondary status will remain until acknowledged, then primary status is returned.

(b) Memory data is placed on the status lines at the end of a 76 command execution and stays until acknowledged. Primary status is then returned.

When data is requested, SSTROBE will go low to indicate that data is ready for transfer. Otherwise, status can be read at any time. The sign bit ST07 should be tested (except for the 76 command) for positive or negative indication to tell whether primary or secondary status is being presented. Primary status is a low (0 bit or plus polarity). Secondary status is a high (1 bit or minus polarity).

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HCD-75 STATUS CODES (Continued)

PRIMARY STATUS

ST07	Always 0, low, positive sign polarity.
ST06	Tape at requested operating speed.
ST05	Head moving
ST04	Cartridge is not ready for use.
ST03	Reserved, except that during Auto load this bit is true (=1) for a file protected cartridge.
ST02	Beginning of tape
ST01	End of tape
STC0	Cartridge automatic load sequence is in progress.

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HCD-75 STATUS CODES (Continued)

SECONDARY STATUS

ST07	Always 1, high, negative sign polarity
ST06	Illegal command
ST05	Abnormal drive motor load
ST04	Abnormal tachometer feedback
ST03	Rom checksum or ram error
ST02	Stepper motor error
ST01	Off tape
ST00	Read amplifier or electronic gain control error.

After the acknowledgement of any secondary status error, except illegal command, the cartridge will be unlocked and the drive will go not ready. The drive will then respond only to:

a. 76 commands
b. Write memory commands
c. 4F command
d. Reset
e. Cartridge out - then cartridge in

Illegal commands will stop motion; however, normal operation can be resumed.

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HCD-75 DRIVE COMMAND LIST

HEX CODE		NO. OF BYTES
04	Put out drive L.E.D.	
07	Put out cartridge L.E.D.	
0A	Unload cartridge (go to E.O.T. then unlock). This command can be used to abort the auto load sequence.	
10	AGC - 14%	
19	Light the drive fault indicator	1
1C	Light the cartridge fault indicator	1
*1F	Head up one step (+127 step tr offset max)	1
*22	Head down one step (-127 step tr offset max)	1
25	A.G.C. -7%	1
28	A.G.C. nominal	1
2B	A.G.C. +7%	1
2E	A.G.C. +14%	1
31	Run tape forward at 60 i.p.s.	1
34	Run tape forward at 90 i.p.s.	1
37	Run tape reverse at 60 i.p.s.	1
3A	Run tape reserse at 90 i.p.s.	1
3D	Stop tape motion	1
43	Unlock the tape cartridge (stops motion). This command can be used to abort the cartridge automatic load sequence.	1
46	Position tape at B.O.T. 90 i.p.s.	1
4C	Position tape at E.O.T. 90 i.p.s.	1
4F	Execute the automatic cartridge load sequence.	1

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HCD-75 DRIVE COMMAND LIST (Continued)

HEX CODE		NO. OF BYTES
70	Set the read base upper byte to a value equal to the second byte of this command. The default selection with reset is 00 so that the user can read any ram cell 0000 to 00FF. This command can be used to set up a prom read transfer of any cell from C000 to CFFF. The data transfer occurs on a subsequent 76 command execution.	2
*73	Move the head to the track specified by the second byte. 00 is the lowest, 0F is the highest track position. This command will clear any head offset prior to track change.	2
76	Transfer the contents of th_ memory cell specified by the second byte (stops motion). The data transfer must be acknowledged. Ram or prom memory can be read. (See 70 command.)	

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HCD-75 DRIVE COMMAND LIST (Continued)

70C0 Set prom read base C0.

7601 Read low prom revision level from location C001.

70C8 Set prom read base C8.

7601 Read high prom revision level from location C801.

7000 Set ram read base.

7602 Stop motion and report cartridge - in - place and file protect switch status on the status lines.

```
7  6 X X X X X X
|  |
|  |_____________ Write permitted (High true)
|
|________________ Cartridge in place (High true)
```

Other ram locations of user interest:

00DD Read per byte which is stored by the 70 command.
00D7 Temporary storage for secondary status of data which is passed over the status lines to the user.
00E3 Primary status storage.
00EE Current track number (00 lowest, 0F highest).

80-B7 Write the second byte into the ram cell specified by the first byte of this command. Ram memory 0080 through 00B7 can be written.

* The end sense circuits are defeated if the head is stepped while the drive is in motion. Tape could run off the hubs.

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HCD-75 DRIVE-ILLEGAL COMMANDS

In the event of an illegal command, drive motion will stop. After status acknowledge is received, normal operation can be resumed. The following list will produce illegal command status:

1. The command is not in the repertoire.

* 2. A command other than write ram, 76, or 4F was attempted when the drive was "not ready", after unlocking the cartridge.

3. Write ram instructions which attempt to write in protected memory are illegal.

4. Forward motion was attempted from EOT or reverse motion was attempted from BOT.

5. The write enable line (RW ENABLE) was low at transfer.

* The 0A or 43 commands can be used to abort the cartridge auto load sequence even though the drive is not ready.

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ADDITIONAL PROGRAM INFORMATION

FORTY THREE AND 0A COMMANDS

The 43 (unlock) or the 0A (unload) commands can be used to abort the automatic load sequence. They will be executed even though SSTROBE is high when issued. The cartridge will be at rest and unlocked when SSTROBE goes low. To resume the automatic load sequence, either execute a 4F command or remove then reinsert a cartridge.

HEAD OFFSET COMMANDS 1F AND 22

These commands can be used to offset the normal head reference. No writing is allowed during head offset. The head will automatically return to normal track reference after a track change command. Even selecting the same track number will return the head to normal reference, provided that the head is not stepped more than +/- 127 steps off normal. Improper track selection will result in future track changes, if these limits are exceeded.

A.G.C. COMMANDS 10, 25, 28, 2B AND 2E.

These commands can be used to alter the normal read amplifier gain. The 28 command returns gain to normal. The amplifier cannot be altered beyond +/- 14% limits.

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ADDITIONAL PROGRAM INFORMATION (Continued)

SECONDARY STATUS

Memory Error

Both ROM and RAM memory are tested following reset. Memory error status is set, if either fails.

Motherboard L.E.D. Indicators

Two indicators on the front of the drive motherboard can be used to isolate possible trouble sources. One indicator is for possible drive problems, the other is for possible cartridge problems. These patterns apply:

CONDITION	DRIVE L.E.D.	CARTRIDGE L.E.D
Reset	ON	ON
Start of auto load sequence	OFF	OFF
Abnormal drive motor load	OFF	ON
Abnormal tach feedback	ON	OFF
Memory error	ON	OFF
Stepper motor error	ON	ON
Off tape	ON	ON
Read ampl. or A.G.C. error in drive	ON	OFF
Read ampl. error due to foreign cartridge	OFF	ON