THE DIGITAL GROUP

C A S S E T T E S T O R A G E S Y S T E M

CSSB-0-RØ

the digital group
po box 6528 denver, colorado 80206 (303) 777-7133

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I. INTRODUCTION

The Digital Group Cassette Storage System is a total magnetic tape data storage and retrieval system capable of controlling up to four Phi-Deck cassette transports and accessing any of over one million 8-bit bytes within 20 seconds, using standard C-30 Phillips cassettes.

The system is ideal for general purpose data and program storage, file copying, editing, and sorting operations. Each deck is fully controlled to prevent tape breakage. Electronic braking precisely controls tapes for fast forward and rewind operations. A 4- to 5-bit translation scheme called Group Coded Recording, allows higher packing densities with a soft error rate of less than one bit in 10^8. This system operates at 1600 flux changes per inch, yielding a data transfer rate of 800 bytes per second at a tape speed of five inches per second.

SPECIFICATIONS

Recording Density:	1600 FCPI (Flux Changes Per Inch)
Data Density:	1280 BPI (Bits Per Inch) using 4- to 5-bit Group Coded Recording
Data Rate:	800 Bytes per second (6400 Baud)
Data Capacity:	250,000 bytes on each side of a C-30 audio cassette 540,000 bytes on each side of 300 foot data cassette
Tape Speed:	5 IPS Read/Write 100 IPS Fast Forward/Reverse
Speed Tolerance:	±20% (i.e., the system will read a tape that was recorded 20% from the nominal speed without adjustment. It will read tapes outside this range by adjusting the data rate control.)
Error Rate:	Soft - less than 1 bit in 10^8 Hard - virtually zero when using the software package supplied with the system and a good quality audio tape
Power:	+5V DC ±5% 1.0 Amps nominal 1 drive 2.0 Amps maximum 4 drives 4.0 Amps peak for .1 second during drive enable +12V DC unregulated (limits: 11V-20V) 0.4 Amp average with tape moving 0.7 Amp peak during motor start

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II. SOFTWARE INTERFACE

Since the absolute method of controlling the cassette system will differ for each installation, only a basic interface will be described. The user can then modify the basic interface to meet his own requirements.

COMMANDS

The command port (see Table 2.1) interprets the various commands into tape motion and activates the read/write electronics. The two select bits, SEL1 and SEL2, select the active deck, according to Table 2.2. The selected deck can only be changed when all decks are stopped (status bit NOT BUSY is on). Otherwise, even though a command may specify a different deck, the original deck will be used. ENABLE/DISABLE (Enable=1, Disable=Ø) controls the deck capstan motors so that they may be turned off under software control. The capstan motors should be enabled during and at least one second prior to any other commands. STOP/RUN (Stop=1, Run=Ø) controls tape motion. The STOP command also takes up slack in the tape. FWD/REV (Fwd=1, Rev=Ø) controls tape direction, and SLOW/FAST (Slow=1, Fast=Ø) controls tape speed. Note that since "slow reverse" cannot be performed, a "slow forward" is automatically substituted. RCD/READ (Record=1, Read=Ø) controls the Read/Write electronics, and ERASE (=1) will erase the tape when RCD is selected. All commands other than the RECORD or ERASE commands should have RCD/READ=Ø to prevent recording spurious glitches on the tape.

Table 2.1

Status and Command Ports

COMMAND PORT			STATUS PORT	
Bit	Definition (1 active)		Bit	Definition (1 active)
Ø	SEL 1		Ø	OVERRUN/UNDERRUN
1	SEL 2		1	READY (data ready or ready for data)
2	1=ERASE			
3	1=RECORD	Ø=READ	2	STOP (possible jam or end of tape)
4	1=STOP	Ø=RUN		
5	1=FORWARD	Ø=REVERSE	3	NOT BUSY (user may change decks)
6	1=SLOW	Ø=FAST		
7	1=ENABLE	Ø=DISABLE		

Table 2.2

Deck Selection

SEL 2	SEL 1	DECK
Ø	Ø	Ø
Ø	1	1
1	Ø	2
1	1	3

STATUS

The status port (see Table 2.1) provides information on the state of the controller. Four status bits are brought out, leaving four input bits for other uses. Two of the bits, STOP and NOT BUSY, supply information on the deck status. STOP is an immediate response to a stop command or a jam. NOT BUSY occurs about a second after STOP turns on, signifying the deck is totally stopped. STOP is used by the software in all cases, except to switch the selected deck, which can only occur in a not busy state. The other two bits are status bits for the read/write electronics. READY indicates that the deck can accept another data byte (in Record) or that a new data byte is in the DATA-OUT port (in Read). READY is reset about one millisecond after it is set. It is also reset by a command, data in, or data out strobe. OVERRUN/UNDERRUN indicates that the computer has not serviced a READY by supplying or looking at the new character within the required time. It will remain set until a new command is issued. It is to be treated in most cases as an error condition.

INPUT DATA (FOR RECORD)

The data input port requests the data bytes which are to be recorded on the tape. The first byte should be loaded either prior to issuing the record command or within about five milliseconds after issuing the record command. Each subsequent byte of data to be recorded should be loaded when the READY status goes high. Loading the new byte will automatically reset the READY line. The byte should be loaded within .5 milliseconds after the READY signal. Otherwise, OVERRUN/UNDERRUN will come on, and the record electronics will go into erase mode. This may be allowed to happen at the end of a data block in order to record an inter-record gap. If a new command is to be given immediately after the last recorded byte, the OVERRUN/UNDERRUN bit must come on before the command is given. If the command is issued earlier, part of the last byte will not be recorded.

OUTPUT DATA (FOR READ)

The data output port is loaded by the read/write electronics with the data being read from the tape. After issuing a read command, the electronics will look for a sync pattern and then load the output port with the first data byte. At this time, READY will go high. When the byte is read, the READY signal will be reset. The byte should be read within .5 milliseconds after the READY signal. Otherwise, OVERRUN/UNDERRUN will come on, and the read electronics will be halted until another read command is issued.

MECHANICAL CONSIDERATIONS

Since the various tape and head movements require certain amounts of time to stabilize, consideration must be given by the software to insure error free read and record operations.

1. Never issue a record command (or turn on the record bit) when the tape is in any state other than slow forward, and the tape is stabilized against the head. The tape may take as much as one second to align itself with the tape guides on the head and an unaligned tape may record errors. A good practice to insure reliable recording is to read the previous block without error. This implies the tape is tracking correctly for the record operation.

2. When issuing a read command which causes the head to come up against the tape, noise and random patterns as the tape becomes aligned may cause false synchronizing and give erroneous read data. Therefore, it is a good practice in this situation to wait about a second, and then reissue the read command, using only the data from this second read command.

3. When recording the first block of data at the start of a tape, issue an erase command, and then time out about five to seven seconds to allow the tape leader to pass before recording data.

4. To allow the recording of two consecutive blocks at different points in time, always go into erase mode after recording the first block for a time longer than the space between blocks. (This is easily done by ignoring the READY after the last byte has been recorded, and timing out for the erase time. The electronics will immediately begin erasing without glitching) When the next block is to be recorded, it is begun somewhere within the erased section, thus preventing any glitching and subsequent false synchronizing on read operations.

The following bit patterns are recommended for issuing the various commands:

	COMMAND	Bit:	ENABLE 7	SLOW/FAST 6	FWD/BKW 5	STOP/RUN 4	RECORD/READ 3	ERASE 2	1	Ø
36	STOP		1	1	1	1	0	0	Selected Deck	
24	FAST FORWARD		1	0	1	0	0	0	(Note: Sel-	
20	FAST REVERSE		1	0	0	0	0	0	ected deck may	
34	READ		1	1	1	0	0	0	only be changed	
35	RECORD		1	1	1	0	1	0	when status bit	
35(44)	ERASE		1	1	1	0	1	1	NOT BUSY is on.)	
16	STANDBY		0	1	1	1	0	0		

III. HARDWARE INTERFACE

Computer Interface

The basic interface of the cassette controller to the computer occurs through four controller I/O ports. These ports may be connected in various schemes to fully utilize the hardware arrangement of the computer.

The computer's output ports connect to the command port and the data-in port. The computer's input ports interface to the data-out port and the status port. Each port has its own strobe line which is used either to strobe information into the internal latch or to activate the tri-state output in order to read the port.

All outputs from the controller will support ten TTL loads, and all data or control inputs are one TTL load, The command strobe is two TTL loads, the data-in strobe is three TTL loads, the status strobe is four TTL loads, and the data-out strobe is five TTL loads. The data-out and status ports are tri-state, activated by their respective strobes. All strobe signals are active low, and should remain high when not in use. The command data-in and data-out strobes should be low for a period greater than 500nsec, but less than one millisecond. A strobe greater than one millisecond is likely to cause false status indication from the read/write electronics.

Some typical connections are shown below. Figure 3.1 depicts a setup where all input and output ports are provided by the computer. Unless all strobes are obtainable from the computer, a third output port will have to be dedicated for software controlled strobe pulses. The scheme in Figure 3.2 uses this strobe port, but takes advantage of a bus system, since the strobes are no longer tied to specific ports but are under software control. Figure 3.3 uses a bus system found on more complex systems. Here, inputs and outputs are shared on the same line and controlled totally by the strobe signals. Care should be taken when using this method not to load the bus beyond its capacity.

Deck Interface

The cassette controller must also be interfaced to the decks. Refer to Figure 5.1 for the wiring of the decks. The board has four separate connections for each of four decks on all pins except ALLCAP, CAPSUPPLY, ALLENGSW, and ALLENGSWGND. The connectors supplied with the deck cables (when decks are included with the controller) will plug into connections for decks Ø and 1. When decks 2 and/or 3 are used, the above signals must be wired into the connector for deck Ø or 1. Also, HDGND is a common head ground, and all cable shields must be terminated at these two pins.

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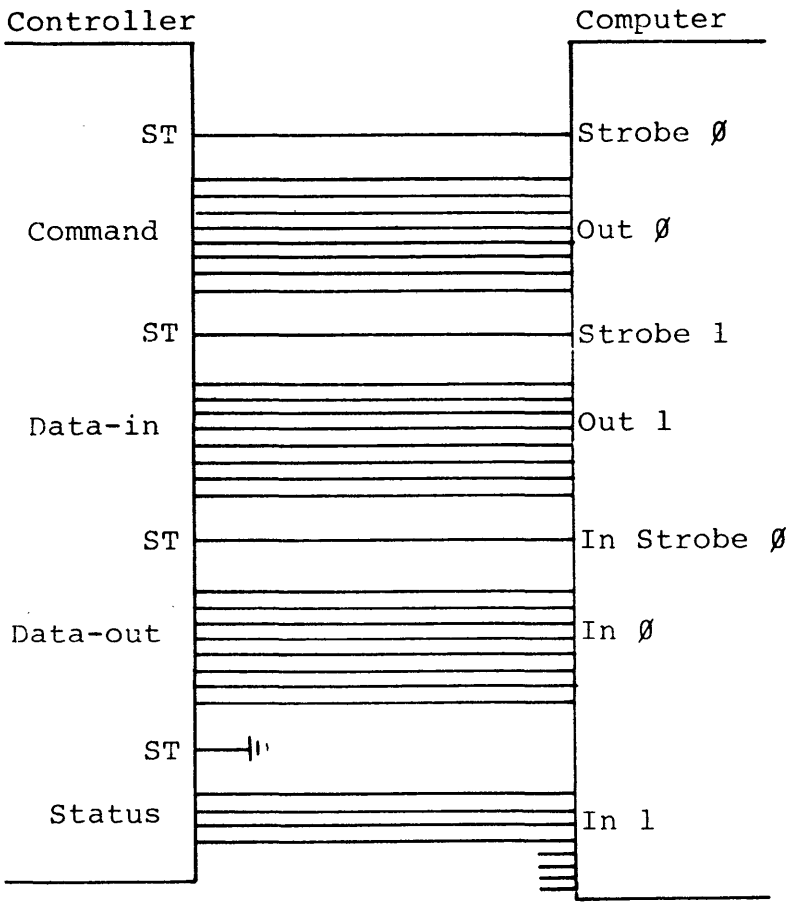

Figure 3.1 Dedicated I/O Ports

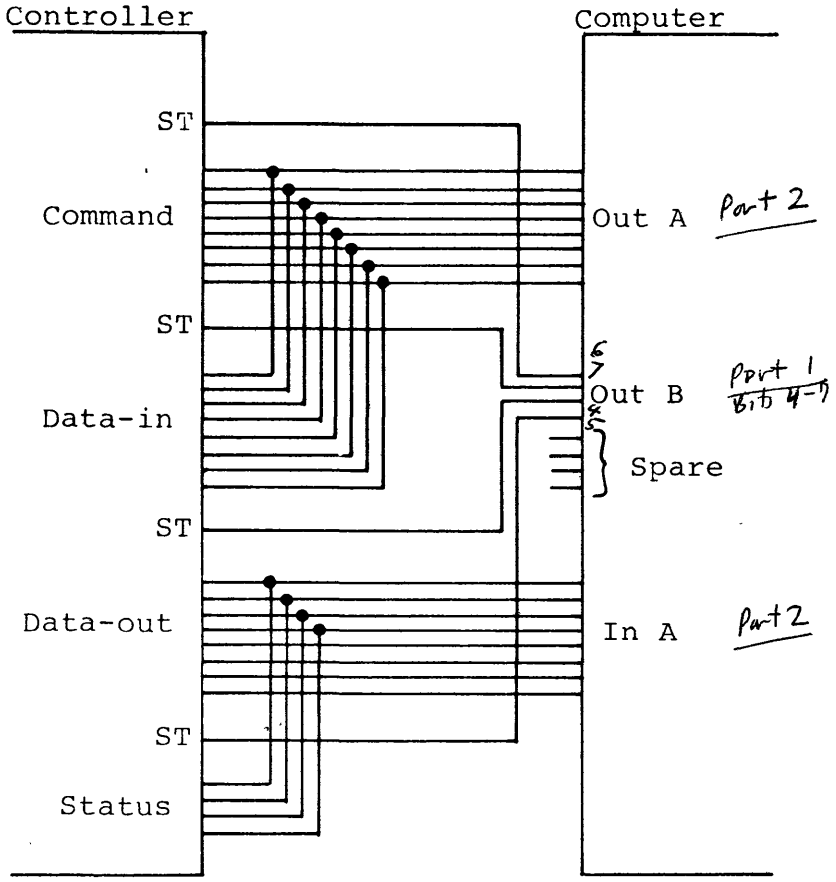

Figure 3.2 Multiplexed I/O Ports with Dedicated Strobes (Used with Digital Group Systems)

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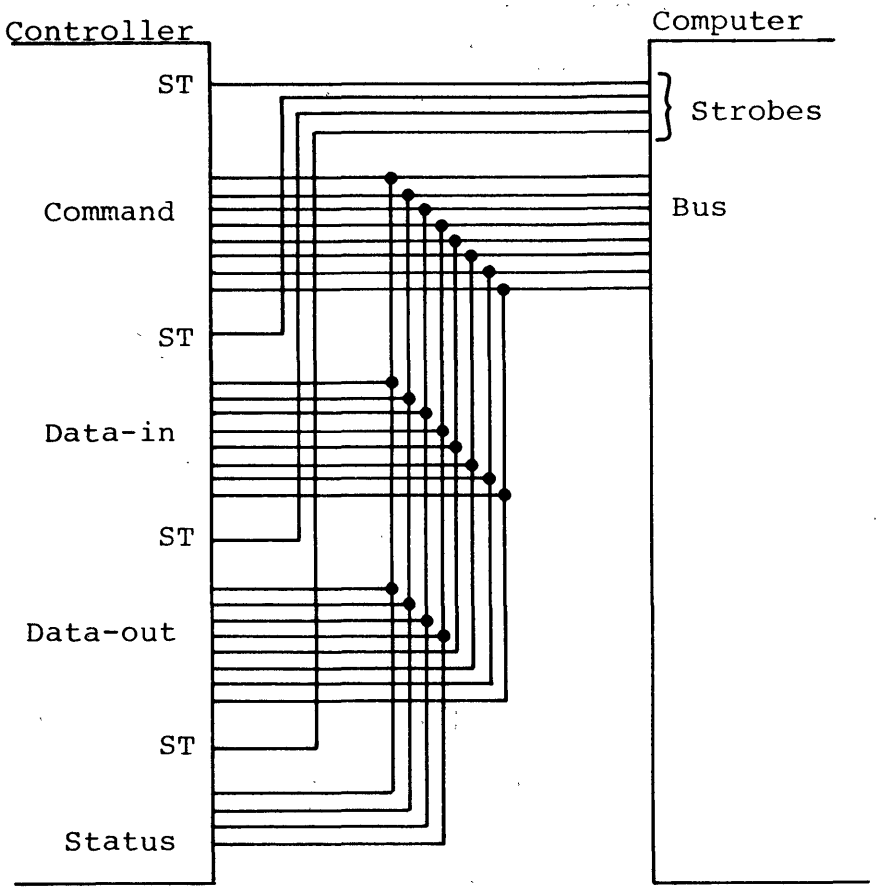

Figure 3.3 Bus Oriented Ports

IV. THEORY OF OPERATION

HEAD ELECTRONICS

The head electronics consists of IC27 and IC28 which drive the head during record and IC13 which amplifies the head signal during read. IC27 and IC28 (75125's) have tri-state outputs which normally are in the high impedence state during a read operation so that they won't influence the low level signal going from the head to the amplifier (IC13). During record, only the sections of IC27 and IC28 associated with the selected drive go into a low impedence state and drive the head in a push-pull manner. R6, R9, R20, and R23 are used to limit the current through the head and should be adjusted for a current of 1.5 times the head saturation current if the standard head is not used. Figure 4.1 shows typical waveforms for the record drivers.

During a read operation, section 1 of IC 13 is used as a pre-amp with balanced inputs and a gain of 3.9. Section 2 is an amplifier with a gain of 22. Section 3 is a low-pass filter and differentiator which produces zero crossings at its output whenever the input signal has a peak. The low-pass filter reduces the differentiator's sensitivity to noise. Section 4 is a Schmitt trigger which detects the zero crossings and produces a TTL compatible signal at its output. Figure 4.2 shows typical waveforms for the read electronics.

BIT SYNCHRONIZING ELECTRONICS

This section of the controller is used to generate the proper fixed frequency clocks for record and variable frequency clocks synchronized to the data during read. The data is also converted from NRZI encoding to level encoding. This section of the electronics consists of IC9, IC37, IC50, IC41, IC42, IC55, IC10, IC11, T13, and associated logic and components.

IC9 oscillates at 14 times the bit rate (it takes ten of these bits for every eight bit data byte that is recorded) and is adjusted using R28. During read, IC37 and its associated reset circuitry divides the OSC signal by 8 if the data is coming in slow, by 7 if the data is coming in on frequency, and by 6 if the data is coming in fast. The incoming data rate is checked every time there is a data bit of value "1". There is no correction for data bits of value "Ø". This compensates for small rapid variations in tape speed. Large speed variations generate a DC error voltage with IC10 and IC11 which is fed back to the control input of oscillator IC9. During record, IC37 divides OCS by 7 and T13 turns off the DC feedback loop.

GROUP CODED RECORDING

Since a flux density of 1,600 flux changes per inch was incorporated, a special effort was made to also increase bit density in a packing scheme which maintains self-synchronization. Figure 4.4 illustrates this convention, group-coded recording, in a comparison with some older methods.

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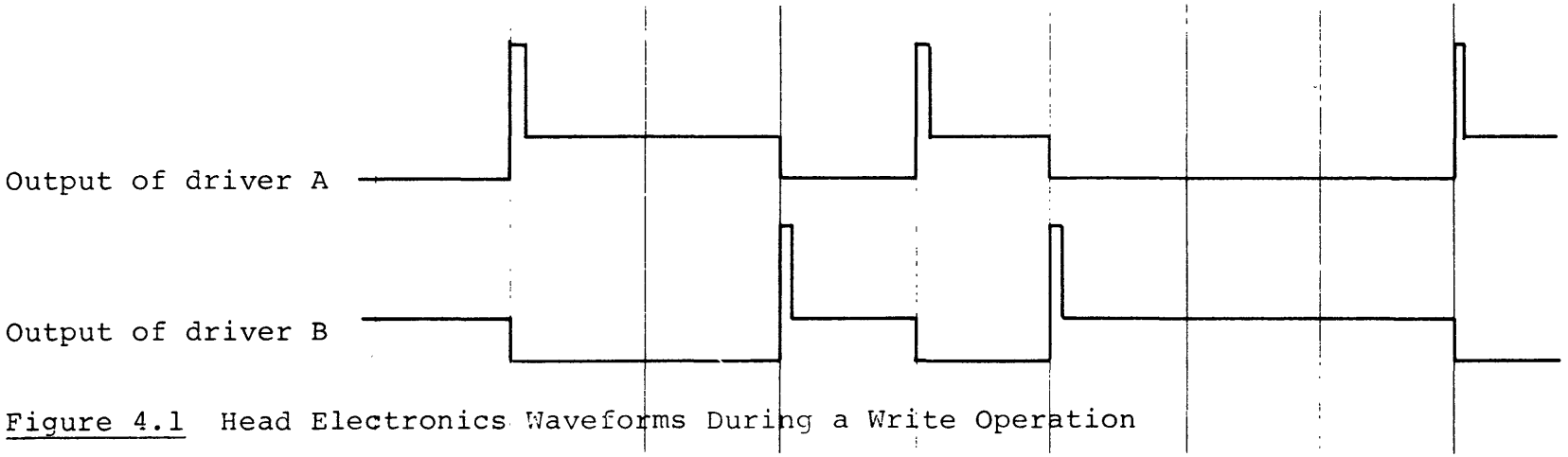

Figure 4.1 Head Electronics Waveforms During a Write Operation

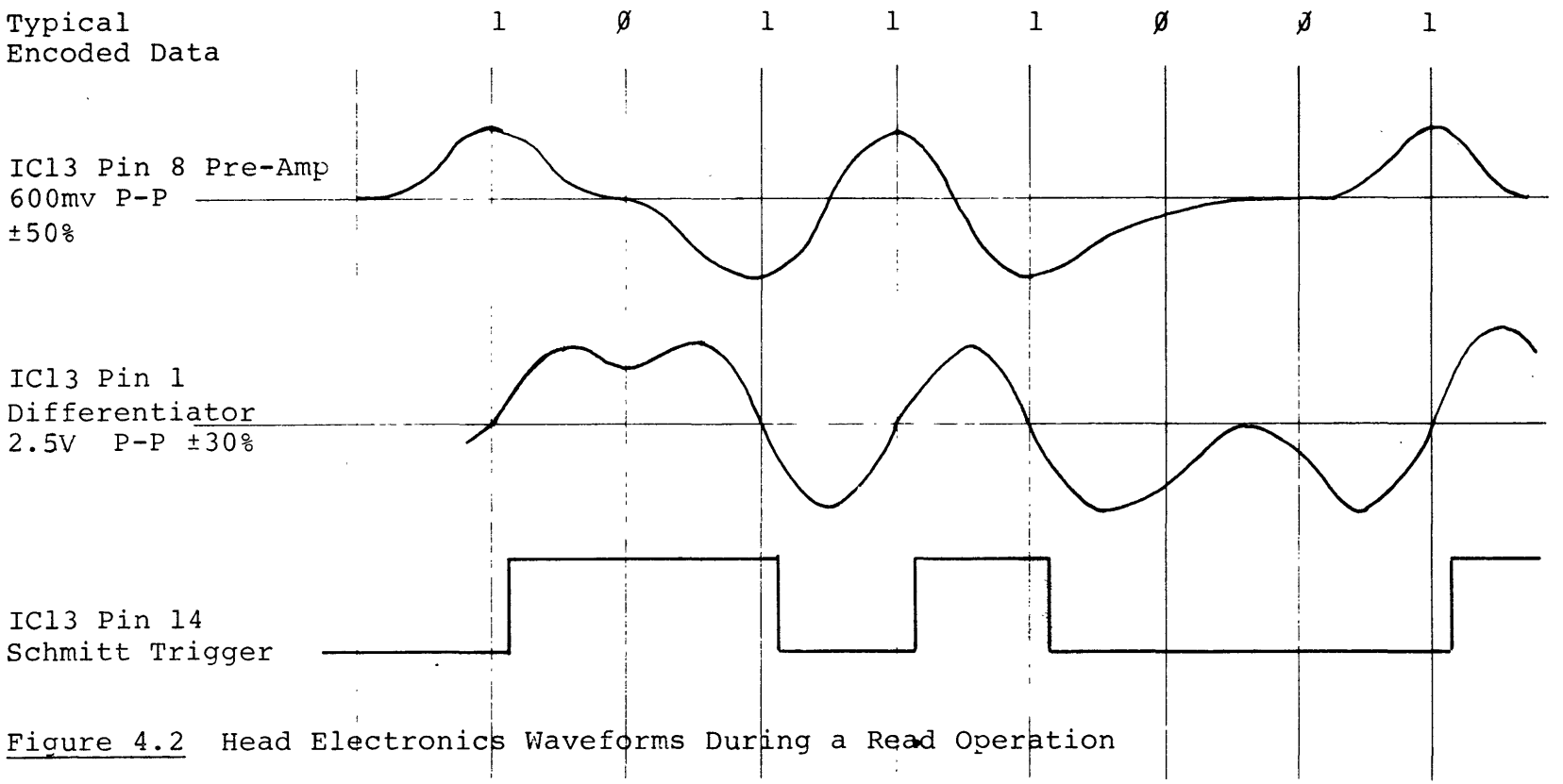

Figure 4.2 Head Electronics Waveforms During a Read Operation

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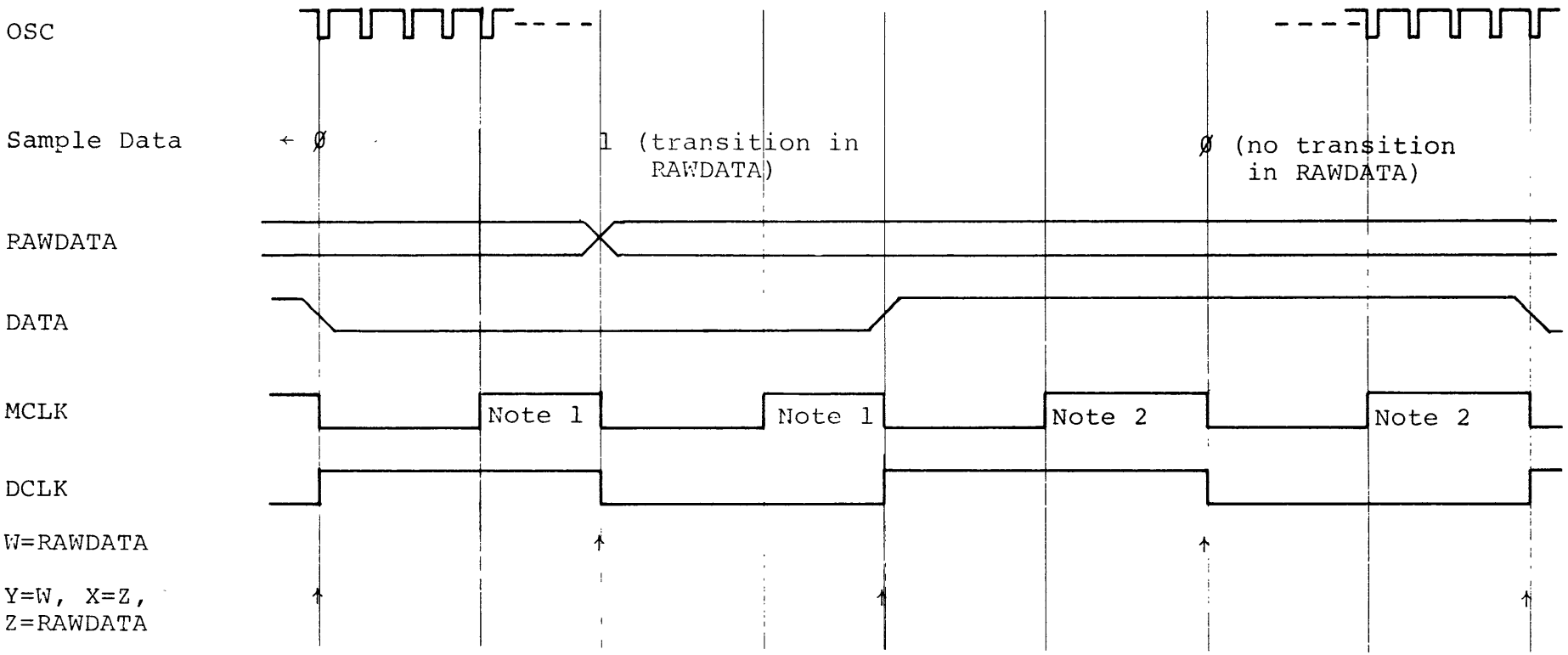

Note 1: This pulse is always 3 OSC cycles if DATA is Ø or RECORDING.
Note 2: This pulse is either 2 or 4 OSC cycles if incoming data is fast or slow respectively and DATA is 1.

Figure 4.3 Bit Synchronizer Timing

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NRZI, non-return-to-zero, illustrates a recording efficiency of 1.0, where recording efficiency is defined as the highest ratio of BPI (bits per inch) to FCPI for a given format. There is, at most, only one flux change per bit. Unfortunately, this is not a self-clocking scheme, and is therefore impractical for use on a cassette system which has inherent speed fluctuations.

PE, phase encoding, was designed to overcome such limitations by providing a flux change at the center of each bit period which would synchronize a clocking circuit. The direction of this flux change indicates whether the bit is a 1 or Ø. The recording efficiency of this method, however, is only Ø.5.

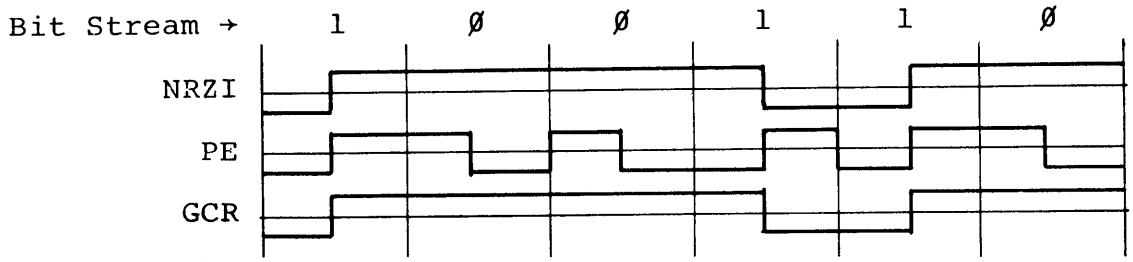

Figure 4.4 Recording Methods

GCR, group-coded recording, at first glance appears very similar to the efficient NRZI method, but with one important difference: No more than two zeros may appear in a row in the bit stream. This guarantees a clock pulse at least once every three bits which provides synchronization. Since a restriction of no more than two zeros in a row cannot be placed on data, a translation scheme is used to encode 4-bit groups into 5-bit groups, and the above restriction is then placed on the 5-bit groups. The translation table is shown in Table 4.5. Since the format is essentially NRZI, we have 4 bits per 5 flux changes, or a recording efficiency of 0.8, which is 60% better than PE.

Table 4.5

4- to 5-Bit Translation Table

4-Bit Data Value	5-Bit Recording Value
0 0 0 0	1 1 0 0 1
0 0 0 1	1 1 0 1 1
0 0 1 0	1 0 0 1 0
0 0 1 1	1 0 0 1 1
0 1 0 0	1 1 1 0 1
0 1 0 1	1 0 1 0 1
0 1 1 0	1 0 1 1 0
0 1 1 1	1 0 1 1 1
1 0 0 0	1 1 0 1 0
1 0 0 1	0 1 0 0 1
1 0 1 0	0 1 0 1 0
1 0 1 1	0 1 0 1 1
1 1 0 0	1 1 1 1 0
1 1 0 1	0 1 1 0 1
1 1 1 0	0 1 1 1 0
1 1 1 1	0 1 1 1 1

RECORDING FORMAT

A synchronous format is automatically added by the electronics to the data being recorded. Of all the 5-bit patterns possible for use in this system, the only pattern not used is 11111. Therefore, this pattern is sent 15 times at the beginning of a data block (75 ones). The purpose of using this pattern is twofold. First, since the start of a block must be found by dropping the head anywhere on the tape, the electronics searches for about 20 ones in a row, and this pattern only occurs at the block start. Second, the ones form a steady clock frequency and allows the self-correcting clocking circuitry to achieve sync in the fastest possible time.

After the ones are recorded, the five bit sequence, 00101, is recorded as a sync character. This particular sequence uniquely defines the absolute start of the block. At that point, the 4 high bits of the first byte are translated to 5 bits and recorded, and then the 4 low bits are translated and recorded. The rest of the bytes are recorded in a similar manner. If a new block is not immediately started, an erase signal will begin after the last byte. Figure 4.6 depicts the format.

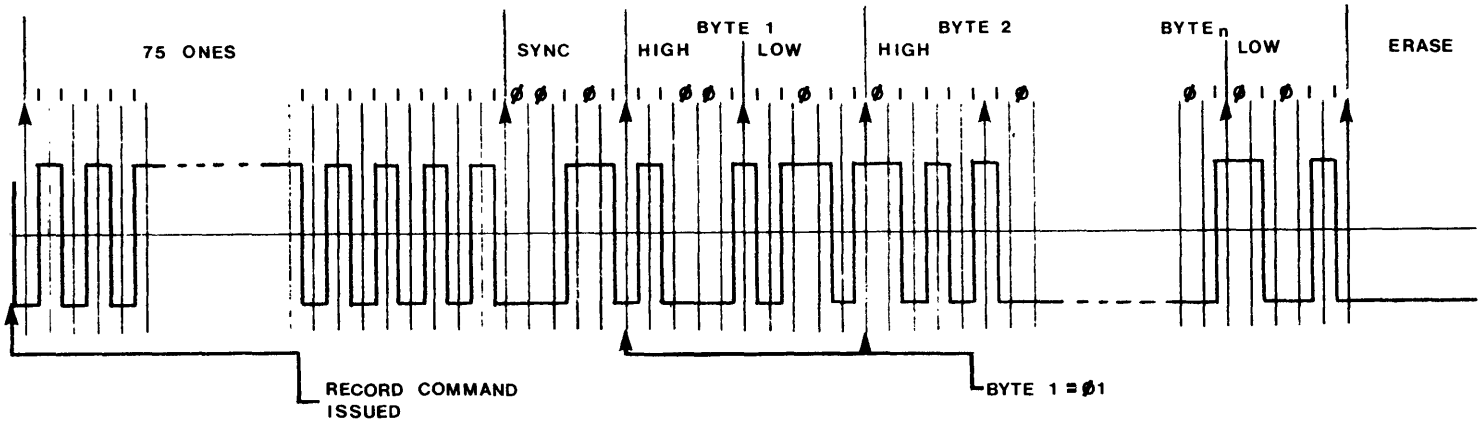

Figure 4.6 Recording Format

DATA FLOW

Record - Data is strobed into IC46 and IC47 with the data input strobe. IC31 and IC32 select the half-byte to be recorded as well as the sync address. IC29 is a ROM which then encodes the 4-bit code into the 5-bit code and sends it to the 5-bit shift register, IC's 30, 5, and 24. The data is then shifted into IC4 which provides the record signal.

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Read - Data from the read circuitry is clocked into the 5-bit shift register (IC's 30, 5, and 24). After each half-byte is loaded, data is routed through the selector (IC's 31 and 32) and into the ROM decoder (IC29). Here, the 5-bit code is decoded back into 4 bits and is loaded alternately into IC43 and IC44 to be strobed out.

CONTROL SEQUENCER

The flip-flops whose outputs are RECORD, RUN, B, and A control the sequence of events in the reading and recording processes. Refer to Table 4.7 for the valid sequencer states. The command strobe forces the "SEARCH FOR ONES" state immediately, and system clocks put the sequencer through the appropriate states when the strobe is removed.

For record mode, the sequencer will go to the "GENERATE ONES" state at the next CLOCK1 pulse. The system then waits for IC's 7 and 20 to count out 75 ones and produce the $\overline{\text{ONESDONE}}$ signal. During this time, the ONES signal forces IC29's chip enable to output all ones into the shift register. After the ones are recorded, "SEND SYNC" is entered which produces the $\overline{\text{SYNC-GEN}}$ signal to load a sync pattern into the shift register. Next, "RECORD A" is entered and selects the high bits of the data byte, loading them into the shift register. Finally, "RECORD B" loads and sends the low bits of the data byte. "RECORD A" and "RECORD B" are then alternately repeated until either the next command strobe, a tape stop or jam, or an underrun condition. The latter two events will force the sequencer to the "GAP" or erase state.

Table 4.7

Valid Sequencer States

	State			
	RECORD	RUN	B	A
Function				
GAP	1	Ø	Ø	1
GENERATE ONES	1	1	Ø	1
RECORD A	1	1	1	1
RECORD B	1	1	1	Ø
SEND SYNC	1	1	Ø	Ø
SEARCH FOR ONES	Ø	Ø	Ø	1
SEARCH FOR SYNC	Ø	1	Ø	1
READ A	Ø	1	1	1
READ B	Ø	1	1	Ø

For read mode, the sequencer remains in the "SEARCH FOR ONES" state until IC's 7 and 20 detect about 20 consecutive ones. If a zero occurs, IC7 is reset and the count begins again. When sufficient ones are found, $\overline{\text{ONEDET}}$ tells the sequencer to go to the "SEARCH FOR SYNC" state. Each read bit is then shifted into IC30 and all five bits in the shift register are selected and routed to the ROM. The SYNC signal occurs when the proper sync bit pattern is found. The "reset to 9" on IC20 is then released and the sequencer is synchronized to the data. Also, the "READ A" state becomes active, and the next five bits of data are shifted in, decoded, and loaded into IC43 as "READ B" is activated. The next five bits are operated on in the same way, except that IC44 is now loaded, and the sequencer goes back to state "READ A."

This sequencer repeats until either a command strobe or an overrun occurs. In the second case, the "SEARCH FOR ONES" state is again forced until the next command strobe.

DATA STATUS LOGIC

READY and OVERRUN/UNDERRUN are controlled by IC21 and only occur at the times the shift register or the data output latches are being loaded. READY is set at the end of state "RECORD B" as the second half-byte of data is loaded into the shift register. It must then be serviced by the time "RECORD A" is entered, since the new first half-byte of data is needed at that point. If READY is not reset at this point (by the input data strobe), OVERRUN/UNDERRUN will latch on.

In read mode, READY is set at the end of state "READ B." It is at this time that the second half-byte of data is loaded into IC44. IF the output data byte is not read before the next half-byte is loaded, the OVERRUN/UNDERRUN flag is latched on.

CLOCKS AND SYSTEM TIMING

There are four major clocking signals derived from a four-phase clock system. MCLK, the master clock, with DCLK, the data clock, generate ECLK, as in Figure 4.8.

IC20 is used to divide DCLK by 5 and get a signal, DIVIDE-BY-5, once every data half-byte. This is combined with other clock phases and sequencer states to obtain the clocks and signals shown in Figure 4.9.

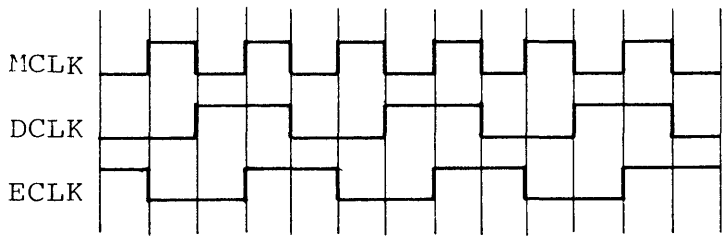


Figure 4.8 4-Phase Clocks

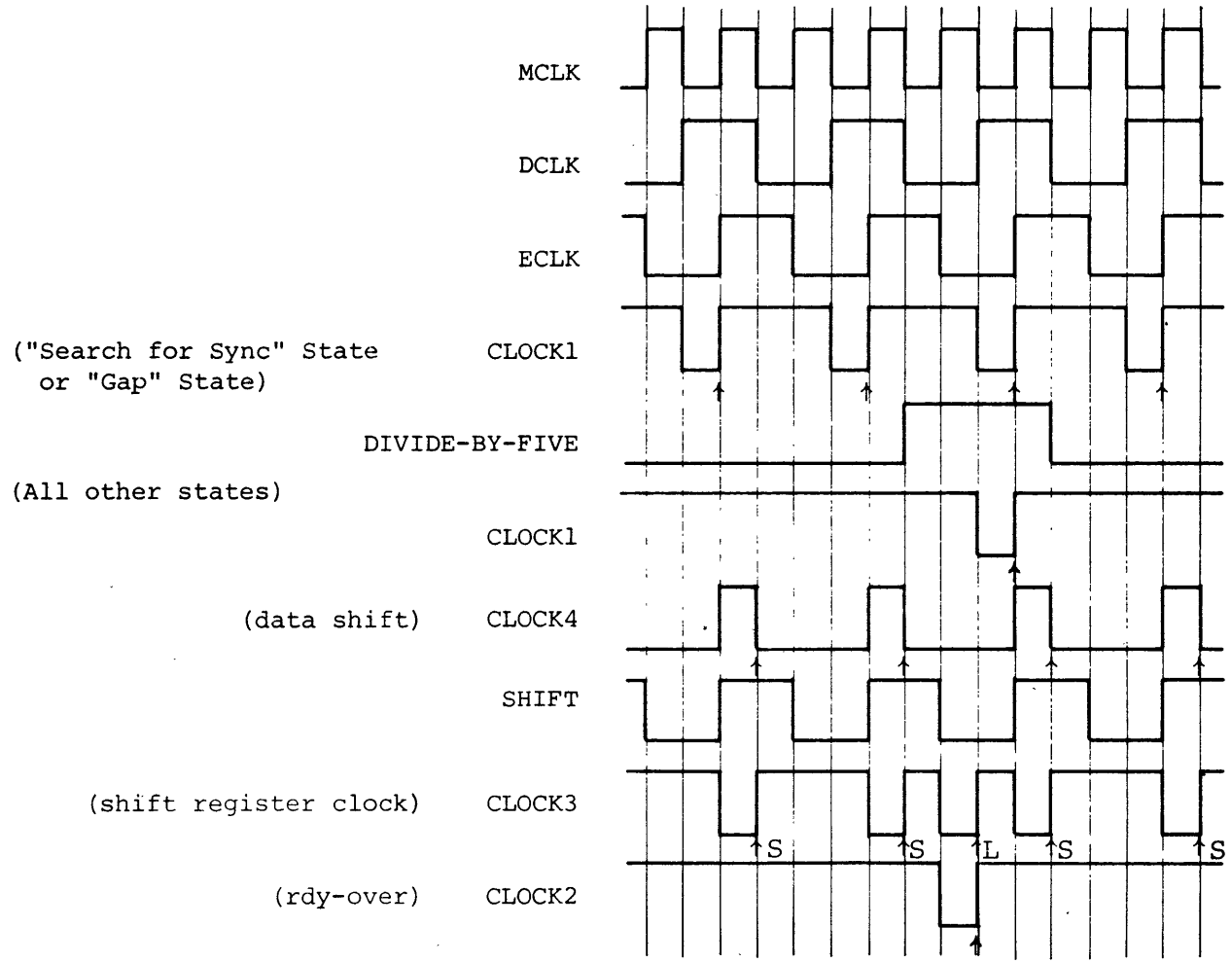


Figure 4.9

SYSTEM CLOCK SIGNALS

MOTOR DRIVE AND SENSE ELECTRONICS

The purpose of this section of the controls is to provide drive to the motors, braking for the motors, deck selection, and sense tape motion for feedback to the motor control electronics.

TAKUPDRV goes to the low state whenever the takeup reel should be driven during read or record. R46 limits the motor torque during this operation. BOTHDRV goes low whenever the motor control electronics senses that the reels should have braking torque applied or that there may be slack tape in the cartridge. R45 limits the torque during this operation. ALCAP is used to turn on the capstan drive motor.

ENGAJDRV goes to the low state whenever the motor control electronics senses that the head and pinch roller should be moved toward or away from the tape. T7, T8, T9, and T10 are used to brake the engage motor whenever it is not being driven. FFDRV and FRDRV are used to drive the tape in the fast forward or fast reverse direction whenever those commands are given.

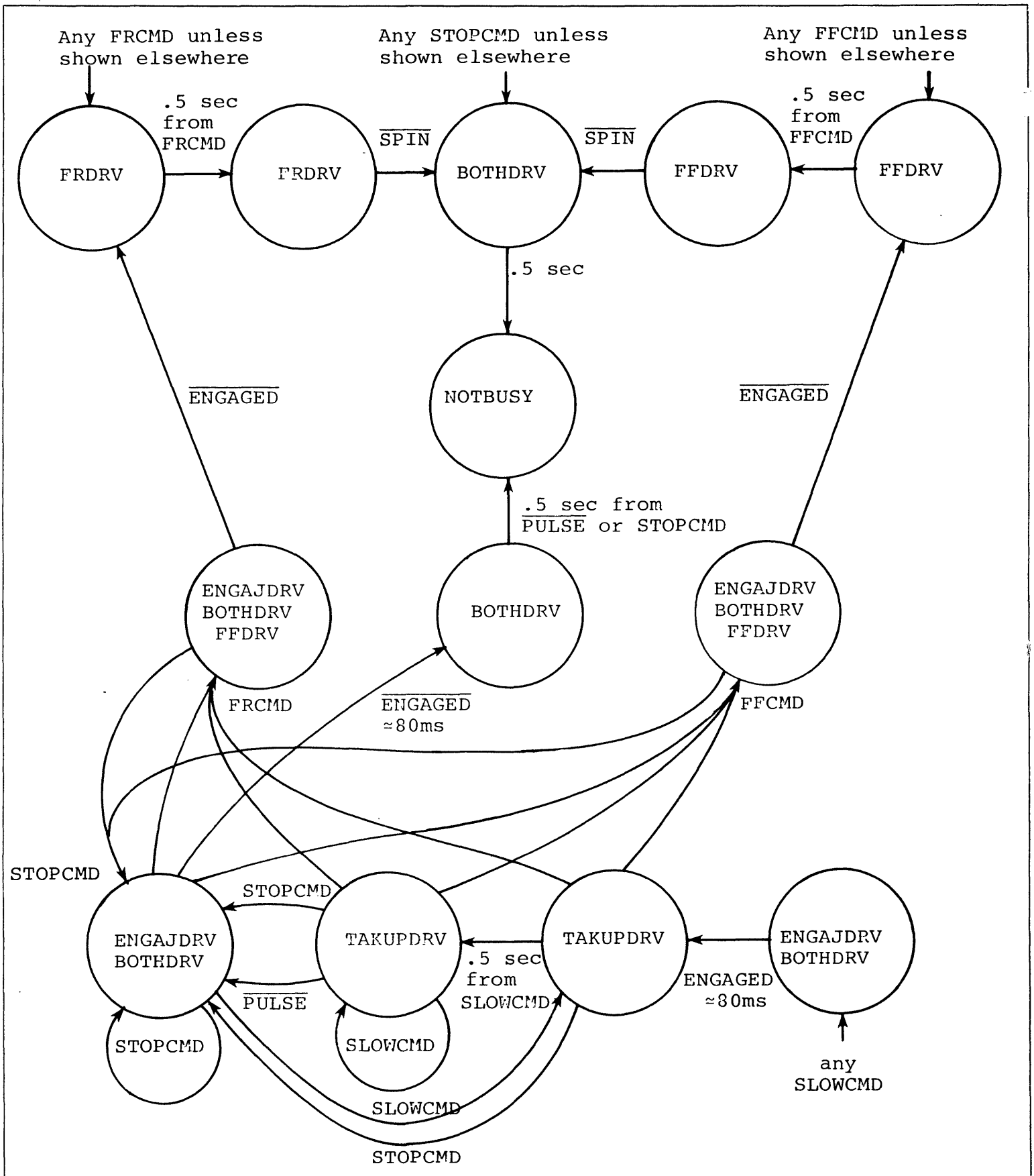
Transistors T2, T3, T4, and T5 in conjunction with steering diodes D1 - D11 and D15 are used to provide drive to the selected deck. Diodes D12, D13 and D14 apply drag to the undriven reel during the fast forward and reverse operations to prevent excessive tape speed and to slow the tape as it nears the end of the reel. Transistors T11 and T12 generate a signal called SPIN which tells the motor control electronics that the undriven reel is turning during the fast forward and reverse operations. The PULSE signal has small negative going pulses on it whenever the takeup reel is turning. This is used to detect tape jams and end of tape during the read, record, or erase operations.

MOTOR CONTROL ELECTRONICS

The motor control electronics senses the status of the tape motion, the position of the headbar, and the commands given by the user and sends control signals to the motor drive circuits. The status bits STOP and NOT BUSY are also generated and sent to the user interface.

The following discussion provides the user with a description of the primary control signals. The user should look at the state diagram given in Figure 4.10 to determine how the deck is actually controlled.

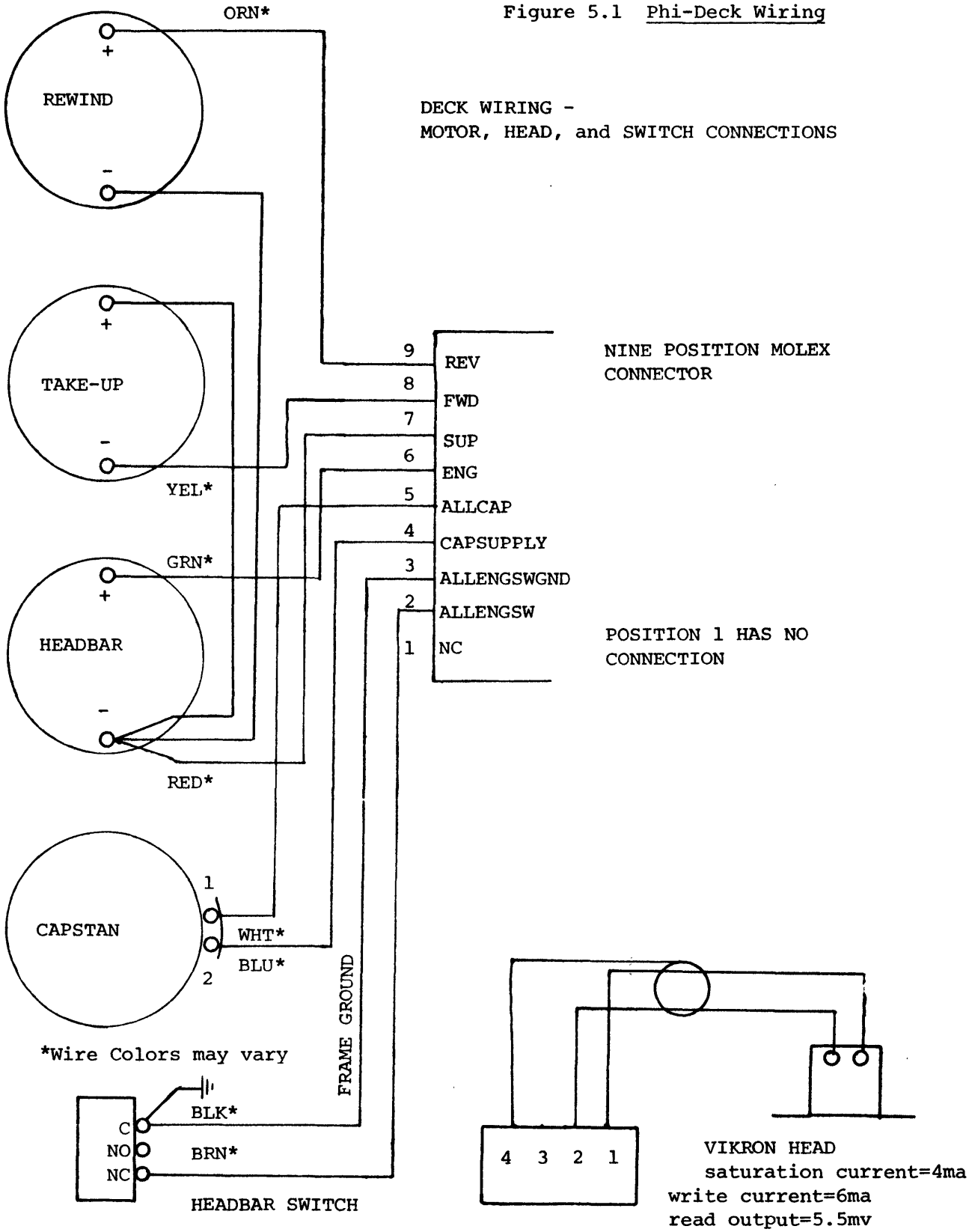
PULSES is generated by a one-shot (IC23) that goes active whenever a command is given and the deck is in the stopped state. PULSES stays active as long as a pulse is received on the PULSE line at least once every half second. If a pulse is not received within the allowed time, $\overline{\text{PULSES}}$ will go to a 1 and cause the deck to go toward the NOT BUSY state. The DELAY signal is also generated by a one-shot (IC23) and is used to inhibit tape motion sensing for 1/2 second after a command is given to allow for the tape to accelerate to the proper speed. This one-shot is also used to time the BOTH signal after a STOP command or tape jam is detected.



Note: Names within circles are motor control signals. Labels on lines indicate commands given by user or events within controller.

Figure 4.10 Motor Control State Diagram

Figure 5.1 Phi-Deck Wiring



NOTE: Four position molex connector may be cut between 2 & 4 to separate HDGND from HDB and HDA.

1. HDB
2. HDA
3. No Connection
4. HDGRND (Shield)

QUIT will go to the 1 level if the manual stop button is pressed, if a STOP command is given, if no pulses are detected and there is an active SLOW command, or if SPIN goes low during any FAST command and DELAY is not active. QUIT is equivalent to STOP on the user interface.

V. CONSTRUCTION

Tools:	Fine tipped, low wattage soldering iron, "wire solder" (around 20 gauge resin solder), small diagonal cutters, needle-nose pliers.
Test Equipment:	Voltmeter 500KHz or better oscilloscope Frequency counter Microprocessor, Mini, etc.
Estimated Construction Time:	6 - 11 hours

1. Using the component placement chart given in the appendix, insert the 12 16-pin sockets into the PC board. If the sockets have an indicator for pin one, orient it away from the edge connector. Invert the board by placing a book on the sockets to hold them in and carefully solder all pins.

2. Insert and solder the 36 14-pin sockets as described above.

3. Insert and solder the 6 8-pin sockets.

4. The controller and deck need +5 Volts at 1 Amp nominal and +12 Volts at 0.7 Amps peak. Insert IC12, using silicone grease and the heat sink. Solder R57 and R58.

5. Apply power to the board and check voltages. The 9 Volt supply should be between 8.4 and 9.6 Volts. The 5 Volts should be between 4.75 and 5.25.

6. Remove power from the board.

7. Insert and solder the three resistors rated above 1/4 watt (R44, R45, and R46).

8. Insert and solder the data-rate potentiometer (R28). Orient it so that it may be adjusted from the top of the board.

9. Insert and solder the remaining resistors.

10. Insert and solder all polarized capacitors (C2, C13 - C19, C22, C27, C30, C32). C13 and C14 are marked with a + or -. The others have a solid section of color on the positive lead. The board has + notations to aid in orientation.

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11. Insert and solder the various remaining capacitors.

12. Insert and solder the four 1N4148 diodes and the 15 1N4001 diodes. All diodes should be oriented so that the bands on the diode are toward the right side of the board. There is also a diode symbol on the board to aid in orientation.

13. Insert and solder T6 - T12 into place. The emitter lead for these transistors is marked with a dot on one of the transistor pads. The appendix contains a pictorial to aid in orienting the various transistors supplied in your kit.

14. Insert and solder the FET (T13). Orient it so that the drain is toward the top of the board (opposite from the connector).

15. Insert and solder T1 - T5. These transistors are placed vertically with the leads inserted fully through the circuit board. Note that the emitter lead is marked with an E on the circuit board.

16. Insert all IC's into their respective sockets, observing correct orientation (pin 1 away from edge connectors).

17. Wire the board into the microprocessor's I/O structure, as described below. Connect the Phi-Deck by slipping the Molex connector supplied with the deck onto pins $\overline{H}$ - $\overline{R}$ of the controller's 36-pin socket. Orient the Molex connectors such that the orange wire is on pin $\overline{R}$. This puts the deck into position Ø. Remove the protective plastic shield from the digital head on the transport if one has been supplied.

18. If deck 1 will also be used. connect its Molex connector similarly to the connector for deck Ø. Bend the pins out on the 36-pin socket and slip on the connector. Decks 2 and 3 must be rewired at the connector, since several of the necessary signal pins are common to all of the decks.

19. Connect the shielded pair from deck Ø to pins 1 and A. Connect the ground to pin 5 or E. If deck 1 is to be used, connect the shielded pair to pins 2 and B (reverse the connector's orientation) and rewire the ground pin into deck Ø's ground connector. For decks 2 and 3, a different method of connection must be employed, as no more Molex connectors will fit.

20. Proceed with the initial checkout of the board by following the steps under section VII, DEBUG.

21. When the board seems to be working properly, perform the oscillator calibration and read amplifier gain calibration procedures under section VI, CALIBRATION. Calibrate the motor speed only if it is absolutely necessary. The Cassette Storage System is now ready for use.

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USING THE CONTROLLER IN A DIGITAL GROUP SYSTEM

The connection diagram in Figure 3.2 of the controller manual is used with the Digital Group Software packages. Most systems will use the wiring chart (Table 6.1).

An optional stop switch may be wired to the controller. A normally open momentary push button which brings the manual stop pin ($\overline{B}$) to ground will stop all deck movement.

VI. CALIBRATION

Oscillator Calibration - To insure compatibility between decks and tapes among all users of this system, the data rate should be adjusted to meet the standard specifications. Before you proceed with the adjustment of R28, the controller must be placed in the record mode by issuing a record command from the computer. This disables the DC feedback path to pin 5 of IC9. Adjust R28 for a 112 KHz signal at pin 3 of IC9. In record mode, this will produce an 8 KHz signal on DCLK. This bit rate (8,000 bits/sec) will record 1,600 flux changes per inch at a tape speed of five inches per second. The data rate is then 6,400 baud when referenced to the data transfer rate between the computer and the controller.

Motor Speed Calibration - The capstan motor on the Phi-Deck is preadjusted to 5 ips at the factory. The following adjustment may be made periodically to keep the deck speed within tolerance. (Note: Side B of your tape has approximately one minute of a 4 KHz test signal recorded on it. This is equivalent to 1,600 FCPI.) Using the 4 KHz test signal recorded on the reverse side of the cassette supplied with your controller, monitor the tape signal in the read mode on IC13, pin 14. With a non-metallic screwdriver or alignment tool, adjust the tape speed through the hole on top of the capstan motor so that the frequency of the tape signal is 4 KHz.

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Table 6.1

Wiring Chart

Phi-Deck Board				I/O Board (Ports Ø-3)	
PIN #		DESCRIPTION	CONNECT TO	PIN #	DESCRIPTION
6		DO7		26	MSB
7		DO6		25	MSB-1
8		DO5 Data		24	MSB-2 Input
9		DO4 Output		23	MSB-3 Port 2
10		DO3 Lines		22	LSB+3
11		DO2		21	LSB+2
12		DO1		20	LSB+1
13		DOØ		19	LSB
14		Data Output Strobe		R	MSB-3, Output Port 1
15		DI7		$\bar{D}$	MSB
16		DI6		$\bar{C}$	MSB-1 Output
17		DI5		$\bar{B}$	MSB-2 Port 2
18		DI4 Data		$\bar{A}$	MSB-3
19		DI3 Input		Z	LSB+3
20		DI2 Lines		Y	LSB+2
21		DI1		X	LSB+1
22		DIØ		W	LSB
23		Data Input Strobe		U	MSB, Output Port 1
L	*	Not Busy		22	LSB+3
M	*	Stop	Status	21	LSB+2 Input
N	*	Ready	Port	20	LSB+1 Port 2
P	*	Overrun/Underrun		19	LSB
R		Status Strobe		S	MSB-2, Output Port 1
S	*	Enable/Disable		$\bar{D}$	MSB
T	*	Slow/Fast		$\bar{C}$	MSB-1
U	*	FWD/BKWD	Command	$\bar{B}$	MSB-2 Output
V	*	Stop/Run	Port	$\bar{A}$	MSB-3 Port 2
W	*	RCD/READ		Z	LSB+3
X	*	ERASE		Y	LSB+2
Y	*	SEL2		X	LSB+1
Z	*	SEL1		W	LSB
$\bar{A}$		Command Strobe		T	MSB-1, Output Port 1

$\bar{B}$ $\overline{\text{Manstop}}$ Stop

Momentary, Normally Open Switch

* These pins may actually be wired to the opposite pin on the Phi-Deck Board connector (i.e., pin L to pin 10 on the Phi-Deck Board).

Read Amplifier Gain Calibration - First, record several minutes of test data onto a tape that you will be using. (Once you have decided on a type of tape that gives you good results and that is readily available, you should not change tapes.) Now place the controller in read mode and read your tape. Monitor the signal at IC13, pin 1. If the amplitude is not within the limit shown in Figure 4.2, try different values of R18 until the amplitude is within limits. This adjustment is not critical and your controller will give good results even if your amplitude is not within the limits specified.

VII. DEBUG

Reread the software section to be certain the correct procedures are being executed. Insert controller card (do not connect Phi-Deck yet) and turn power on.

Issue input and output commands to the I/O ports and verify that the strobe signals are present when the command is issued. Also, verify that the data is being latched in the command and data latches correctly (IC33, 46, 47, and 28).

CONNECT THE PHI-DECK AND PROCEED THROUGH THE FOLLOWING SECTIONS.

MOTOR CONTROL ELECTRONICS

Place an old cassette into the deck (if the motor control electronics is not working properly this test may destroy the tape). Issue a fast forward command and check tape movement (these commands are given in the Mechanical Considerations portion of this manual.) Issue a fast reverse command and check tape movement. Remove cassette and issue a stop command. Both reel motors should turn in opposite directions. Reinsert the cassette and issue a record command. The head should engage the tape and the takeup reel should turn. Place your finger on the takeup reel motor pulley. The head should disengage within 1.5 seconds after stopping the motor. If any of the above tests fail, refer to the Theory of Operation for the motor drive and sense electronics and the motor control electronics and proceed to trace the problem.

HEAD SENSE AND BIT SYNCHRONIZING ELECTRONICS

Place controller in record mode and output data bytes to the controller every time READY comes true. You should see waveforms similar to those shown in Figure 4.1 at the outputs of the selected head driver (IC27 or IC28). Waveforms similar to these should also appear on the head of the selected drive.

The read amplifiers may be tested by using the tape you made in the previous paragraph, placing the deck in read mode after rewinding the tape, and looking for the waveforms given in Figure 4.2. If the voltage at IC13, pin 1 is clipping or not within the range shown, refer to Calibration for Adjustment. This adjustment is not critical and is probably not the cause of the controller malfunction.

The bit synchronizing electronics may be checked by verifying the timing diagram shown in Figure 4.3.

READ/WRITE ELECTRONICS

Test all of the clocking signals depicted in Figure 4.9. If a signal is not present or correct, trace back through the logic generating that signal. Make sure about 0.2 Volts of the tape head signal is present on record, and not on read. Check that RECORD reflects the selected state and RDY had a pulsing signal when recording or reading.

The basic clock, IC9, may be removed, and a bounceless switch (Figure 7.1) used to single step the system (14 clocks per data bit). If an oscilloscope is not available, an audio amplifier with the circuit in Figure 7.2 can be used to probe for clocks and data flow. For example, recording or reading in hex "5A" will sound like a 4 KHz square wave on pin 6 of IC5, and (on record) a 2 KHz square wave on pin 3 of IC4. (This signal is not present on erase and read.)

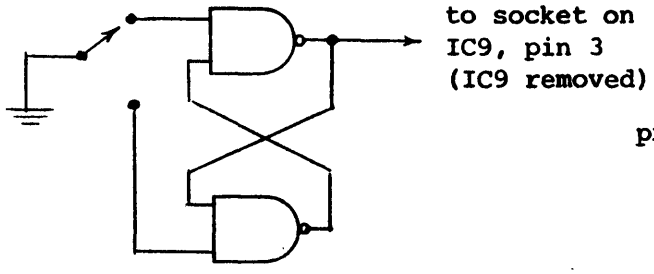

Figure 7.1 Single-step Clock

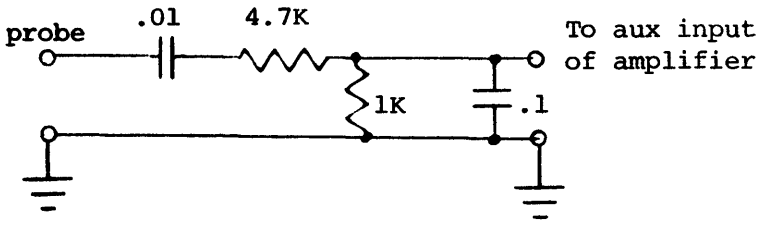

Figure 7.2 Digital to Audio Sensor

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VIII. APPENDIX

A. Parts List

B. PROM Pattern

C. Connector Pinout

D. Component Placement

E. Schematic

F. Transistor Orientation

G. Driver Software Description

H. Recording Format

I. Flowcharts

J. Program Tape and Listings

K. Phi-Deck Maintenance

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A. PARTS LIST

DESCRIPTION	QUANTITY	CIRCUIT REFERENCE
74S00	1	IC49
7400	8	IC1,8,10,14,16,17,25,38,
7402	1	IC15
7404	2	IC34,40
7408	1	IC36
7410	2	IC19,39
7411	1	IC18
7420	2	IC6,22
7451	2	IC2,24
7473	1	IC41
7474	6	IC3,5,21,42,50,55
7475	4	IC33,46,47,48
7486	1	IC26
7490	1	IC20
7493	2	IC7,37
74107	1	IC4
74123	1	IC23
74125	3	IC27,28,45
74153	2	IC31,32
74155	1	IC35
74173,8551	2	IC43,44
74195	1	IC30
74S188,8223,6330-1J	1	IC29
75451	4	IC51,52,53,54
LM324	1	IC13
LM340T-8.0,uA7808	1	IC12
LM358	1	IC11
LM555	1	IC9
2N4403	4	T7,8,9,10
2N5129	1	T12
2N5139	2	T6,11
2N6109	4	T2,3,4,5
2N6410,MJE2050	1	T1
MPF971	1	T13
1.5Ω,1/2W	1	R44
7.5Ω,1W	1	R46
18Ω,2W	1	R45
47Ω	2	R53,57
82Ω	1	R27
220Ω	1	R12
470Ω	1	R48
510Ω	1	R58
680Ω	8	R32,33,34,35,36,37,38,39
1KΩ	7	R6,9,20,23,26,31,55
1.2KΩ	5	R15,16,19,30,42
2.2KΩ	2	R1,29
4.7KΩ	2	R2,49
5KΩPOT	1	R28

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DESCRIPTION	QUANTITY	CIRCUIT REFERENCE.
10KΩ	13	R7,8,10,11,14,17,21,22, 24,25,43,47,54
15KΩ	1	R50
22KΩ	2	R40,41
39KΩ	2	R4,5
47KΩ	1	R3
100KΩ	1	R13
150KΩ	2	R51,52
220KΩ	1	R18
1 Meg Ω	1	R56
220pfd mylar	1	C4
.0015mfd mylar	1	C12
.0033mfd mylar	1	C25
.005mfd mylar	1	C3
.01mfd disc	14	C5,6,7,8,9,10,11,20,21, 23,26,28,29,31
.1mfd disc	2	C1,24
1mfd tantalum	10	C2,15,16,17,18,19,22,27, 30,32
100mfd electrolytic	2	C13,14
1N4001	15	D1,2,3,4,5,6,7,8,9,10,11, 12,13,14,15
1N4148	4	D16,17,18,19
TO-220 Heatsink, THM6072B	1	
4-40 Screws	2	
4-40 Nuts	2	
#4 Lockwashers	2	
8-Pin DIP Sockets	6	
14-Pin DIP Sockets	36	
16-Pin DIP Sockets	12	
Dual 22-Pin Edge Connectors	1	
Dual 36-Pin Edge Connectors	1	
PC Board	1	

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B. PROM PATTERN

A4	A3	A2	A1	A0	B0	B1	B2	B3	B4	B5	B6	B7
0	0	0	0	0	1	1	0	1	1	1	0	0
0	0	0	0	1	1	1	1	1	0	0	0	0
0	0	0	1	0	1	0	1	0	1	0	0	0
0	0	0	1	1	1	0	1	1	0	0	1	0
0	0	1	0	0	1	1	0	1	1	1	0	0
0	0	1	0	1	1	0	0	1	0	0	0	1
0	0	1	1	0	1	0	1	0	1	0	0	0
0	0	1	1	1	1	0	1	1	1	0	1	0
0	1	0	0	0	1	1	1	0	1	1	1	0
0	1	0	0	1	0	1	0	1	1	0	1	0
0	1	0	1	0	0	1	1	0	1	1	0	0
0	1	0	1	1	0	1	1	1	1	1	1	0
0	1	1	0	0	1	1	1	0	1	1	1	0
0	1	1	0	1	0	1	0	1	1	0	1	0
0	1	1	1	0	0	1	1	0	1	1	0	0
0	1	1	1	1	0	1	1	1	1	1	1	0
1	0	0	0	0	0	0	0	0	0	1	1	0
1	0	0	0	1	0	0	0	0	0	1	0	0
1	0	0	1	0	0	0	0	0	0	1	0	0
1	0	0	1	1	0	0	0	0	0	1	1	0
1	0	1	0	0	0	0	0	0	0	1	1	0
1	0	1	0	1	0	0	0	0	0	0	1	0
1	0	1	1	0	0	0	0	0	0	1	0	0
1	0	1	1	1	0	0	0	0	0	1	1	0
1	1	0	0	0	0	0	0	0	0	0	1	0
1	1	0	0	1	0	0	0	0	0	0	0	0
1	1	0	1	0	0	0	0	0	1	0	0	0
1	1	0	1	1	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1	0	0
1	1	1	0	1	0	0	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	1	0	0	0
1	1	1	1	1	0	0	0	1	0	0	1	0

C. CONNECTOR PINOUT

Top of Card - Component Side

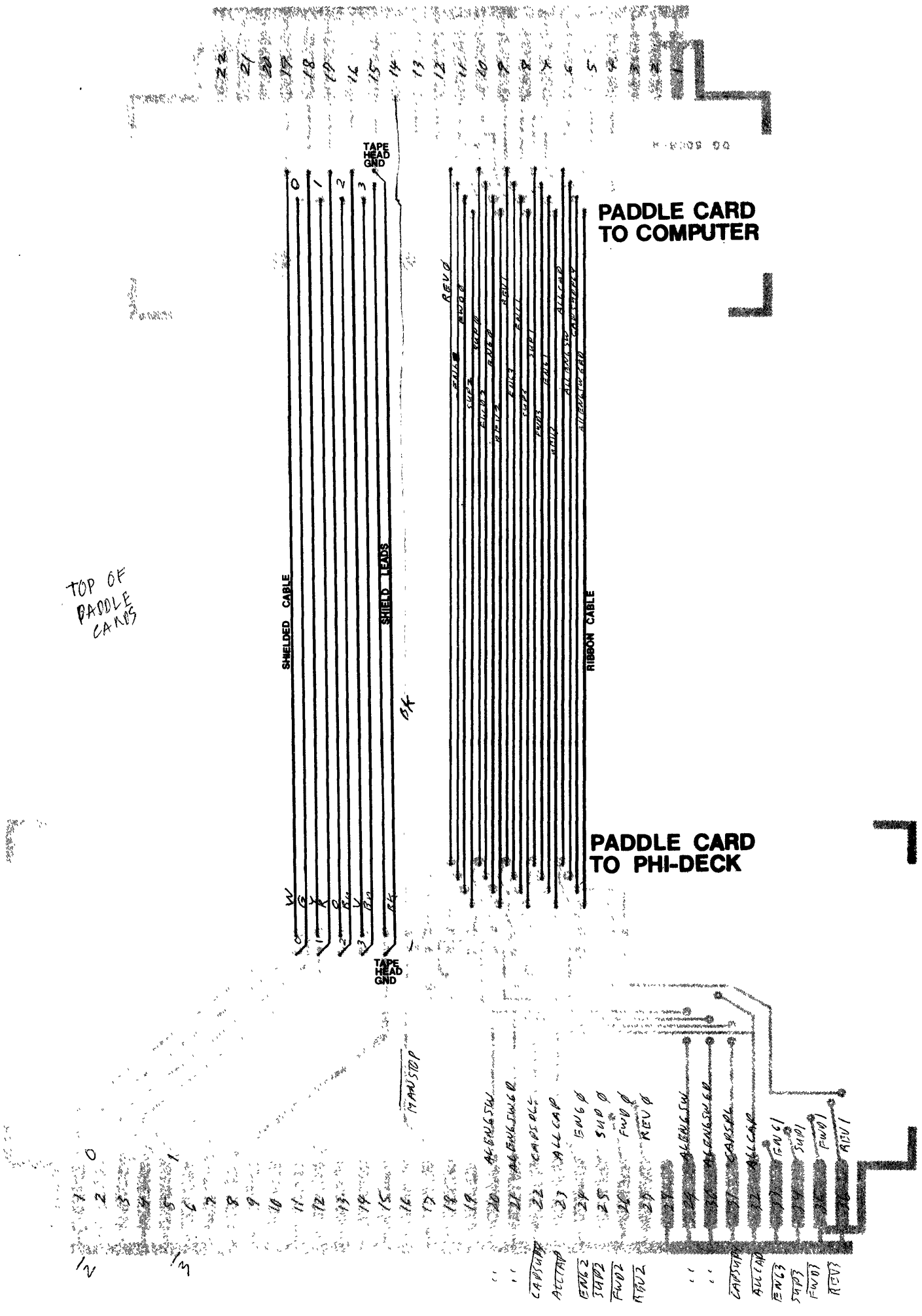
Pin No.	Description	
1	HDAØ	
2	HDA1	
3	HDA2	
4	HDA3	
5	HDGND	
6	DO7	
7	DO6	
8	DO5	Data
9	DO4	Output
10	DO3	Lines
11	DO2	
12	DO1	
13	DOØ	
14	Data Output Strobe	
15	DI7	
16	DI6	
17	DI5	
18	DI4	Data
19	DI3	Input
20	DI2	Lines
21	DI1	
22	DIØ	
23	Data Input Strobe	
24	+9V Out	
25	ENG3	
26	SUP3	
27	FWD3	
28	REV3	
29	ALLENGSW	
30	ALLENGSWGND	
31	CAPSUPPLY	
32	ALCAP	
33	ENG1	
34	SUP1	
35	FWD1	
36	REV1	

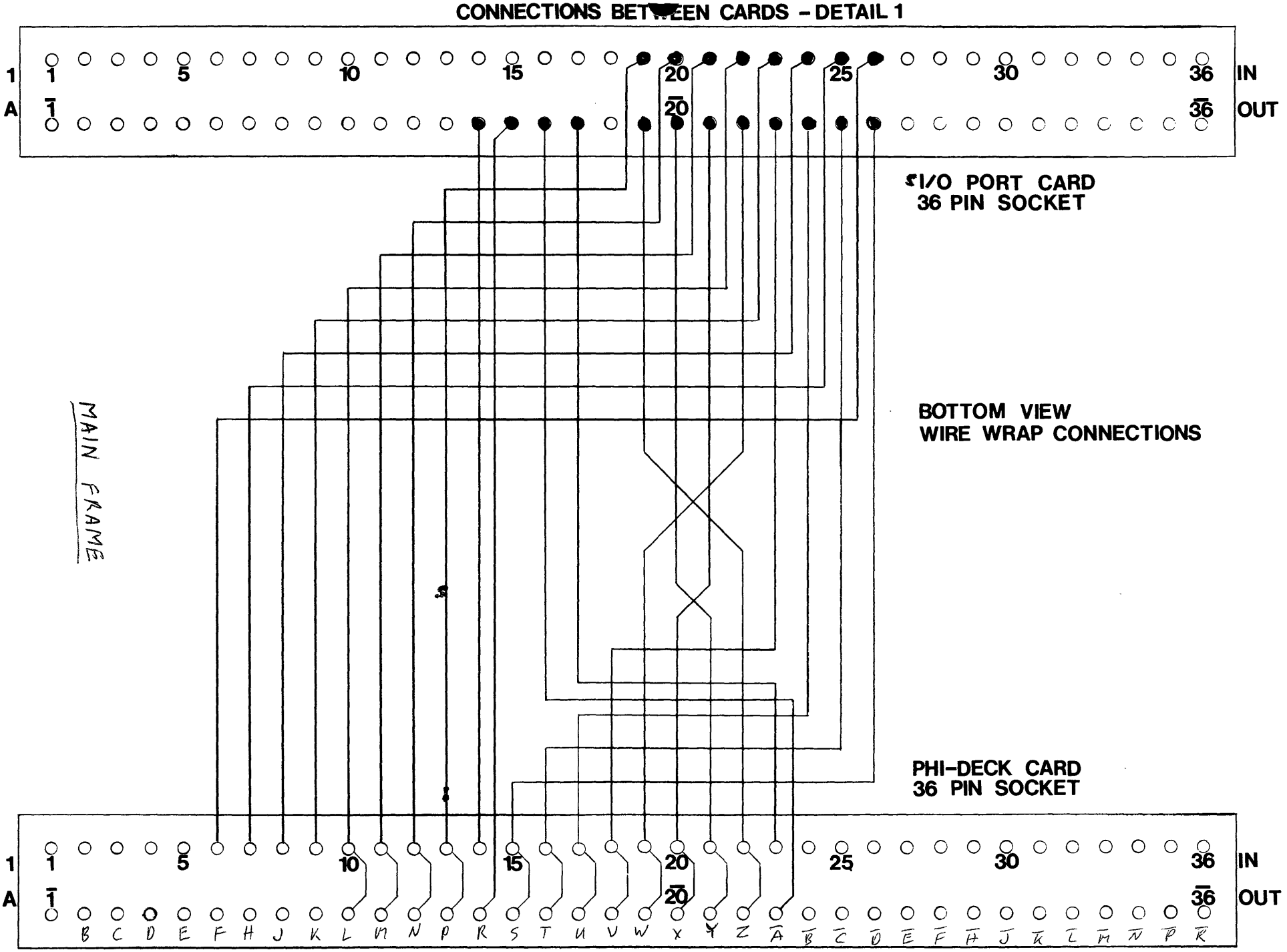
Bottom of Card - Circuit Side

Pin No.	Description	
A	HDBØ	
B	HDB1	
C	HDB2	
D	HDB3	
E	HDGND	
F	DATA READY IRQ	
H	n/c	
J	n/c	
K	n/c	
L	Not Busy	
M	Stop	Status
N	Ready	Port
P	Overrun/underrun	
R	Status Strobe	
S	Enable/Disable	
T	Slow/Fast	
U	FWD/BKWD	Command
V	Stop/Run	Port
W	RCD/READ	
X	ERASE	
Y	SEL 2	
Z	SEL 1	
$\bar{A}$	Command Strobe	
$\bar{B}$	$\overline{\text{Manstop}}$	
$\bar{C}$	ENG2	
$\bar{D}$	SUP2	
$\bar{E}$	FWD2	
$\bar{F}$	REV2	
$\bar{H}$	ALLENGSW	
$\bar{J}$	ALLENGSWGND	
$\bar{K}$	CAPSUPPLY	
$\bar{L}$	ALCAP	
$\bar{M}$	ENGØ	
$\bar{N}$	SUPØ	
$\bar{P}$	FWDØ	
$\bar{R}$	REVØ	

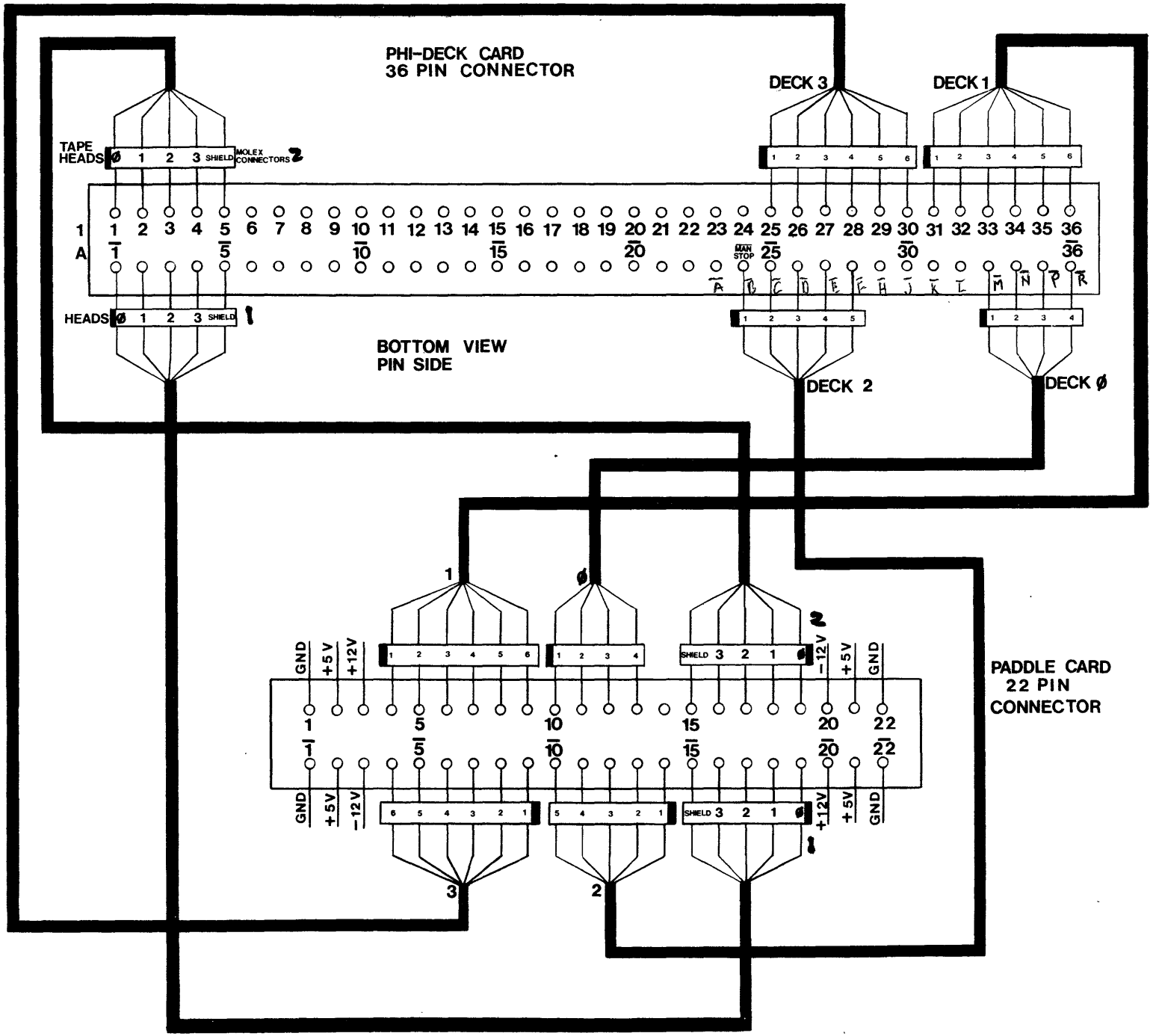
Note: n/c = no connection
Pin 1 on 22-pin connector = +5V
Pin 2 on 22-pin connector = GND
Pin 22 on 22-pin connector = +12V

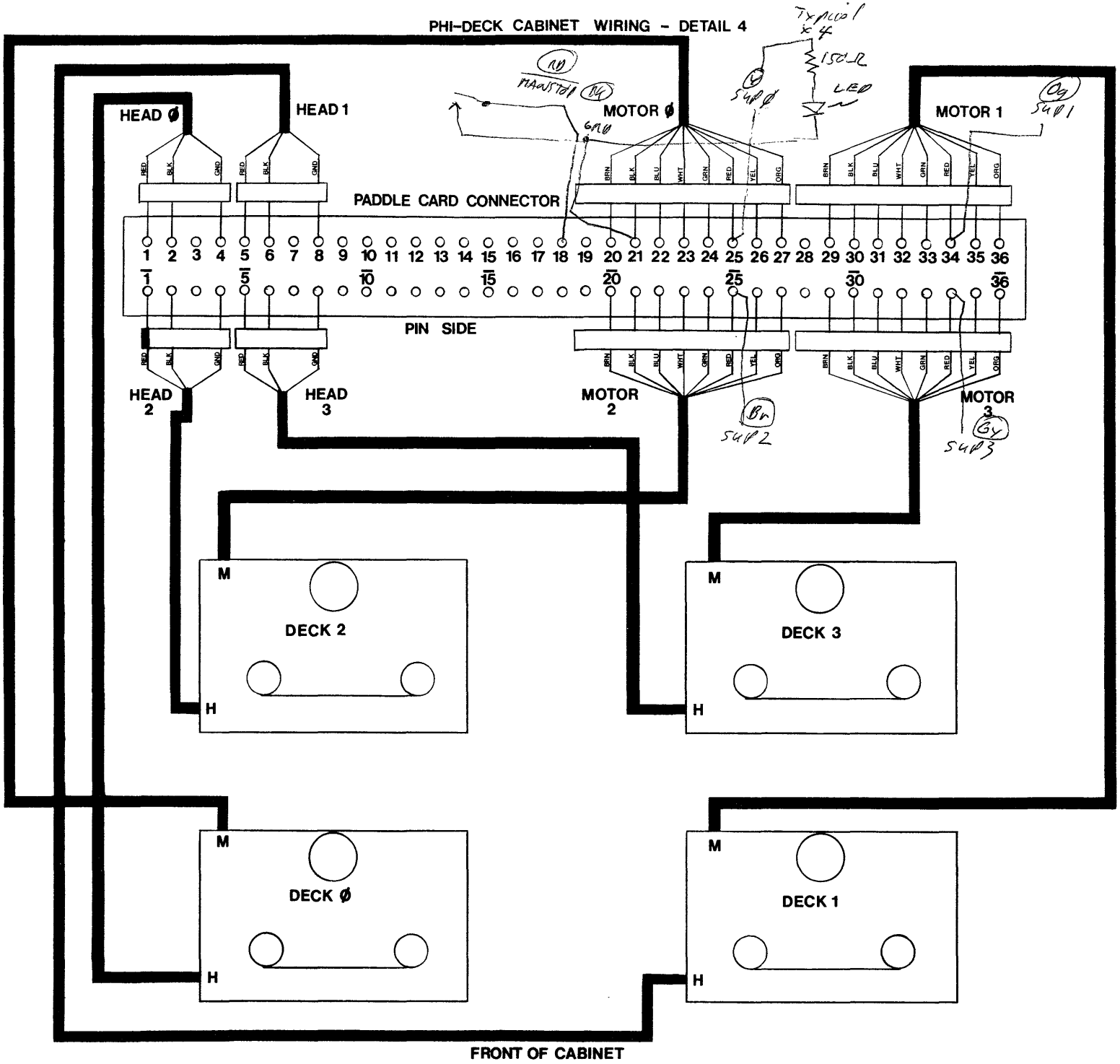
DETAIL 3


PADDLE CARD TO COMPUTER
PADDLE CARD TO PHI-DECK
SHIELDED CABLE
SHIELD LEADS
RIBBON CABLE
TAPE HEAD GND
TAPE HEAD GND
TOP OF PADDLE CARDS
MAN STOP

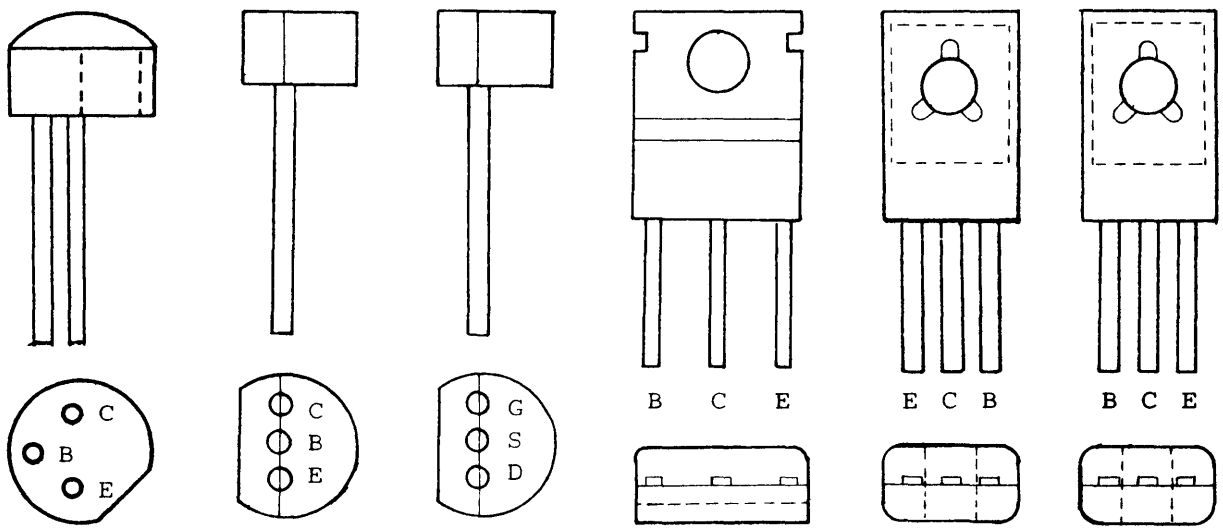

CONNECTIONS BETWEEN CARDS - DETAIL 1
1
A
1
5
10
15
20
25
30
36
IN
OUT
I/O PORT CARD
36 PIN SOCKET
MAIN FRAME
BOTTOM VIEW
WIRE WRAP CONNECTIONS
PHI-DECK CARD
36 PIN SOCKET
B C D E F H J K L M N P R S T U V W X Y Z A B C D E F H J K L M N P R

PHI-DECK CARD CONNECTIONS TO
PADDLE CARD BACKPLANE - DETAIL 2




PHI-DECK CABINET WIRING - DETAIL 4
HEAD Ø
HEAD 1
MOTOR Ø
MOTOR 1
PADDLE CARD CONNECTOR
PIN SIDE
HEAD 2
HEAD 3
MOTOR 2
MOTOR 3
DECK 2
DECK 3
DECK Ø
DECK 1
M
H
FRONT OF CABINET

F. TRANSISTOR ORIENTATION



Transistor	Case
2N6109	D
2N5139	A or B
2N5129	A or B
2N4403	B
2N6410	F
MJE2050	E
MPF971	C

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G. DRIVER SOFTWARE DESCRIPTION

The software supplied with the Digital Group Cassette Storage System contains deck control subroutines to allow the user to concentrate on applications. The READ and RECORD routines provide all error recovery during read, and data verification during record.

The software package consists of several major routines to aid the user in controlling the decks. These are the RECORD, CMDOUT, READ, and REWIND routines. There are numerous minor subroutines the user may invoke if he feels the need to control the deck on a more basic level.

The sample 8080 program given below is a simple example of how to use the major routines. The sample program will read the tape on deck Ø and write the data on deck 1, one block at a time. This program will halt if an unrecoverable error occurs. The major routines are described in more detail following the example. (Note: The sample Z80 program may be found under Program Listings.)

```
* SAMPLE PROGRAM TO COPY A TAPE
* ON DECK Ø TO A TAPE ON DECK 1
* ONE BLOCK AT A TIME

LABEL     OP      OPERAND     COMMENT

START     MVI     A,Ø         SET DECK Ø
          STA     DECK
          CALL    REWIND      REWIND DECK Ø
          MVI     A,1         SET DECK 1
          STA     DECK
          CALL    REWIND      REWIND DECK 1
          SUB     A           CLEAR REGISTER A
          STA     TEMPID      INITIALIZE ID
REDBLK    IN      TAPEIN      WAIT FOR NOT BUSY
          ANI     Ø8H         BECAUSE THE DECK
          JZ      REDBLK      NUMBER IS CHANGING
          MVI     A,Ø         SET DECK Ø
          STA     DECK
          LXI     H,BUFFER    SET UP POINTER
          SHLD    POINTR
          LDA     TEMPID      SET UP ID
          STA     IDR
          MVI     E,Ø         SET READ MODE
          CALL    READ        READ BLOCK
          PUSH    PSW         SAVE REGISTER A
          MVI     C,FØH       STOP DECK
          CALL    CMDOUT
          POP     PSW         RESTORE REGISTER A
          CPI     Ø           ERROR?
          JZ      WRTBLK      NO
          CPI     2           BLOCK FOUND?
```

```
LABEL           OP          OPERAND         COMMENT

                RZ                          NO, FINISHED
                HLT                         HALT BECAUSE ERROR
WRTBLK          IN          TAPEIN          WAIT FOR NOT BUSY
                ANI         Ø8H             BECAUSE THE DECK
                JZ          WRTBLK          NUMBER IS CHANGING
                MVI         A,1             SET DECK 1
                STA         DECK
                LXI         H,BUFFER        SET UP POINTER
                SHLD        POINTW
                LDA         TEMPID          SET UP ID
                STA         IDW
                INR         A               INCREMENT ID
                STA         TEMPID
                MOV         A,B             SET UP COUNT
                CPI         Ø               256?
                JZ          X256            YES
                MOV         L,B
                MVI         H,Ø
                JMP         CALRCD
X256            MVI         H,1
                MVI         L,Ø
CALRCD          CALL        RECORD          RECORD BLOCK
                CPI         Ø               ERROR?
                JZ          REDBLK          NO, COPY NEXT BLOCK
                HLT                         HALT BECAUSE ERROR
TEMPID          DS          1
BUFFER          DS          256
                END
```

The REWIND routine will stop the operating deck, select the specified deck, and rewind it. This routine returns to the calling routine after the selected deck has been rewound and readied for another command. Memory location "DECK" must contain the selected deck number (in binary) before the routine is called.

The RECORD routine will record data in the standard block format and then check the recorded data to verify that it was recorded without error. If an error is detected, that portion of the tape is erased and all the remaining data is re-recorded. This process is repeated until all data has been recorded successfully, or an unrecoverable error is detected.

As the user records data he must record blocks in sequence starting with IDW = Ø,1,2, etc. Numbers may not be skipped! After a series of blocks have been recorded, the user may re-record a block, but all old blocks following the new blocks may be lost. Although not absolutely necessary, it is recommended that tapes be erased with a bulk eraser or using the Phi-Deck in erase mode to obtain maximum performance and prevent the controller software from becoming confused with the old data.

In order to use this routine properly, the input variables must be set up properly:

1. The deck number must be placed in memory location DECK.
2. The low order byte of the block ID must be placed in memory location IDW, and the high order byte must be placed in IDW+1.
3. The low order byte of the address of the first byte to be recorded is placed in memory location POINTW, and the high order byte is placed in POINTW+1.
4. The number of bytes to be recorded is placed in register pair H and L. A count of zero will cause the record routine to simply return without recording any data.

When the record routine returns control to the calling routine, the registers and memory are modified as follows:

1. All Registers are altered.
2. IDW returns the ID of the last block recorded plus one.
3. POINTW points one location greater than the last byte recorded.
4. The error code is returned in the A register and should be checked after every call to the RECORD routine. The error codes are:

   Ø - Record completed with no errors
   1 - CRC error in block ID-1
   2 - Block ID-1 not found
   3 - End of tape or jam

The READ routine will read one block and return to the calling routine. The deck is left running so the user must either read another block or issue a stop command to the deck directly (see the CMDOUT routine).

To use this routine the following variables must be set up properly:

1. The deck number is placed in memory location DECK.
2. Memory location IDR contains the low order byte of the ID of the block to be read. IDR+1 contains the high order byte.
3. Memory location POINTR contains the low order byte of the address of the the data that is to be deposited. POINTR+1 contains the high order byte.
4. Register E contains the mode. Ø indicates that the data block is to be read into memory starting at the location specified by POINTR. 1 indicates that the data block is to be checked for errors only (in this mode POINTR is not used).
5. RETRYS (Register D) should be initialized only if the ALTRD or ALTRD2 entry points are used. It is automatically initialized to 10 if the READ entry point is used. The user should normally use the READ entry point.

When the read routine returns control to the calling routine, the registers and memory are modified as follows:

1. Registers A,B,C,D,H, and L are modified.

2. COUNT (Register B) contains the number of bytes contained in the block:

Ø	=	256 bytes
1	=	1 byte
2	=	2 bytes
255	=	255 bytes

3. ERROR (Register A) contains the error code after a read operation has been completed. The error codes are:

Ø	-	No errors
1	-	Unrecoverable data error
2	-	Unable to find block specified by ID
3	-	End of tape or jam

The CMDOUT routine is used to issue commands to the transport. Memory location DECK must contain the number of the deck that is referenced by the command. Register C must contain the command to be issued to the deck. The valid commands are:

COMMAND	VALUE IN REGISTER C
STOP	1 1 1 1 0 0 0 0
FAST FORWARD	1 0 1 0 0 0 0 0
FAST REVERSE	1 0 0 0 0 0 0 0
READ	1 1 1 0 0 0 0 0
RECORD	1 1 1 0 1 0 0 0
ERASE	1 1 1 0 1 1 0 0
STANDBY	0 1 1 1 0 0 0 0

H. RECORDING FORMAT

This appendix shows the block format as it is recorded on the tape by the driver software and controller. Each byte recorded on the tape consists of 10 bits or flux changes (see hardware description).

DESCRIPTION	BYTES RECORDED
75 one bits	7.5
SYNC character	.5
ID high	1.
ID low	1.
COUNT	1.
CRC 1	1.
CRC 2	1.
DATA	1. to 256
CRC 1	1.
CRC 2	1.
TOTALS*	16 to 271

*The record routine will erase to an equivalent of 271 bytes for short blocks so that all blocks will be the same size.

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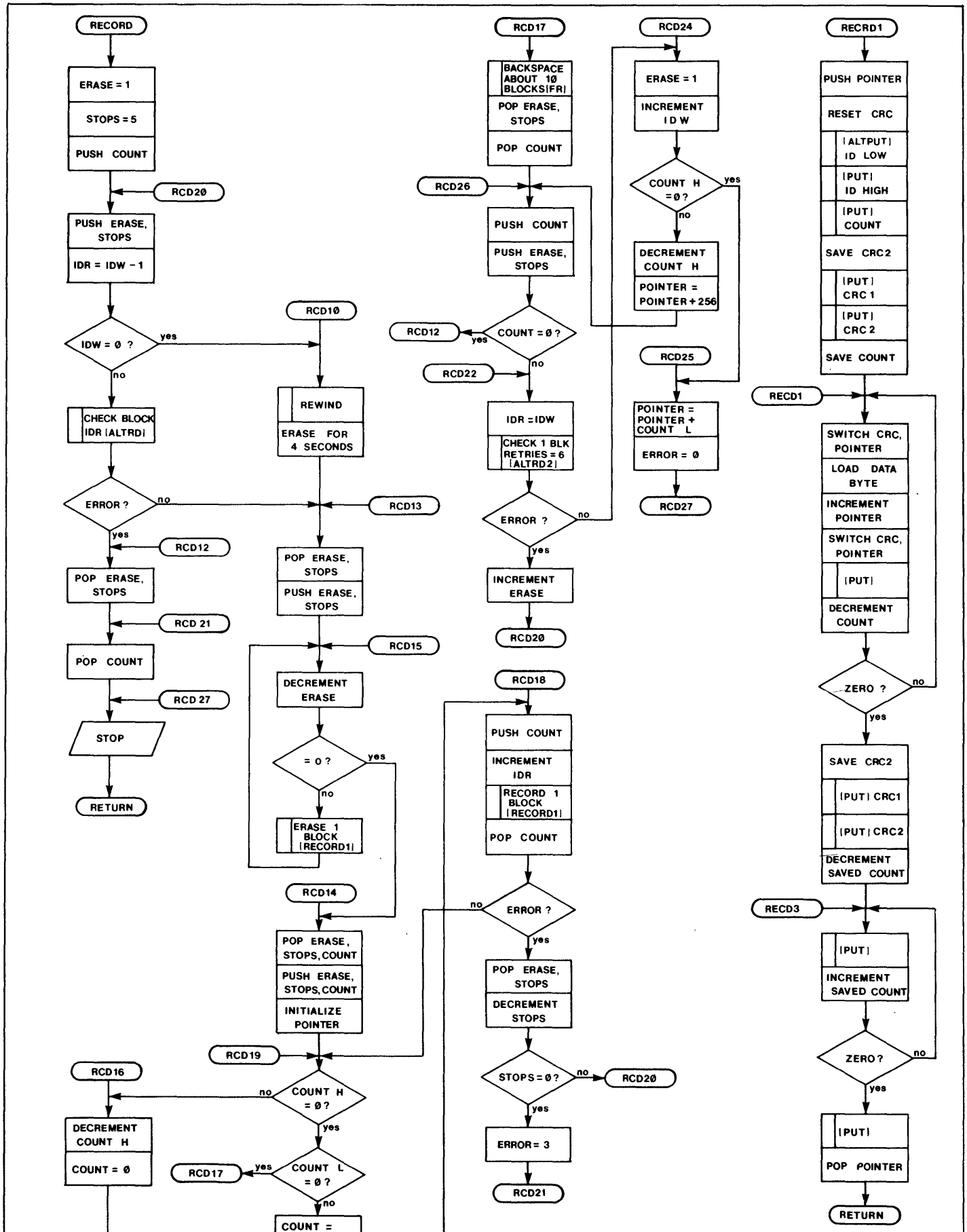

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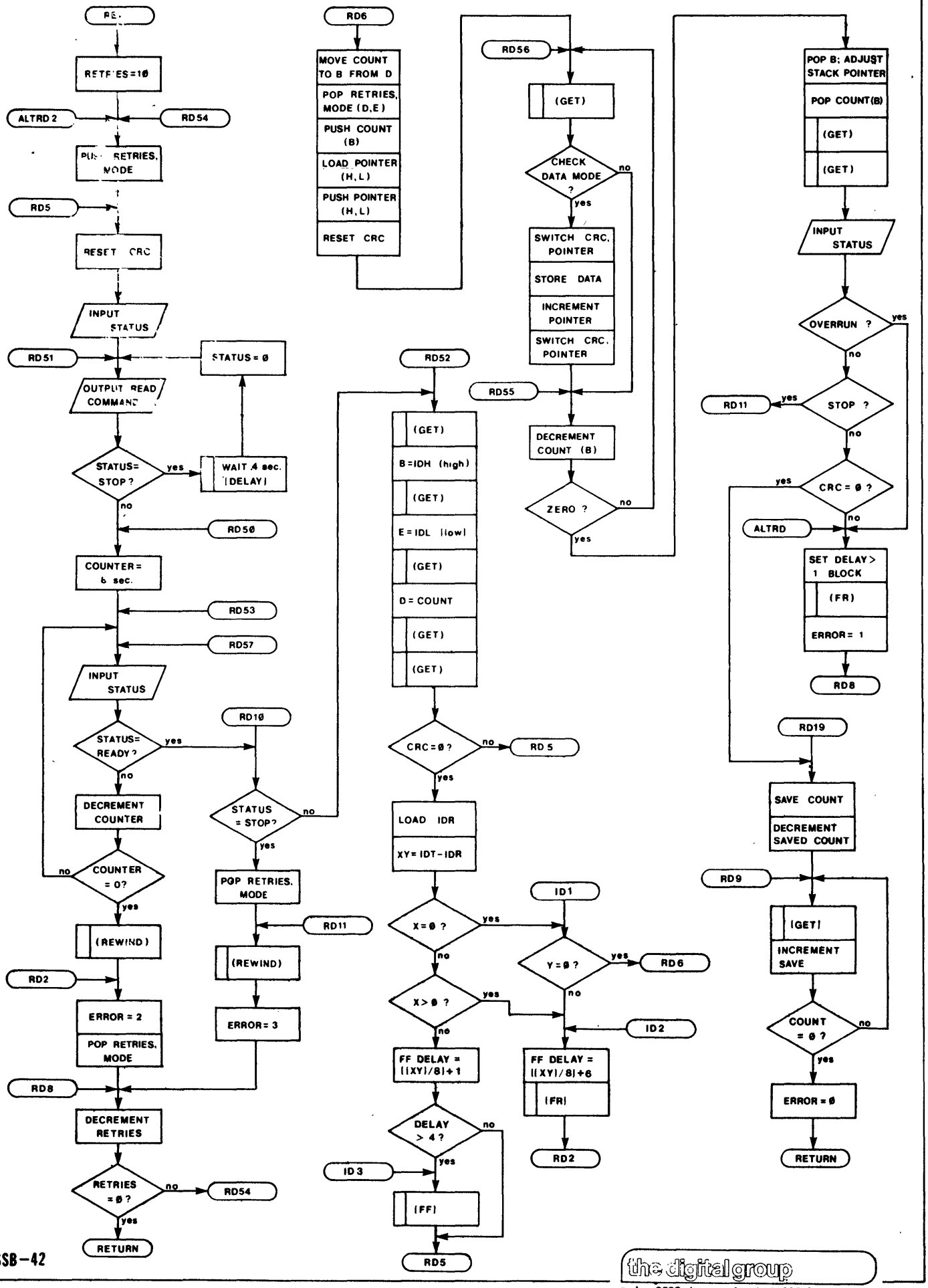

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J. PROGRAM TAPE AND LISTINGS

****
*
* The tape supplied with the program listing is an
* AUDIO CASSETTE recorded at 11ØØ Baud in Suding
* format. This WILL NOT load from the PHI-DECK.
*
****

The program tape contains four programs in the following order:

1. Phi-Deck Demo for Z-8Ø
2. Z-8Ø Ops System
3. Phi-Deck Demo for 8Ø8Ø
4. 8Ø8Ø Ops System

Each program includes the PHI-DECK driver routines in the program listing in locations Ø9ØØH thru ØB9DH (Ø11ØØØ thru Ø13235).

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Z-8Ø PHI-DECK DEMO SOFTWARE

1. Programs are loaded via audio cassette.
2. At completion of a successful load a listing of Phi-Deck commands will be displayed.
3. In addition to the displayed options, there are three possible options - "R", "S", and "P".
4. "R" will return control to the Z-8Ø Ops System which includes:
   1 Read - Read an audio cassette
   2 Write - Write an audio cassette
   3 Octal Dump - Storage Dump in octal
   4 Octal Program - User programming in octal
   5 Hex Dump - Storage Dump in hex
   6 Hex Program - User programming in hex
   7 Phi-Deck Ops
5. "S" will display memory in either hex or octal depending upon last option (hex or octal) chosen by the user.
6. "P" will allow user to program as in Z-8Ø Ops System in either hex or octal depending upon last method chosen in Z-8Ø options 3 thru 6.
7. Reset will return control to Phi-Deck ops.
8. "P", "R", and "S" will operate when in Storage Dump, Program, or Phi-Deck Ops.
9. Phi-Deck option "#" allows the user to select any of 4 decks (Ø-3) by pressing shift # then desired deck number. To return to Phi-Deck Ops press Y. The selected deck number will be displayed in the options listing upon return.
10. Phi-Deck option "Ø" will copy a tape from deck Ø to deck 1. This is not intended as an efficient method of duplicating tapes, only as a demonstration of Phi-Deck routines.
11. Page Ø15 is being used as a 256 byte buffer in the Copy Tape option.
12. Phi-Deck option "1" will erase a tape on the selected deck.
13. Phi-Deck option "2" will fast reverse the selected deck.
14. Phi-Deck option "3" will fast forward the selected deck.
15. Phi-Deck option "4" will place all decks in standby. The capstan motors will be turned off.
16. Phi-Deck option "5" will stop the selected deck.
17. Phi-Deck option "6" will issue a read command to the selected deck. This will not read data from a tape.
18. Phi-Deck option "7" will issue a record command to the selected deck. This will not record data on a tape.
19. Phi-Deck option "8" will record 256 byte blocks of data in a fixed pattern.
20. Phi-Deck option "9" will read 256 byte blocks of data from a tape in a fixed pattern. An "e" will be displayed on the monitor for blocks in error and a "g" for good blocks.

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CHANGES TO Z-8Ø OPERATING SYSTEM
FOR PHI-DECK DEMO

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
Ø54E	ØØ				Address for key 7
Ø54F	Ø7				
Ø5FØ	13				Spaces
Ø5F1	B7				7
Ø5F2	AØ				
Ø5F3	DØ				P
Ø5F4	C8				H
Ø5F5	C9				I
Ø5F6	AØ				
Ø5F7	C4				D
Ø5F8	C5				E
Ø5F9	C3				C
Ø5FA	CB				K
Ø5FB	AØ				
Ø5FC	CF				O
Ø5FD	DØ				P
Ø5FE	D3				S
Ø5FF	ØØ				Return
Ø1Ø3	ØØ		RST 8		
Ø1Ø4	Ø7				
Ø4Ø1	Ø3				
Ø4Ø2	Ø5				
Ø4D6	Ø3				
Ø4D7	Ø5				
Ø5ØØ	C3				
Ø5Ø1	ØØ				
Ø5Ø2	Ø7				

```
LOC      OBJ              LABEL   OP     OPERAND     COMMENTS

0700 31 00 02      0190          LD     SP,0200H LOAD STACK POINTER
0703 ED 46         0200          IM     0        SET INTERRUPT MODE 0
0705               0210 *                        (8080 IDENTICAL)
0705 FB            0220          EI               ENABLE INTERRUPTS
0706 3A B0 0A      0230          LD     A,(DECK)
0709 F6 B0         0240          OR     0B0H     CONVERT TO ASCII
070B 32 83 07      0250          LD     (DKNBR),A LOAD DECK # IN MESSAGE
070E 21 6E 07      0260          LD     HL,MSG1
0711 CD 00 02      0270          CALL   TVEDIT   CALL TV EDITOR
0714 CD A8 01      0280 KYBD     CALL   01A8H    CALL KEYBOARD
0717 FE BA         0290          CP     0BAH     NUMBER?
0719 D2 38 07      0300          JP     NC,LETTER NO
071C FE B0         0310          CP     0B0H     NUMBER?
071E DA 4A 07      0320          JP     C,CHAR NC
0721 F5            0330          PUSH   AF       SAVE A&F
0722 CD E6 00      0340          CALL   ERASE    ERASE SCREEN
0725 F1            0350          POP    AF       RESTORE A&F
0726 07            0360          RLCA            PRODUCE L INDEX
0727 D6 09         0370          SUB    09H
0729 6F            0380          LD     L,A
072A 26 07         0390 HINDEX   LD     H,07H    H INDEX
072C 7E            0400          LD     A,(HL)   SELECT ADDRESS
072D 32 36 07      0410          LD     (0736H),A
0730 23            0420          INC    HL
0731 7E            0430          LD     A,(HL)
0732 32 37 07      0440          LD     (0737H),A
0735 C3 00 00      0450          JP     SELADR
0738 F6 20         0460 LETTER   OR     20H
073A FE F3         0470          CP     0F3H     "S" ?
073C CA 00 03      0480          JP     Z,TVDUMP YES, JUMP TO TV
073F               0490 *                        STORAGE DUMP
073F FE F2         0500          CP     0F2H     "R" ?
0741 CA 03 05      0510          JP     Z,0503H YES, JUMP TO Z80 OPS SYSTEM
0744 FE F0         0520          CP     0F0H     "P" ?
0746 CA 91 24      0530          JP     Z,2491H YES, JUMP TO KEYBOARD
0749               0540 *                        PROGRAMMER ROUTINE
0749 CF            0550          RST    8D
074A FE A3         0560 CHAR     CP     0A3H
074C C2 14 07      0570          JP     NZ,KYBD
074F 2E 6C         0580          LD     L,6CH
0751 C3 2A 07      0590          JP     HINDEX
0754 00            0600          NOP
0755 00            0610          NOP
0756 00            0620          NOP
```

```
0757 00                 0630          NOP
0758 AD 08              0640          DW    08ADH  0 SELECT ADDRESS
075A D8 08              0650          DW    08D8H  1 SELECT ADDRESS
075C D2 08              0660          DW    08D2H  2 SELECT ADDRESS
075E CC 08              0670          DW    08CCH  3 SELECT ADDRESS
0760 DE 08              0680          DW    08DEH  4 SELECT ADDRESS
0762 E4 08              0690          DW    08E4H  5 SELECT ADDRESS
0764 EA 08              0700          DW    08EAH  6 SELECT ADDRESS
0766 F0 08              0710          DW    08F0H  7 SELECT ADDRESS
0768 B6 08              0720          DW    08B6H  8 SELECT ADDRESS
076A BF 08              0730          DW    08BFH  9 SELECT ADDRESS
076C 80 08              0740          DW    0880H  # SELECT ADDRESS
076E FF                 0750 MSG1     DB    0FFH   ERASE
076F                    0760          DW    '# SEI DECK'
 A3 A0 D3 C5 CC
 A0 C4 C5 C3 CB

0779 04                 0770          DB    4D     SPACES
077A                    0780          DW    'IN USE - '
 C9 CE A0 D5 D3
 C5 A0 AD A0
0783                    0790 DKNBR    DW    '0'
 B0
0784 08                 0800          DB    8D     SPACES
0785                    0810          DW    '0 COPY TAPE'
 B0 A0 C3 CF D0
 D9 A0 D4 C1 D0
 C5
 7B0 15                 0820          DB    21D    SPACES
0791                    0830          DW    '1 ERASE'
 B1 A0 C5 D2 C1
 D3 C5
0798 19                 0840          DB    25D    SPACES
0799                    0850          DW    '2 FAST REVERSE'
 B2 A0 C6 C1 D3
 D4 A0 D2 C5 D6
 C5 D2 D3 C5
07A7 12                 0860          DB    18D    SPACES
07A8                    0870          DW    '3 FAST FORWARD'
 B3 A0 C6 C1 D3
 D4 A0 C6 CF D2
 D7 C1 D2 C4
07B6 12                 0880          DB    18D    SPACES
07B7                    0890          DW    '4 STANDBY'
 B4 A0 D3 D4 C1
 CE C4 C2 D9
07C0 17                 0900          DB    23D    SPACES
07C1                    0910          DW    '5 STOP'
 B5 A0 D3 D4 CF
 D0
07C7 1A                 0920          DB    26D    SPACES
07C8                    0930          DW    '6 READ'
 B6 A0 D2 C5 C1
 C4
 7CE 1A                 0940          DB    26D    SPACES
07CF                    0950          DW    '7 RECORD'
```

```
 B7 A0 D2 C5 C3
 CF D2 C4
07D7 18                 0960          DB   24D    SPACES
07D8                    0970          DW   '8 RECORD TEST DATA'
 B8 A0 D2 C5 C3
 CF D2 C4 A0 D4
 C5 D3 D4 A0 C4
 C1 D4 C1
07EA 0E                 0980          DB   14D    SPACES
07EB                    0990          DW   '9 READ TEST DATA'
 B9 A0 D2 C5 C1
 C4 A0 D4 C5 D3
 D4 A0 C4 C1 D4
 C1
07FB 57                 1000          DB   87D    SPACES
07FC                    1010          DW   'PHI DECK COMMANDS'
 D0 C8 C9 A0 C4
 C5 C3 CB A0 C3
 CF CD CD C1 CE
 C4 D3
080D 00                 1020          DB   0D     RETURN
080E FF                 1030 MSG2     DB   0FFH   ERASE
080F 07                 1040          DB   7D     SPACES
0810                    1050          DW   'TAPE BEING COPIED'
 D4 C1 D0 C5 A0
 C2 C5 C9 CE C7
 A0 C3 CF D0 C9
 C5 C4
0821 00                 1060          DB   0D     RETURN
0822 FF                 1070 MSG3     DB   0FFH   ERASE
0823 06                 1080          DB   6D     SPACES
0824                    1090          DW   'RECORDING TEST DATA'
 D2 C5 C3 CF D2
 C4 C9 CE C7 A0
 D4 C5 D3 D4 A0
 C4 C1 D4 C1
0837 00                 1100          DB   0D     RETURN
0838 FF                 1110 MSG4     DB   0FFH   ERASE
0839 06                 1120          DB   6D     SPACES
083A                    1130          DW   'TEST DATA BEING READ'
 D4 C5 D3 D4 A0
 C4 C1 D4 C1 A0
 C2 C5 C9 CE C7
 A0 D2 C5 C1 C4

084E 06                 1140          DB   6D     SPACES
084F 00                 1150          DB   0D     RETURN
0850 FF                 1160 MSG5     DB   0FFH   ERASE
0851                    1170          DW   'SELECT DECK NUMBER (0-3)'
 D3 C5 CC C5 C3
 D4 A0 C4 C5 C3
 CB A0 CE D5 CD
 C2 C5 D2 A0 A8
 B0 AD B3 A9
0869 28                 1180          DB   40D    SPACES
086A                    1190          DW   'DECK # '
```

```
 C4 C5 C3 CE A0
 A3 A0
0871                    1200 DNBR   DW   '0'
 B0
0872 38                 1210        DB   56D    SPACES
0873                    1220        DW   'DONE? (Y?)'
 C4 CF CE C5 BF
 A0 A8 D9 BF A9

087D 00                 1230        DB   0D     RETURN
087E 00                 1240        NOP
087F 00                 1250        NOP
0880 21 50 08           1260 TV     LD   HL,MSG5 LOAD H&L WITH DECK
0883                    1270 *                   SELECT MESSAGE
0883 3A B0 0A           1280        LD   A,(DECK) LOAD A WITH DECK #
0886 F6 B0              1290        OR   0B0H   CONVERT TO ASCII
0888 32 71 08           1300        LD   (DNBR),A LOAD DECK NUMBER IN
088B                    1310 *                   MESSAGE AREA
088B CD 00 02           1320        CALL TVEDIT CALL TV EDITOR
088E DB 00              1330 IN     IN   0      INPUT FROM KEYBOARD
0890 FE B4              1340        CP   0B4H   >"3" ?
0892 D2 A5 08           1350        JP   NC,DONE YES, CHECK FOR "Y"
0895 FE B0              1360        CP   0B0H   <"0" ?
0897 DA 8E 08           1370        JP   C,IN   YES, JUMP TO KEYBOARD
089A                    1380 *                   (LOOK FOR A NUMBER)
089A 32 83 07           1390        LD   (DKNBR),A IF BETWEEN 0 & 3, LOAD
089D                    1400 *                     DECK NUMBER IN MESSAGE
089D E6 03              1410        AND  3D     MASK ALL BUT 3 LSB'S
089F 32 B0 0A           1420        LD   (DECK),A LOAD DECK NUMBER AT "DECK"
08A2 C3 80 08           1430        JP   TV     DISPLAY MESSAGE WITH NEW DECK #
08A5 F6 20              1440 DONE   OR   20H    CONVERT TO LOWER CASE
08A7 FE F9              1450        CP   0F9H   "Y" ?
08A9 C2 80 08           1460        JP   NZ,TV  NO, JUMP TO MESSAGE
08AC CF                 1470        RST  8D     RESTART AT PHI DECK
08AD                    1480 *                   COMMANDS IF "Y"
08AD 21 0E 08           1490 CPYTP  LD   HL,MSG2 LOAD H&L WITH MESSAGE AREA
08B0 CD 00 02           1500        CALL TVEDIT CALL TV EDITOR
08B3 C3 C8 08           1510        JP   CPY    JUMP TO COPY TAPE ROUTINE
08B6 21 22 08           1520 RCTD   LD   HL,MSG3 LOAD H&L WITH MESSAGE AREA
08B9 CD 00 02           1530        CALL TVEDIT CALL TV EDITOR
08BC C3 A0 0B           1540        JP   RCDTD  JUMP TO RECORD TEST DATA
08BF                    1550 *                   ROUTINE
08BF 21 38 08           1560 RDTD   LD   HL,MSG4 LOAD H&L WITH MESSAGE AREA
08C2 CD 00 02           1570        CALL TVEDIT CALL TV EDITOR
08C5 C3 CC 0B           1580        JP   RTD    JUMP TO READ TEST DATA
08C8                    1590 *                   ROUTINE
08C8 CD 00 0C           1600 CPY    CALL COPY   CALL COPY TAPE ROUTINE
08CB CF                 1610        RST  8D     RESTART
08CC 0E A0              1620 FFWD   LD   C,0A0H LOAD C WITH FAST FORWARD
08CE                    1630 *                   COMMAND
08CE CD 9B 0A           1640        CALL CMDOUT OUTPUT COMMAND
08D1 CF                 1650        RST  8D     RESTART
08D2 0E 80              1660 FREV   LD   C,80H  LOAD C WITH FAST REVERSE
08D4                    1670 *                   COMMAND
08D4 CD 9B 0A           1680        CALL CMDOUT OUTPUT COMMAND
08D7 CF                 1690        RST  8D     RESTART
```

```
08D8 0E EC          1700 ERASET LD   C,0ECH LOAD C WITH ERASE COMMAND
08DA CD 9B 0A       1710        CALL CMDOUT OUTPUT COMMAND
08DD CF             1720        RST  8D     RESTART
08DE 0E 70          1730 STNDBY LD   C,70H  LOAD C WITH STANDBY COMMAND
08E0 CD 9B 0A       1740        CALL CMDOUT OUTPUT COMMAND
08E3 CF             1750        RST  8D     RESTART
08E4 0E F0          1760 STOP   LD   C,0F0H LOAD C WITH STOP COMMAND
08E6 CD 9B 0A       1770        CALL CMDOUT OUIPUT COMMAND
08E9 CF             1780        RST  8D     RESTART
08EA 0E E0          1790 READ   LD   C,0E0H LOAD C WITH READ COMMAND
08EC CD 9B 0A       1800        CALL CMDOUT OUTPUT COMMAND
08EF CF             1810        RST  8D     RESTART
08F0 0E E8          1820 RECORD LD   C,0E8H LOAD C WITH RECORD COMMAND
08F2 CD 9B 0A       1830        CALL CMDOUT OUTPUT COMMAND
08F5 CF             1840        RST  8D     RESTART
```

```
0BA0 06 00          0100 RCDTD  LD   B,0D    INITIALIZE COUNT
0BA2 0E E8          0110        LD   C,0E8H LOAD C WITH RECORD COMMAND
0BA4 CD 9B 0A       0120        CALL CMDOUT OUTPUT COMMAND
0BA7 48             0130 RCD    LD   C,B    LOAD C WITH COUNT
0BA8 CD AE 0A       0140        CALL DOUT   OUTPUT DATA
0BAB DB 02          0150 STATUS IN   2D     INPUT STATUS
0BAD E6 03          0160        AND  3D     READY?
0BAF CA AB 0B       0170        JP   Z,STATUS NO, CHECK STATUS
0BB2 05             0180        DEC  B      DECREMENT COUNT
0BB3 C2 A7 0B       0190        JP   NZ,RCD 256?
0BB6 16 02          0200        LD   D,2D   YES, OUTPUT DUMMY CHARACTERS
0BB8 4E             0210 LOOP   LD   C,B
0BB9 CD AE 0A       0220        CALL DOUT
0BBC DB 02          0230 STAT   IN   2D     INPUT STATUS
0BBE E6 03          0240        AND  3D     READY?
0BC0 CA BC 0B       0250        JP   Z,STAT NO, CHECK STATUS
0BC3 15             0260        DEC  D      DECREMENT LOOP
0BC4 C2 B8 0B       0270        JP   NZ,LOOP
0BC7 C3 A0 0B       0280        JP   RCDTD  RECORD NEXT BLOCK
0BCA 00             0290        NOP
0BCB 00             0300        NOP
0BCC 06 02          0310 RTD    LD   B,0    INITIALIZE COUNT
0BCE 0E E0          0320        LD   C,0E0H LOAD C WITH READ COMMAND
0BD0 CD 9B 0A       0330        CALL CMDOUT OUTPUT COMMAND
0BD3 DB 02          0340 STATR  IN   2D     INPUT STATUS
0BD5 E6 03          0350        AND  3D     READY?
0BD7 CA D3 0B       0360        JP   Z,STATR NO, CHECK STATUS
0BDA CD 8F 0A       0370        CALL DIN    YES INPUT DATA
0BDD 79             0380        LD   A,C    LOAD A WITH DATA
0BDE B8             0390        CP   B      COMPARE TO COUNT
0BDF C2 EF 0B       0400        JP   NZ,ERROR
0BE2 05             0410        DEC  B      DECREMENT COUNT
0BE3 C2 D3 0B       0420        JP   NZ,STATR
0BE6 21 FA 0B       0430        LD   HL,GOOD OUTPUT "G" IF BLOCK IS GOOD
0BE9 CD 00 02       0440        CALL TVEDIT CALL TV EDITOR
0BEC C3 CC 0B       0450        JP   RTD    READ NEXT BLOCK
0BEF 21 F8 0B       0460 ERROR  LD   HL,ERR OUTPUT "E" IF BLOCK IS
0BF2                0470 *                  IN ERROR
0BF2 CD 00 02       0480        CALL TVEDIT CALL TV EDITOR
0BF5 C3 CC 0B       0490        JP   RTD    READ NEXT BLOCK
0BF8 E5             0500 ERR    DB   0E5H
0BF9 02             0510        DB   2      RETURN
0BFA E7             0520 GOOD   DB   0E7H
0BFB 22             0530        DB   "      RETURN
0BFC 00             0540        NOP
0BFD 00             0550        NOP
0BFE 00             0560        NOP
0BFF 00             0570        NOP
0C00 3E 02          0580 COPY   LD   A,2     SET DECK 2
0C02 32 B4 0A       0590        LD   (DECK),A STORE DECK 2
0C05 CD 4F 0A       0600        CALL REWIND REWIND DECK 2
0C08 3E 01          0610        LD   A,1D   SET DECK 1
0C0A 32 B4 0A       0620        LD   (DECK),A STORE DECK 1
```

```
0C0D CD 4F 0A          0630          CALL REWIND REWIND DECK 1
0C10 97                0640          SUB  A       CLEAR A
0C11 32 76 0C          0650          LD   (TEMPID),A INITIALIZE ID
0C14 DB 02             0660 REDBLK   IN   TAPEIN
0C16 E6 08             0670          AND  8D      WAIT FOR NOT BUSY
0C18 CA 14 0C          0680          JP   Z,REDBLK
0C1B 3E 00             0690          LD   A,0     SET DECK 0
0C1D 32 B0 0A          0700          LD   (DECK),A STORE DECK 0
0C20 21 00 0D          0710          LD   HL,BUFFER SET UP POINTER
0C23 22 B3 0A          0720          LD   (POINTR),HL POINTER ADDRESS
0C26 3A 76 0C          0730          LD   A,(TEMPID) SET UP ID
0C29 32 B1 0A          0740          LD   (IDR),A
0C2C 1E 00             0750          LD   E,0     SET UP READ MODE
0C2E CD B9 0A          0760          CALL READ
0C31 F5                0770          PUSH AF      SAVE A & FLAGS
0C32 0E F0             0780          LD   C,0F0H STOP DECK
0C34 CD 9B 0A          0790          CALL CMDOUT
0C37 F1                0800          POP  AF      RESTORE A & FLAGS
0C38 FE 00             0810          CP   0       ERROR?
0C3A CA 41 0C          0820          JP   Z,WRTBLK NO
0C3D FE 02             0830          CP   2D      BLOCK FOUND?
0C3F C8                0840          RET  Z       NO, FINISHED
0C40 76                0850          HALT         HALT BECAUSE OF ERROR
0C41 DB 02             0860 WRTBLK   IN   TAPEIN
0C43 E6 08             0870          AND  8D      WAIT FOR NOT BUSY
0C45 CA 41 0C          0880          JP   Z,WRTBLK
0C48 3E 01             0890          LD   A,1D    SET DECK 1
0C4A 32 B0 0A          0900          LD   (DECK),A STORE DECK 1
0C4D 21 00 0D          0910          LD   HL,BUFFER SET UP POINTER
0C50 22 B7 0A          0920          LD   (POINTW),HL
0C53 3A 76 0C          0930          LD   A,(TEMPID) SET UP ID
0C56 32 B5 0A          0940          LD   (IDW),A
0C59 3C                0950          INC  A
0C5A 32 76 0C          0960          LD   (TEMPID),A
0C5D 78                0970          LD   A,B     SET UP COUNT
0C5E FE 00             0980          CP   0       256?
0C60 CA 69 0C          0990          JP   Z,X256
0C63 68                1000          LD   L,B
0C64 26 00             1010          LD   H,0
0C66 C3 6D 0C          1020          JP   CALRCD
0C69 26 01             1030 X256     LD   H,1D
0C6B 2E 00             1040          LD   L,0
0C6D CD 00 09          1050 CALRCD   CALL RECORD
0C70 FE 00             1060          CP   0
0C72 CA 14 0C          1070          JP   Z,REDBLK
0C75 76                1080          HALT
```

```
LOC   OBJ                    LABEL   OP     OPERAND  COMMENTS

2900                         0100 * RECORD (UNTIL COUNT EXHAUSTED)
2900                         0110 * DECK IS STOPPED AFTER RETURN
2900                         0120 * INPUT:
2900                         0130 *       DECK - DECK NUMBER LOCATED IN MEMORY
2900                         0140 *       POINTW - LOCATED IN MEMORY
2900                         0150 *                (FIRST DATA BYTE)
2900                         0160 *       IDW - LOCATED IN MEMORY (FIRST BLOCK)
2900                         0170 *       COUNT - REGISTER H,L
2900                         0180 * OUTPUT:
2900                         0190 *       POINTW - LOCATED IN MEMORY
2900                         0200 *                (LAST DATA BYTE + 1)
2900                         0210 *       ERROR - REGISTER A
2900                         0220 *                0 - NO ERRORS
2900                         0230 *                1 - CRC ERROR IN BLOCK
2900                         0240 *                    IDA - 1
2900                         0250 *                2 - BLOCK IDA-1 NOT FOUND
2900                         0260 *                3 - TAPE END OR JAM
2900                         0270 *       IDW - LOCATED IN MEMORY
2900                         0280 *             (LAST BLOCK + 1)
2900                         0290 *       ALTERED
2900                         0300 *             REGISTERS - A,F,C,D,E,H,L,IDR,POINTR
2900 16 01                   0310 RECORD  LD    D,1D     ERASE=1
2902 1E 05                   0320         LD    E,5D     STOPS=5
2904 E5                      0330         PUSH  HL       COUNT
2905 D5                      0340 RCD20   PUSH  DE       ERASE, STOPS
2906 2A B5 2A                0350         LD    HL,(IDW)
2909 2B                      0360         DEC   HL       IDR=IDA -1
290A 22 B1 2A                0370         LD    (IDR),HL
290D 23                      0380         INC   HL
290E 7D                      0390         LD    A,L      IDW=0 ?
290F B4                      0400         OR    H
2910 CA 29 09                0410         JP    Z,RCD10 YES
2913 16 0F                   0420         LD    D,11D    RETRIES = 12
2915 1E 01                   0430         LD    E,1D     CHECK MODE
2917 CD 7F 0B                0440         CALL  ALTRD
291A 3C                      0450         INC   A        ERROR?
291B 3D                      0460         DEC   A
291C CA 36 09                0470         JP    Z,RCD13 NO
291F D1                      0480 RCD12   POP   DE       ERASE, STOPS
2920 E1                      0490 RCD21   POP   HL       COUNT
2921 0E 90                   0500 RCD27   LD    C,90H    STOP
2923 47                      0510         LD    B,A      SAVE ERROR
2924 CD 9B 0A                0520         CALL  CMDOUT
2927 78                      0530         LD    A,B      RESTORE ERROR
2928 C9                      0540         RET
2929 CD 4F 0A                0550 RCD10   CALL  REWIND
292C 0E EC                   0560         LD    C,0ECH ERASE
292E CD 9B 0A                0570         CALL  CMDOUT
```

```
0931 3E 28          0580          LD   A,40D  4 SECONDS
0933 CD 81 0A       0590          CALL DELAY
0936 D1             0600 RCD13    POP  DE     ERASE, STOPS
0937 D5             0610          PUSH DE
0938 15             0620 RCD15    DEC  D      ERASE (ERASE - 1) BLOCKS
0939 CA 49 09       0630          JP   Z,RCD14
093C 0E EC          0640          LD   C,0ECH ERASE
093E CD 9B 0A       0650          CALL CMDOUT
0941 D5             0660          PUSH DE
0942 CD DA 09       0670          CALL RECRD1
0945 D1             0680          POP  DE
0946 C3 38 09       0690          JP   RCD15
0949 E1             0700 RCD14    POP  HL     ERASE, STOPS
094A D1             0710          POP  DE     COUNT
094B D5             0720          PUSH DE
094C E5             0730          PUSH HL
094D 2A B7 0A       0740          LD   HL,(POINTW) POINTER
0950 15             0750 RCD19    DEC  D      COUNT HIGH = 0?
0951 14             0760          INC  D
0952 C2 D4 09       0770          JP   NZ,RCD16 NO
0955 1D             0780          DEC  E
0956 1C             0790          INC  E
0957 CA 81 09       0800          JP   Z,RCD17 YES
095A 43             0810          LD   B,E    COUNT = COUNTL
095B 1E 00          0820          LD   E,0D   COUNTL =0
095D D5             0830 RCD18    PUSH DE     SAVE COUNT
095E EB             0840          EX   DE,HL
095F 2A B1 0A       0850          LD   HL,(IDR)
0962 23             0860          INC  HL
0963 22 B1 0A       0870          LD   (IDR),HL
0966 EB             0880          EX   DE,HL
0967 0E E8          0890          LD   C,0E8H RECORD
0969 CD 9B 0A       0900          CALL CMDOUT
096C CD DA 09       0910          CALL RECRD1
096F DF 02          0920          IN   TAPEIN ERROR?
0971 E6 0D          0930          AND  0DH
0973 D1             0940          POP  DE     GET COUNT
0974 CA 50 09       0950          JP   Z,RCD19 NO
0977 E1             0960          POP  DE     DECREMENT STOPS
0978 1D             0970          DEC  E      0?
0979 C2 05 09       0980          JP   NZ,RCD20 NO
097C 3E 03          0990          LD   A,3D   ERROR=3
097E C3 20 09       1000          JP   RCD21
0981 3E 05          1010 RCD17    LD   A,5D   APPROXIMATELY 10 BLOCKS
0983 CD 68 0A       1020          CALL FR
0986 E1             1030          POP  HL     ERASE, STOPS
0987 D1             1040          POP  DE     COUNT
0988 D5             1050 RCD26    PUSH DE
0989 E5             1060          PUSH HL
098A 97             1070          SUB  A      COUNT=0?
098B 82             1080          ADD  D
098C C2 93 09       1090          JP   NZ,RCD22 NO
098F 83             1100          ADD  E
0990 CA 1F 09       1110          JP   Z,RCD12 YES
0993 2A B5 0A       1120 RCD22    LD   HL,(IDW)
0996 22 B1 0A       1130          LD   (IDR),HL
```

```
0999 16 06          1140          LD   L,6D   RETRIES = 6
099B 1E 01          1150          LD   E,1D   CHECK MODE
099D CD BB 0A       1160          CALL ALTRD2
09A0 3C             1170          INC  A      ERROR?
09A1 3D             1180          DEC  A
09A2 D1             1190          POP  DE
09A3 CA AA 09       1200          JP   Z,RCD24 NO
09A6 14             1210          INC  D      INCREMENT ERASE
09A7 C3 C5 09       1220          JP   RCD20
09AA 16 01          1230 RCD24    LD   D,1D   ERASE=1
09AC 2A FC 0A       1240          LD   HL,(IDW) INCREMENT IDW
09AF 23             1250          INC  HL
09B0 22 FC 0A       1260          LD   (IDW),HL
09B3 EB             1270          EX   DE,HL
09B4 D1             1280          POP  DE
09B5 14             1290          INC  D      COUNT" =0?
09B6 15             1300          DEC  D
09B7 CA C7 09       1310          JP   Z,RCD25 YES
09BA 15             1320          DEC  D      DECREMENT COUNTH
09BB E5             1330          PUSH HL
09BC 2A B7 0A       1340          LD   HL,(POINTW)
09BF 24             1350          INC  H
09C0 22 B7 0A       1360          LD   (POINTW),HL
09C3 E1             1370          POP  HL
09C4 C3 88 09       1380          JP   RCD26
09C7 2A B7 0A       1390 RCD25    LD   HL,(POINTW) ALL COUNTL TO POINTER
09CA 16 00          1400          LD   L,0"
09CC 19             1410          ADD  HL,DE
09CD 22 B7 0A       1420          LD   (POINTW),HL
09D0 97             1430          SUB  A      ERROR = 0
09D1 C3 21 09       1440          JP   RCD27
09D4 15             1450 RCD18    DEC  D      DECREMENT COUNTH
09D5 26 00          1460          LD   H,0D   COUNT=0
09D7 C3 57 09       1470          JP   RCD19
09DA                1480 * RECRD1 (RECORD ONE BLOCK)
09DA                1490 *          RECORD OR ERASE COMMAND MUST BE ISSUED
09DA                1500 *            BEFORE CALLING.
09DA                1510 *          UNDERRUN AND STOP SHOULD BE CHECKED
09DA                1520 *            AFTER RETURN.
09DA                1530 *          INPUTS:
09DA                1540 *            DECK - DECK NUMBER LOCATED
09DA                1550 *                   IN MEMORY
09DA                1560 *            ID - REGISTER I,J
09DA                1570 *            COUNT - REGISTER D
09DA                1580 *                    (01=1 BYTE, 00=256 BYTES)
09DA                1590 *            POINTER - REGISTER H,L
09DA                1600 *                      (FIRST DATA BYTE)
09DA                1610 *          OUTPUT:
09DA                1620 *            POINTER - REGISTER H,L
09DA                1630 *            (LAST DATA BYTE + 1)
09DA                1640 *          ALTERED
09DA                1650 *            REGISTERS - A,B,C,D,E,H,L
09DA E5             1660 RECRD1   PUSH HL     PUSH POINTER
09DB 21 02 00       1670          LD   HL,01  RESET 1+0
09DE 4A             1680          LD   C,D    ID = 100
09DF CD 48 0A       1690          CALL ALTPUT
```

```
09E2 4B          1720        LD   C,E    ID LOW
09E3 CD 42 0A    1730        CALL PUT
09E6 48          1740        LD   C,B    COUNT
09E7 CD 42 0A    1750        CALL PUT
09EA 54          1760        LD   D,H    SAVE CRC2
09EB 4D          1770        LD   C,L    CRC1
09EC CD 42 0A    1780        CALL PUT
09EF 4A          1790        LD   C,D    CRC2
09F0 CD 42 0A    1800        CALL PUT
09F3 58          1810        LD   E,B    SAVE COUNT
09F4 E3          1820 RECD1  EX   (SP),HL SWITCH CRC, POINTER
09F5 4E          1830        LD   C,(HL) LOAD DATA
09F6 23          1840        INC  HL     INCREMENT POINTER
09F7 E3          1850        EX   (SP),HL SWITCH CRC,POINTER
09F8 CD 42 0A    1860        CALL PUT
09FB 05          1870        DEC  B      DECREMENT COUNT
09FC C2 F4 09    1880        JP   NZ,RECD1 NOT ZERO
09FF 54          1890        LD   D,H    SAVE CRC2
0A00 4D          1900        LD   C,L    CRC1
0A01 CD 42 0A    1910        CALL PUT
0A04 4A          1920        LD   C,D    CRC2
0A05 CD 42 0A    1930        CALL PUT
0A08 1D          1940        DEC  E      DECREMENT SAVED COUNT
0A09 CD 42 0A    1950 RECD3  CALL PUT
0A0C 1C          1960        INC  E      INCREMENT SAVED COUNT
0A0D C2 09 0A    1970        JP   NZ,RECD3 NOT ZERO
0A10 CD 42 0A    1980        CALL PUT
0A13 E1          1990        POP  HL     POP POINTER
0A14 C9          2000        RET
0A15             2010 *       GET
0A15             2020 *       CRC IN H,L
0A15             2030 *       DATA RETURNED IN C
0A15             2040 *       A,C,H,L ALTERED
0A15 DB 02       2050 GET    IN   TAPEIN STATUS
0A17 E6 0F       2060        AND  0FH
0A19 CA 15 0A    2070        JP   Z,GET
0A1C CD 8F 0A    2080        CALL DIN
0A1F D5          2090 CRC    PUSH DE
0A20 79          2100        LD   A,C
0A21 AD          2110        XOR  L
0A22 6F          2120        LD   L,A
0A23 1E 07       2130        LD   E,7D   7 TIMES
0A25 17          2140 CRCA   RLA  A
0A26 AD          2150        XOR  L
0A27 1D          2160        DEC  E
0A28 C2 25 0A    2170        JP   NZ,CRCA DONE?
0A2B 6F          2180        LD   L,A    YES
0A2C 0F          2190        RRCA A
0A2D 0F          2200        RRCA A
0A2E 5F          2210        LD   E,A    SAVE 1
0A2F E6 C0       2220        AND  0C0H
0A31 AC          2230        XOR  H
0A32 57          2240        LD   D,A    SAVE 2
0A33 7B          2250        LD   A,E    RESTORE 1
0A34 E6 3F       2260        AND  3FH
0A36 AD          2270        XOR  L
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0A37 67              2280         LD   E,A     CRC HIGH DONE
0A38 17              2290         RLA  A       TEST BIT 7
0A39 7A              2300         LD   A,D     RESTORE 2
0A3A D2 3F 0A        2310         JP   NC,CRCFIN BIT 7 WAS 1?
0A3D EE 21           2320         XOR  21      YES
0A3F 6F              2330 CRCFIN  LD   L,A     CRC LOW DONE
0A40 D1              2340         POP  DE
0A41 C9              2350         RET
0A42                 2360 *       PUT
0A42                 2370 *       DATA IN REGISTER C
0A42                 2380 *       CRC IN H,L
0A42                 2390 *       A,H,L ALTERED
0A42 DB 02           2400 PUT     IN   TAPEIN STATUS
0A44 E6 0F           2410         AND  0FH
0A46 CA 42 0A        2420         JP   Z,PUT
0A49 CD A8 0A        2430 ALTPUT  CALL DOUT
0A4C C3 1F 0A        2440         JP   CRC
0A4F                 2450 *       REWIND
0A4F                 2460 *       REGISTER A,C ALTERED
0A4F                 2470 *       THIS ROUTINE WILL GUARANTEE
0A4F                 2480 *       DECK SELECTION
0A4F 0E 90           2490 REWIND  LD   C,90H  STOP
0A51 CD 9E 0A        2500         CALL CMDOUT
0A54 DB 02           2510 REWB    IN   TAPEIN
0A56 E6 08           2520         AND  08H
0A58 CA 54 0A        2530         JP   Z,REWB
0A5B 0E 80           2540         LD   C,80H  FR
0A5D CD 9E 0A        2550         CALL CMDOUT
0A62 DB 02           2560 REWA    IN   TAPEIN
0A62 E6 08           2570         AND  8D
0A64 CA 60 0A        2580         JP   Z,REWA
0A67 C9              2590         RET
0A68                 2600 *       FAST REVERSE, FAST FORWARI
0A68                 2610 *       REGISTER A CONTAINS MULTIPLE
0A68                 2620 *       OF 100 MILLI-SECONDS DELAY
0A68                 2630 *       REGISTER A ALTERED
0A68 C5              2640 FR      PUSH BC
0A69 F5              2650         PUSH AF
0A6A 0E 80           2660         LD   C,80H
0A6C CD 9E 0A        2670 FRA     CALL CMDOUT
0A6F F1              2680         POP  AF
0A70 CD 81 0A        2690         CALL DELAY
0A73 0E 90           2700         LD   C,90H
0A75 CD 9E 0A        2710         CALL CMDOUT
0A78 C1              2720         POP  BC
0A79 C9              2730         RET
0A7A C5              2740 FF      PUSH BC
0A7B F5              2750         PUSH AF
0A7C 0E A0           2760         LD   C,0A0H
0A7E C3 6C 0A        2770         JP   FRA
0A81                 2780 *       DELAY MULTIPLE OF 100 MS IN REGISTER A
0A81                 2790 *       REGISTERS A,B,C ALTERED
0A81 01 B4 29        2800 DELAY   LD   BC,29B4H
0A84 0B              2810 D1      DEC  BC
0A85 04              2820         INC  B
0A86 05              2830         DEC  B
```

```
0A87 C2 84 0A          2840          JP    NZ,D1
0A8A 3D                2850          DEC   A
0A8B C2 81 0A          2860          JP    NZ,DELAY
0A8E C9                2870          RET
0A8F                   2880 *        INPUT DATA BYTE (DATA RETURNED IN C)
0A8F                   2890 *        REGISTER A IS ALTERED
0A8F 3E EF             2900 DIN      LD    A,0EFH
0A91 D3 01             2910          OUT   STROBE
0A93 DB 02             2920          IN    TAPEIN
0A95 4F                2930          LD    C,A
0A96 3E DF             2940 DINA     LD    A,0DFH
0A98 D3 01             2950          OUT   STROBE
0A9A C9                2960          RET
0A9B                   2970 *        OUTPUT COMMAND (DATA IN REGISTER C)
0A9B                   2980 *        DECK IS OR'D WITH DATA
0A9B                   2990 *        REGISTER A IS ALTERED
0A9B 3A B2 0A          3000 CMDOUT   LD    A,(DECK)
0A9E B1                3010          OR    C
0A9F D3 02             3020          OUT   TAPOUT
0AA1 3E 9F             3030          LD    A,9FH
0AA3 D3 01             3040 CMDA     OUT   STROBE
0AA5 C3 96 0A          3050          JP    DINA
0AA8                   3060 *        OUTPUT DATA (DATA IN REGISTER C)
0AA8                   3070 *        REGISTER A IS ALTERED
0AA8 79                3080 DOUT     LD    A,C
0AA9 D3 02             3090          OUT   TAPOUT
0AAB 3E 5F             3100          LD    A,5FH
0AAD C3 A3 0A          3110          JP    CMDA
0AB0                   3120 *        VARIABLE DATA AREA
0AB0                   3130 DECK     DS    1D      DECK NUMBER TO BE USED
0AB1                   3140 IDR      DS    2D      READ ID
0AB3                   3150 POINTR   DS    2D      READ POINTER
0AB5                   3160 IDW      DS    2D      WRITE ID
0AB7                   3170 POINTW   DS    2D      WRITE POINTER
0AB9                   3180 *        READ ONE BLOCK
0AB9                   3190 *          DECK REMAINS RUNNING AFTER RETURN
0AB9                   3200 *        INPUT:
0AB9                   3210 *          DECK - DECK NUMBER LOCATED IN MEMORY
0AB9                   3220 *          POINTR - LOCATED IN MEMORY
0AB9                   3230 *                   (FIRST BYTE)
0AB9                   3240 *          IDR - LOCATED IN MEMORY
0AB9                   3250 *          RETRYS - REGISTER D
0AB9                   3260 *                   (ALTRD ONLY)
0AB9                   3270 *          MODE - REGISTER E
0AB9                   3280 *                 0=READ
0AB9                   3290 *                 1=CHECK
0AB9                   3300 *          OUTPUT:
0AB9                   3310 *            DECK, POINTER, IDR UNCHANGED
0AB9                   3320 *            REGISTER - A,B,C,D,H,L ALTERED
0AB9                   3330 *            COUNT - REGISTER B
0AB9                   3340 *                    01=1 BYTE
0AB9                   3350 *                    00=256 BYTES
0AB9                   3360 *            ERROR - REGISTER A
0AB9                   3370 *                    0=NO ERRORS
0AB9                   3380 *                    1=CRC ERROR
0AB9                   3390 *                    2=BLOCK NOT FOUND
```

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0AB9                    3400 *                  3=END OF TAPE OR JAM
0AB9                    3410 *          ENTRY POINTS:
0AB9                    3420 *            READ - NORMAL ENTRY
0AB9                    3430 *            ALTRD - DECK WILL BACKSPACE
0AB9                    3440 *                    FIRST, USER MUST SUPPLY RETRIES
0AB9                    3450 *            ALTRD2 - NORMAL, EXCEPT USER MUST
0AB9                    3460 *                     SUPPLY RETRIES.
0AB9 16 0A              3470 READ   LD   D,10D  RETRIES
0ABB D5                 3480 RD54   PUSH DE     RETRIES, MODE
0ABC                    3490 ALTRD2 EQU  RD54
0ABC 21 00 00           3500 RD5    LD   HL,0D  RESET CRC
0ABF DB 02              3510        IN   TAPEIN STATUS
0AC1 57                 3520        LD   D,A
0AC2 0E E0              3530 RD51   LD   C,0E0H READ
0AC4 CD 9B 0A           3540        CALL CMDOUT
0AC7 7A                 3550        LD   A,D    STOP?
0AC8 E6 04              3560        AND  04H
0ACA CA D7 0A           3570        JP   Z,RD50 NO
0ACD 3E 04              3580        LD   A,4D   .4 SECONDS
0ACF CD 81 0A           3590        CALL DELAY
0AD2 16 00              3600        LD   D,0D   STATUS=0
0AD4 C3 C2 0A           3610        JP   RD51
0AD7 06 3A              3620 RD50   LD   B,3AH  8 SECOND TIMEOUT
0AD9 50                 3630 RD57   LD   D,B
0ADA DB 02              3640 RD53   IN   TAPEIN STATUS
0ADC E6 0F              3650        AND  0FH    READY?
0ADE C2 90 0B           3660        JP   NZ,RD10 YES
0AE1 1B                 3670        DEC  DE
0AE2 14                 3680        INC  D
0AE3 15                 3690        DEC  D
0AE4 C2 DA 0A           3700        JP   NZ,RD53
0AE7 05                 3710        DEC  B
0AE8 C2 D9 0A           3720        JP   NZ,RD57
0AEB CD 4F 0A           3730        CALL REWIND
0AEE 3E 02              3740 RD2    LD   A,2D   ERROR=2
0AF0 D1                 3750        POP  DE     RETRIES, MODE
0AF1 15                 3760 RD8    DEC  D
0AF2 C2 BB 0A           3770        JP   NZ,RD54
0AF5 C9                 3780        RET
0AF6 CD 15 0A           3790 RD52   CALL GET    IDH
0AF9 41                 3800        LD   B,C
0AFA CD 15 0A           3810        CALL GET    IDL
0AFD 59                 3820        LD   E,C
0AFE CD 15 0A           3830        CALL GET    COUNT
0B01 51                 3840        LD   D,C
0B02 CD 15 0A           3850        CALL GET    CRC1
0B05 CD 15 0A           3860        CALL GET    CRC2
0B08 97                 3870        SUB  A      CRC=0?
0B09 84                 3880        ADD  H
0B0A C2 BC 0A           3890        JP   NZ,RD5 NO
0B0D 85                 3900        ADD  L
0B0E C2 BC 0A           3910        JP   NZ,RD5 NO
0B11                    3920 *      COMPUTE      BE  TAPEID
0B11                    3930 *                   -HL  IDR
0B11                    3940 *                   =XY
0B11 7B                 3950        LD   A,E
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0B12 2A F1 0A        3960        LD   HL,(ITP)
0B15 95              3970        SUB  L
0B16 5F              3980        LD   E,A     REGISTER A CONTAINS Y
0B17 6F              3990        LD   L,A
0B18 7B              4000        LD   A,E
0B19 9C              4010        SBC  H       REGISTER A CONTAINS X
0B1A 67              4020        LD   H,A     H=X1/2
0B1B 29              4030        ADD  HL,HL
0B1C 29              4040        ADD  HL,HL
0B1D 29              4050        ADD  HL,HL
0B1E 29              4060        ADD  HL,HL
0B1F 29              4070        ADD  HL,HL
0B20 7C              4080        LD   A,H
0B21 CA 38 0B        4090        JP   Z,ID1
0B24 F2 3D 0B        4100        JP   P,ID2
0B27 2F              4110        CPL          COMPUTE FF DELAY
0B28 C6 02           4120        ADD  2D      ADD1+1 FOR 2'S COMP
0B2A FA 32 0B        4130        JP   M,ID3
0B2D FE 04           4140        CP   4D      GREATER THAN THRESHOLD?
0B2F FA BC 0A        4150        JP   M,RD5   NO
0B32 CD 7A 0A        4160 ID3    CALL FF
0B35 C3 BC 0A        4170        JP   RD5
0B38 1C              4180 ID1    INC  E       Y=0?
0B39 1D              4190        DEC  E
0B3A CA 45 0B        4200        JP   Z,RD6   YES
0B3D C6 06           4210 ID2    ADD  6D
0B3F CD 68 0A        4220        CALL FR
0B42 C3 EB 0A        4230        JP   RD2
0B45 42              4240 RD6    LD   B,D     COUNT
0B46 D1              4250        POP  DE      RETRIES, MODE
0B47 C5              4260        PUSH BC      CCUNT
0B48 2A B3 0A        4270        LD   HL,(POINTR)
0B4B E5              4280        PUSH HL
0B4C 21 02 00        4290        LD   HL,0D   RESET CRC
0B4F CD 15 0A        4300 RD56   CALL GET
0B52 1C              4310        INC  E
0B53 1D              4320        DEC  E
0B54 C2 5F 0B        4330        JP   NZ,RD55
0B57 E3              4340        EX   (SP),HL SWITCH CRC,POINTER
0B58 71              4350        LD   (HL),C STORE DATA
0B59 23              4360        INC  HL      BUMP POINTER
0B5A E3              4370        EX   (SP),HL SWITCH CRC, POINTER
0B5B 05              4380 RD55   DEC  B       DECREMENT CCUNT
0B5C C2 4F 0B        4390        JP   NZ,RD56
0B5F C1              4400        POP  BC      ADJUST STACK POINTER
0B60 C1              4410        POP  BC      CCUNT
0B61 CD 15 0A        4420        CALL GET
0B64 CD 15 0A        4430        CALL GET
0B67 DB 02           4440        IN   TAPEIN STATUS
0B69 1F              4450        RRA          OVERRUN?
0B6A DA 7B 0B        4460        JP   C,ALTRD YES
0B6D 1F              4470        RRA  A
0B6E 1F              4480        RRA  A       STOP?
0B6F DA 96 0B        4490        JP   C,RD11 YES
0B72 97              4500        SUB  A
0B73 84              4510        ADD  H
```

```
0B74 C2 7F 0B        4520          JP   NZ,ALTRD NO
0B77 85              4530          ADD  L
0B78 CA 85 0B        4540          JP   Z,RD19
0B7B 3E 05           4550 ALTRD    LD   A,5D    GREATER THAN 1 BLOCK
0B7D CD 6E 0A        4560          CALL ER
0B80 3E 01           4570          LD   A,1D    ERROR=1
0B82 C3 F1 0A        4580          JP   RDE
0B85 50              4590 RD19     LD   I,B     SAVE COUNT
0B86 15              4600          DEC  D       DECREMENT SAVED COUNT
0B87 CD 15 0A        4610 RD9      CALL GET
0B8A 14              4620          INC  D       INCREMENT SAVED COUNT
0B8B C2 87 0B        4630          JP   NZ,RD9
0B8E 97              4640          SUB  A       ERROR=0
0B8F C9              4650          RET
0B90 E6 04           4660 RD10     AND  04H     STOP?
0B92 CA F6 0A        4670          JP   Z,RD52 NO
0B95 D1              4680          POP  DE      RETRIES, MODE
0B96 CD 4F 0A        4690 RD11     CALL REWIND
0B99 3E 03           4700          LD   A,3D    ERROR=3
0B9B C3 F1 0A        4710          JP   RDE
```

8Ø8Ø PHI-DECK DEMO SOFTWARE

1. Programs are loaded via AUDIO CASSETTE.
2. At completion of a successful load, a listing of Phi-Deck Command options will be displayed.
3. In addition to the options displayed on the screen, there are also three options possible - "R", "S", and "P".
4. "R" will return control to 8Ø8Ø OPS System options which include:
   1 READ Cassette - Read an Audio Cassette
   2 WRITE Cassette - Write an Audio Cassette
   3 TV Storage Dump - TV Display of Memory in Octal
   4 Keyboard Program - User may program in Octal
   5 PHI-DECK OPS
5. "S" will display memory as option 3 in 8Ø8Ø OPS System.
6. "P" will allow user to program same as option 4 in 8Ø8Ø OPS System.
7. Reset will return control to Phi-Deck Commands.
8. "P", "R", and "S" will operate also when in Program, Storage Dump, or Phi-Deck OPS.
9. Phi-Deck Option "#" allows user to select any of four decks (Ø-3) by first pressing shift and # then the desired deck number. To return to Phi-Deck OPS press Y. The deck number selected will be displayed in Options listing upon return.
10. Phi-Deck Option "1" will erase a tape on the selected deck.
11. Phi-Deck Option "2" will fast reverse the selected deck.
12. Phi-Deck Option "3" will fast forward the selected deck.
13. Phi-Deck Option "4" will place all decks in standby. The capstan motors will be turned off.
14. Phi-Deck Option "5" will stop the selected deck.
15. Phi-Deck Option "6" will issue a read command to the selected deck. This will not read data from the tape.
16. Phi-Deck Option "7" will issue a record command to the selected deck. This will not record data on the tape.
17. Phi-Deck Option "8" will record 256 byte blocks of data in a fixed pattern.
18. Phi-Deck Option "9" will read 256 byte blocks of data in the same pattern as recorded in Option "8". An "e" will be displayed on the monitor for blocks in error and a "g" for good blocks.
19. Page Ø15 is being used as a 256 byte buffer in the copy tape routine.
20. Option "Ø" will copy a tape from deck #Ø to deck #1. This is not intended as an efficient method of duplicating Phi-Deck Tapes, only as a demonstration of Phi-Deck routines.

CHANGES TO 8Ø8Ø OPERATING SYSTEM
FOR PHI-DECK DEMO

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
ØØ5 112	17Ø				ADDRESS JUMP
ØØ5 113	ØØ7				FOR KEY 5
ØØ5 271	Ø16				SPACES
ØØ5 272	265				5
ØØ5 273	24Ø				
ØØ5 274	32Ø				P
ØØ5 275	31Ø				H
ØØ5 276	311				I
ØØ5 277	24Ø				
ØØ5 3ØØ	3Ø4				D
ØØ5 3Ø1	3Ø5				E
ØØ5 3Ø2	3Ø3				C
ØØ5 3Ø3	313				K
ØØ5 3Ø4	24Ø				
ØØ5 3Ø5	317				O
ØØ5 3Ø6	32Ø				P
ØØ5 3Ø7	323				S
ØØ5 31Ø	ØØØ				RETURN
ØØ1 ØØ3	17Ø				
ØØ1 ØØ4	ØØ7				
ØØ3 257	ØØ3				
ØØ3 26Ø	ØØ5				
ØØ4 176	ØØ3				
ØØ4 177	ØØ5				
ØØ5 ØØØ	3Ø3				
ØØ5 ØØ1	17Ø				
ØØ5 ØØ2	ØØ7				

8Ø8Ø PHI-DECK DEMO SOFTWARE

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
ØØ7 ØØØ	Ø76 ØØØ	COPY	MVI	A, Ø	SET DECK Ø
ØØ7 ØØ2	Ø62 26Ø Ø12		STA	DECK	STORE DECK #
ØØ7 ØØ5	315 117 Ø12		CALL	REWIND	REWIND DECK Ø
ØØ7 Ø1Ø	Ø76 ØØ1		MVI	A,1	SET DECK 1
ØØ7 Ø12	Ø62 26Ø Ø12		STA	DECK	STORE DECK #
ØØ7 Ø15	315 117 Ø12		CALL	REWIND	REWIND DECK 1
ØØ7 Ø2Ø	227		SUB	A	CLEAR A
ØØ7 Ø21	Ø62 166 ØØ7		STA	TEMPID	INITIALIZE ID
ØØ7 Ø24	333 ØØ2	REDBLK	IN	TAPEIN	WAIT FOR NOT BUSY
ØØ7 Ø26	346 Ø1Ø		ANI	Ø1Ø	
ØØ7 Ø3Ø	312 Ø24 ØØ7		JZ	REDBLK	
ØØ7 Ø33	Ø76 ØØØ		MVI	A,Ø	SET DECK Ø
ØØ7 Ø35	Ø62 26Ø Ø12		STA	DECK	STORE DECK #
ØØ7 Ø4Ø	Ø41 ØØØ Ø15		LXI	H,BUFFER	SET UP POINTER
ØØ7 Ø43	Ø42 263 Ø12		SHLD	POINTR	STORE POINTER ADDRESS
ØØ7 Ø46	Ø72 166 ØØ7		LDA	TEMPID	SET UP ID
ØØ7 Ø51	Ø62 261 Ø12		STA	IDR	
ØØ7 Ø54	Ø36 ØØØ		MVI	E,Ø	SET UP READ MODE
ØØ7 Ø56	315 271 Ø12		CALL	READ	READ A BLOCK
ØØ7 Ø61	365		PUSH	PSW	SAVE A
ØØ7 Ø62	Ø16 36Ø		MVI	C, 36Ø	STOP DECK
ØØ7 Ø64	315 233 Ø12		CALL	CMDOUT	
ØØ7 Ø67	361		POP	PSW	RESTORE A
ØØ7 Ø7Ø	376 ØØØ		CPI	Ø	ERROR
ØØ7 Ø72	312 1Ø1 ØØ7		JZ	WRTBLK	NO
ØØ7 Ø75	376 ØØ2		CPI	ØØ2	BLOCK FOUND?
ØØ7 Ø77	31Ø		RZ		NO, FINISHED
ØØ7 1ØØ	166		HLT		HALT BECAUSE OF ERROR
ØØ7 1Ø1	333 ØØ2	WRTBLK	IN	TAPEIN	WAIT FOR NOT BUSY DECK NUMBER CHANGING
ØØ7 1Ø3	346 Ø1Ø		ANI	Ø1Ø	
ØØ7 1Ø5	312 1Ø1 ØØ7		JZ	WRTBLK	
ØØ7 11Ø	Ø76 ØØ1		MVI	A,1	SET DECK 1
ØØ7 112	Ø62 26Ø Ø12		STA	DECK	
ØØ7 115	Ø41 ØØØ Ø15		LXI	H,BUFFER	SET UP POINTER
ØØ7 12Ø	Ø42 267 Ø12		SHLD	POINTW	
ØØ7 123	Ø72 166 ØØ7		LDA	TEMPID	SET UP ID
ØØ7 126	Ø62 265 Ø12		STA	IDW	
ØØ7 131	Ø74		INR	A	INCREMENT ID
ØØ7 132	Ø62 166 ØØ7		STA	TEMPID	
ØØ7 135	17Ø		MOV	A,B	SET UP COUNT
ØØ7 136	376 ØØØ		CPI	Ø	256?
ØØ7 14Ø	312 151 ØØ7		JZ	X256	
ØØ7 143	15Ø		MOV	L,B	

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
ØØ7 144	Ø46 ØØØ		MVI	H,Ø	
ØØ7 146	3Ø3 155 ØØ7		JMP	CALRCD	
ØØ7 151	Ø46 ØØ1	X256	MVI	H,1	
ØØ7 153	Ø56 ØØØ		MVI	L,Ø	
ØØ7 155	315 ØØØ Ø11	CALRCD	CALL	RECORD	RECORD BLOCK
ØØ7 16Ø	376 ØØØ		CPI	Ø	
ØØ7 162	312 Ø24 ØØ7		JZ	REDBLK	
ØØ7 165	166		HLT		
ØØ7 166	ØØØ ØØØ	TEMPID			
ØØ7 17Ø	Ø61 ØØØ ØØ2		LXI	SP	LOAD STACK POINTER
ØØ7 173	373		EI		
ØØ7 174	Ø41 316 ØØ7		LXI	H	
ØØ7 177	Ø72 26Ø Ø12		LDA	(Ø12 26Ø)	LOAD A W DECK #
ØØ7 2Ø2	366 26Ø		ORI	26Ø	CONVERT TO ASCII
ØØ7 2Ø4	Ø62 342 ØØ7		STA	ØØ7 342	PLACE DECK # IN MESSAGE
ØØ7 2Ø7	315 Ø45 ØØ2		CALL	TVEDIT	CALL TV EDITOR
ØØ7 212	315 ØØØ ØØ2	KYBD	CALL		CALL KEYBOARD
ØØ7 215	376 272		CPI	272	NUMBER?
ØØ7 217	322 155 Ø1Ø		JNC	LETTER	NO, JUMP TO LETTERS
ØØ7 222	376 26Ø		CPI	26Ø	< Ø ?
ØØ7 224	332 256 ØØ7		JC	CHARS	YES, JUMP TO CHARS
ØØ7 227	365		PUSH	A	SAVE A
ØØ7 23Ø	315 Ø21 ØØ2		CALL	ERASE	ERASE
ØØ7 233	361		POP	A	RESTORE A
ØØ7 234	ØØ7		RLC		ROTATE LEFT
ØØ7 235	3Ø6 127		ADI	127	PRODUCE L INDEX
ØØ7 237	157		MOV	L,A	
ØØ7 24Ø	Ø46 ØØ7		MVI	H, ØØ7	H INDEX
ØØ7 242	176		MOV	A,M	
ØØ7 243	Ø62 254 ØØ7		STA		STORE A
ØØ7 246	Ø43		INX	H	INCREMENT H & L
ØØ7 247	176		MOV	A,M	
ØØ7 25Ø	Ø62 255 ØØ7		STA		
ØØ7 253	3Ø3 * *		JMP		
ØØ7 256	376 243	CHARS	CPI	243	# ?
ØØ7 26Ø	3Ø2 212 ØØ7		JNZ	KYBD	
ØØ7 263	Ø56 314		MVI	L, 314	
ØØ7 265	3Ø3 24Ø ØØ7		JMP		
ØØ7 27Ø	3ØØ Ø13				Ø SELECT ADDRESS
ØØ7 272	217 Ø1Ø				1 SELECT ADDRESS
ØØ7 274	211 Ø1Ø				2 SELECT ADDRESS
ØØ7 276	2Ø3 Ø1Ø				3 SELECT ADDRESS

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
ØØ7 3ØØ	225 Ø1Ø				4 SELECT ADDRESS
ØØ7 3Ø2	233 Ø1Ø				5 SELECT ADDRESS
ØØ7 3Ø4	241 Ø1Ø				6 SELECT ADDRESS
ØØ7 3Ø6	247 Ø1Ø				7 SELECT ADDRESS
ØØ7 31Ø	311 Ø13				8 SELECT ADDRESS
ØØ7 312	322 Ø13				9 SELECT ADDRESS
ØØ7 314	115 Ø14				# SELECT ADDRESS
ØØ7 316	377				ERASE
ØØ7 317	243				#
ØØ7 32Ø	24Ø				
ØØ7 321	323				S
ØØ7 322	345				e
ØØ7 323	354				l
ØØ7 324	24Ø				
ØØ7 325	3Ø4				D
ØØ7 326	345				e
ØØ7 327	343				c
ØØ7 33Ø	353				k
ØØ7 331	ØØ4				SPACES
ØØ7 332	311				I
ØØ7 333	356				n
ØØ7 334	24Ø				
ØØ7 335	325				U
ØØ7 336	363				s
ØØ7 337	345				e
ØØ7 34Ø	24Ø				
ØØ7 341	24Ø				
ØØ7 342	26Ø				Ø
ØØ7 343	Ø11				SPACES
ØØ7 344	26Ø				Ø
ØØ7 345	24Ø				
ØØ7 346	3Ø3				C
ØØ7 347	357				o
ØØ7 35Ø	36Ø				p
ØØ7 351	371				y
ØØ7 352	24Ø				
ØØ7 353	324				T
ØØ7 354	341				a
ØØ7 355	36Ø				p
ØØ7 356	345				e
ØØ7 357	Ø25				SPACES
ØØ7 36Ø	261				1
ØØ7 361	24Ø				

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
ØØ7 362	3Ø5				E
ØØ7 363	362				r
ØØ7 364	341				a
ØØ7 365	363				s
ØØ7 366	345				e
ØØ7 367	Ø31				SPACES
ØØ7 370	262				2
ØØ7 371	24Ø				
ØØ7 372	3Ø6				F
ØØ7 373	341				a
ØØ7 374	363				s
ØØ7 375	364				t
ØØ7 376	24Ø				
ØØ7 377	322				R
Ø1Ø ØØØ	345				e
Ø1Ø ØØ1	366				v
Ø1Ø ØØ2	345				e
Ø1Ø ØØ3	362				r
Ø1Ø ØØ4	363				s
Ø1Ø ØØ5	345				e
Ø1Ø ØØ6	Ø22				SPACES
Ø1Ø ØØ7	263				3
Ø1Ø Ø1Ø	24Ø				
Ø1Ø Ø11	3Ø6				F
Ø1Ø Ø12	341				a
Ø1Ø Ø13	363				s
Ø1Ø Ø14	364				t
Ø1Ø Ø15	24Ø				
Ø1Ø Ø16	3Ø6				F
Ø1Ø Ø17	357				o
Ø1Ø Ø2Ø	362				r
Ø1Ø Ø21	367				w
Ø1Ø Ø22	341				a
Ø1Ø Ø23	362				r
Ø1Ø Ø24	344				d
Ø1Ø Ø25	Ø22				SPACES
Ø1Ø Ø26	264				4
Ø1Ø Ø27	24Ø				
Ø1Ø Ø3Ø	323				S
Ø1Ø Ø31	364				t
Ø1Ø Ø32	341				a
Ø1Ø Ø33	356				n
Ø1Ø Ø34	344				d
Ø1Ø Ø35	342				b
Ø1Ø Ø36	371				y
Ø1Ø Ø37	Ø27				SPACES

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
Ø1Ø Ø4Ø	265				5
Ø1Ø Ø41	24Ø				
Ø1Ø Ø42	323				S
Ø1Ø Ø43	364				t
Ø1Ø Ø44	357				o
Ø1Ø Ø45	36Ø				p
Ø1Ø Ø46	Ø32				SPACES
Ø1Ø Ø47	266				6
Ø1Ø Ø5Ø	24Ø				
Ø1Ø Ø51	322				R
Ø1Ø Ø52	345				e
Ø1Ø Ø53	341				a
Ø1Ø Ø54	344				d
Ø1Ø Ø55	Ø32				SPACES
Ø1Ø Ø56	267				7
Ø1Ø Ø57	24Ø				
Ø1Ø Ø6Ø	322				R
Ø1Ø Ø61	345				e
Ø1Ø Ø62	343				c
Ø1Ø Ø63	357				o
Ø1Ø Ø64	362				r
Ø1Ø Ø65	344				d
Ø1Ø Ø66	Ø3Ø				SPACES
Ø1Ø Ø67	27Ø				8
Ø1Ø Ø7Ø	24Ø				
Ø1Ø Ø71	322				R
Ø1Ø Ø72	345				e
Ø1Ø Ø73	343				c
Ø1Ø Ø74	357				o
Ø1Ø Ø75	362				r
Ø1Ø Ø76	344				d
Ø1Ø Ø77	24Ø				
Ø1Ø 1ØØ	324				T
Ø1Ø 1Ø1	345				e
Ø1Ø 1Ø2	363				s
Ø1Ø 1Ø3	364				t
Ø1Ø 1Ø4	24Ø				
Ø1Ø 1Ø5	3Ø4				D
Ø1Ø 1Ø6	341				a
Ø1Ø 1Ø7	364				t
Ø1Ø 11Ø	341				a
Ø1Ø 111	Ø16				SPACES
Ø1Ø 112	271				9
Ø1Ø 113	24Ø				
Ø1Ø 114	322				R

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
Ø1Ø 115	345				e
Ø1Ø 116	341				a
Ø1Ø 117	344				d
Ø1Ø 12Ø	24Ø				
Ø1Ø 121	324				T
Ø1Ø 122	345				e
Ø1Ø 123	363				s
Ø1Ø 124	364				t
Ø1Ø 125	24Ø				
Ø1Ø 126	3Ø4				D
Ø1Ø 127	341				a
Ø1Ø 13Ø	364				t
Ø1Ø 131	341				a
Ø1Ø 132	127				SPACES
Ø1Ø 133	32Ø				P
Ø1Ø 134	31Ø				H
Ø1Ø 135	311				I
Ø1Ø 136	24Ø				
Ø1Ø 137	3Ø4				D
Ø1Ø 14Ø	3Ø5				E
Ø1Ø 141	3Ø3				C
Ø1Ø 142	313				K
Ø1Ø 143	24Ø				
Ø1Ø 144	3Ø3				C
Ø1Ø 145	317				O
Ø1Ø 146	315				M
Ø1Ø 147	315				M
Ø1Ø 15Ø	3Ø1				A
Ø1Ø 151	316				N
Ø1Ø 152	3Ø4				D
Ø1Ø 153	323				S
Ø1Ø 154	ØØØ				RETURN
Ø1Ø 155	366 Ø4Ø	LETTER	ORI	Ø4Ø	PRODUCE LOWER CASE
Ø1Ø 157	376 363		CPI	363	'S' ?
Ø1Ø 161	312 ØØØ ØØ3		JZ	ØØ3 ØØØ	JUMP IF 'S' TO STORAGE DUMP
Ø1Ø 164	376 362		CPI	362	'R' ?
Ø1Ø 166	312 ØØ3 ØØ5		JZ	ØØ5 ØØ3	JUMP IF EQUAL TO 8Ø8Ø OPS SYSTEM
Ø1Ø 171	376 36Ø		CPI	36Ø	'P' ?
Ø1Ø 173	312 Ø65 ØØ4		JZ	ØØ4 Ø65	JUMP IF EQUAL TO KEYBOARD PROGRAMMING
Ø1Ø 176	317		RST	Ø1Ø	
Ø1Ø 177	315 ØØØ ØØ7	CPY	CALL	COPY	COPY TAPE ROUTINE

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
Ø1Ø 2Ø2	317		RST	Ø1Ø	RESTART
Ø1Ø 2Ø3	Ø16 24Ø	FFWD	MVI	C, 24Ø	LOAD C w FAST FORWARD
Ø1Ø 2Ø5	315 233 Ø12		CALL	CMDOUT	OUTPUT COMMAND
Ø1Ø 21Ø	317		RST	Ø1Ø	RESTART
Ø1Ø 211	Ø16 2ØØ	FREV	MVI	C, 2ØØ	LOAD C w FAST REVERSE
Ø1Ø 213	315 233 Ø12		CALL	CMDOUT	OUTPUT COMMAND
Ø1Ø 216	317		RST	Ø1Ø	RESTART
Ø1Ø 217	Ø16 354	ERASE	MVI	C, 354	LOAD C w ERASE
Ø1Ø 221	315 233 Ø12		CALL	CMDOUT	OUTPUT COMMAND
Ø1Ø 224	317		RST	Ø1Ø	RESTART
Ø1Ø 225	Ø16 16Ø	STNDBY	MVI	C, 16Ø	LOAD C w STANDBY
Ø1Ø 227	315 233 Ø12		CALL	CMDOUT	OUTPUT COMMAND
Ø1Ø 232	317		RST	Ø1Ø	RESTART
Ø1Ø 233	Ø16 36Ø	STOP	MVI	C, 36Ø	LOAD C w STOP
Ø1Ø 235	315 233 Ø12		CALL	CMDOUT	OUTPUT COMMAND
Ø1Ø 24Ø	317		RST	Ø1Ø	RESTART
Ø1Ø 241	Ø16 34Ø	READ	MVI	C, 34Ø	LOAD C w READ
Ø1Ø 243	315 233 Ø12		CALL	CMDOUT	OUTPUT COMMAND
Ø1Ø 246	317		RST	Ø1Ø	RESTART
Ø1Ø 247	Ø16 35Ø	RECORD	MVI	C, 35Ø	LOAD C w RECORD
Ø1Ø 251	315 233 Ø12		CALL	CMDOUT	OUTPUT COMMAND
Ø1Ø 254	317		RST	Ø1Ø	RESTART
Ø1Ø 26Ø	ØØ6 ØØØ	RCDTD	MVI	B,Ø	INITIALIZE COUNT
Ø1Ø 262	Ø16 35Ø		MVI	C, 35Ø	LOAD C w RECORD
Ø1Ø 264	315 233 Ø12		CALL	CMDOUT	OUTPUT COMMAND
Ø1Ø 267	11Ø	RCD	MOV	C, B	LOAD C w COUNT
Ø1Ø 27Ø	315 25Ø Ø12		CALL	DOUT	OUTPUT DATA
Ø1Ø 273	333 ØØ2	STATUS	IN	2	INPUT STATUS
Ø1Ø 275	346 ØØ3		ANI	3	READY
Ø1Ø 277	312 273 Ø1Ø		JZ	STATUS	NO, INPUT STATUS
Ø1Ø 3Ø2	ØØ5		DEC	B	YES, DECREMENT COUNT
Ø1Ø 3Ø3	3Ø2 267 Ø1Ø		JNZ	RCD	256?
Ø1Ø 3Ø6	Ø26 ØØ2		MVI	D, 2	YES, OUTPUT ADDED CHARACTERS TO ALLOW TIME FOR DELAY
Ø1Ø 31Ø	11Ø	LOOP	MOV	C,B	LOAD C w COUNT
Ø1Ø 311	315 25Ø Ø12		CALL	DOUT	OUTPUT DATA
Ø1Ø 314	333 ØØ2	STAT	IN	2	INPUT STATUS
Ø1Ø 316	346 ØØ3		ANI	3	READY?
Ø1Ø 32Ø	312 314 Ø1Ø		JZ	STAT	NO, INPUT STATUS

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
Ø1Ø 323	Ø25		DEC	D	YES, DECREMENT LOOP COUNT
Ø1Ø 324	3Ø2 31Ø Ø1Ø		JNZ	LOOP	
Ø1Ø 327	3Ø3 26Ø Ø1Ø		JMP	RCDTD	RECORD NEXT BLOCK
Ø1Ø 334	ØØ6 ØØØ	RTD	MVI	B, Ø	INITIALIZE COUNT
Ø1Ø 336	Ø16 34Ø		MVI	C, 340	LOAD C w READ
Ø1Ø 34Ø	315 233 Ø12		CALL	CMDOUT	OUTPUT COMMAND
Ø1Ø 343	333 ØØ2	STATR	IN	2	INPUT STATUS
Ø1Ø 345	346 ØØ3		ANI	3	READY?
Ø1Ø 347	312 343 Ø1Ø		JZ	STATR	NO
Ø1Ø 352	315 217 Ø12		CALL	DIN	YES, INPUT DATA
Ø1Ø 355	171		MOV	A,C	MOVE DATA TO A
Ø1Ø 356	27Ø		CMP	B	COMPARE TO COUNT
Ø1Ø 357	3Ø2 262 Ø13		JNZ	ERROR	JUMP IF NOT EQUAL TO ERROR
Ø1Ø 362	ØØ5		DEC	B	DECREMENT COUNT
Ø1Ø 363	3Ø2 343 Ø1Ø		JNZ	STATR	256? NO, READ NEXT BYTE
Ø1Ø 366	Ø41 275 Ø13		LXI	H	OUTPUT 'g' IF END OF BLOCK
Ø1Ø 371	315 Ø45 ØØ2		CALL	TVEDIT	CALL TV EDITOR
Ø1Ø 374	3Ø3 334 Ø1Ø		JMP	RTD	READ NEXT BLOCK

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
Ø13 262	Ø41 273 Ø13	ERROR	LXI	H	OUTPUT 'e' IF ERROR
Ø13 265	315 Ø45 ØØ2		CALL	TVEDIT	CALL TV EDITOR
Ø13 27Ø	3Ø3 334 Ø1Ø		JMP RTD		READ NEXT BLOCK
Ø13 273	345		DB	345	'e'
Ø13 274	ØØØ		DB	Ø	RETURN
Ø13 275	347		DB	347	'g'
Ø13 276	ØØØ		DB	Ø	RETURN
Ø13 3ØØ	Ø41 335 Ø13		LXI	H	LOAD COPY TAPE MESSAGE AREA
Ø13 3Ø3	315 Ø45 ØØ2		CALL	TVEDIT	CALL TV EDITOR
Ø13 3Ø6	3Ø3 177 Ø1Ø		JMP	CPY	JUMP TO COPY TAPE ROUTINE
Ø13 311	Ø41 361 Ø13		LXI	H	LOAD RECORDING TEST DATA MESSAGE AREA
Ø13 314	315 Ø45 ØØ2		CALL	TVEDIT	CALL TV EDITOR
Ø13 317	3Ø3 26Ø Ø1Ø		JMP	RCDTD	JUMP TO RECORD TEST DATA ROUTINE
Ø13 322	Ø41 ØØ7 Ø14		LXI	H	LOAD READ TEST DATA MESSAGE AREA
Ø13 325	315 Ø45 ØØ2		CALL	TVEDIT	CALL TV EDITOR
Ø13 33Ø	3Ø3 334 Ø1Ø		JMP	RTD	JUMP TO READ TEST DATA ROUTINE
Ø13 335	377				ERASE
Ø13 336	ØØ7				SPACES
Ø13 337	324				T
Ø13 34Ø	341				a
Ø13 341	36Ø				p
Ø13 342	345				e
Ø13 343	24Ø				
Ø13 344	3Ø2				B
Ø13 345	345				e
Ø13 346	351				i
Ø13 347	356				n
Ø13 35Ø	347				g
Ø13 351	24Ø				
Ø13 352	3Ø3				C
Ø13 353	357				o
Ø13 354	36Ø				p
Ø13 355	351				i
Ø13 356	345				e
Ø13 357	344				d
Ø13 36Ø	ØØØ				RETURN
Ø13 361	377				ERASE
Ø13 362	ØØ6				SPACES

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
Ø13 363	322				R
Ø13 364	345				e
Ø13 365	343				c
Ø13 366	357				o
Ø13 367	362				r
Ø13 37Ø	344				d
Ø13 371	351				i
Ø13 372	356				n
Ø13 373	347				g
Ø13 374	24Ø				
Ø13 375	324				T
Ø13 376	345				e
Ø13 377	363				s
Ø14 ØØØ	364				t
Ø14 ØØ1	24Ø				
Ø14 ØØ2	3Ø4				D
Ø14 ØØ3	341				a
Ø14 ØØ4	364				t
Ø14 ØØ5	341				a
Ø14 ØØ6	ØØØ				RETURN
Ø14 ØØ7	377				ERASE
Ø14 Ø1Ø	ØØ6				SPACES
Ø14 Ø11	324				T
Ø14 Ø12	345				e
Ø14 Ø13	363				s
Ø14 Ø14	364				t
Ø14 Ø15	24Ø				
Ø14 Ø16	3Ø4				D
Ø14 Ø17	341				a
Ø14 Ø2Ø	364				t
Ø14 Ø21	341				a
Ø14 Ø22	24Ø				
Ø14 Ø23	3Ø2				B
Ø14 Ø24	345				e
Ø14 Ø25	351				i
Ø14 Ø26	356				n
Ø14 Ø27	347				g
Ø14 Ø3Ø	24Ø				
Ø14 Ø31	322				R
Ø14 Ø32	345				e
Ø14 Ø33	341				a
Ø14 Ø34	344				d
Ø14 Ø35	ØØ6				SPACES

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
Ø14 Ø36	ØØØ				RETURN
Ø14 Ø37	377				ERASE
Ø14 Ø4Ø	323				S
Ø14 Ø41	345				e
Ø14 Ø42	354				l
Ø14 Ø43	345				e
Ø14 Ø44	343				c
Ø14 Ø45	364				t
Ø14 Ø46	24Ø				
Ø14 Ø47	3Ø4				D
Ø14 Ø5Ø	345				e
Ø14 Ø51	343				c
Ø14 Ø52	353				k
Ø14 Ø53	24Ø				
Ø14 Ø54	316				N
Ø14 Ø55	365				u
Ø14 Ø56	355				m
Ø14 Ø57	342				b
Ø14 Ø6Ø	345				e
Ø14 Ø61	362				r
Ø14 Ø62	24Ø				
Ø14 Ø63	25Ø				(
Ø14 Ø64	26Ø				Ø
Ø14 Ø65	255				-
Ø14 Ø66	263				3
Ø14 Ø67	251				)
Ø14 Ø7Ø	Ø5Ø				SPACES
Ø14 Ø71	3Ø4				D
Ø14 Ø72	345				e
Ø14 Ø73	343				c
Ø14 Ø74	353				k
Ø14 Ø75	24Ø				
Ø14 Ø76	243				#
Ø14 Ø77	24Ø				
Ø14 1ØØ	26Ø				Ø
Ø14 1Ø1	Ø7Ø				SPACES
Ø14 1Ø2	3Ø4				D
Ø14 1Ø3	357				o
Ø14 1Ø4	356				n
Ø14 1Ø5	345				e
Ø14 1Ø6	277				?
Ø14 1Ø7	24Ø				
Ø14 11Ø	25Ø				(
Ø14 111	331				Y
Ø14 112	277				?

LOC	OBJ	LABEL	OP	OPERAND	COMMENTS
Ø14 113	251				)
Ø14 114	ØØØ				RETURN
Ø14 115	Ø41 Ø37 Ø14	TV	LXI	H,Ø14 Ø37	LOAD H & L w MESSAGE AREA
Ø14 12Ø	Ø72 26Ø Ø12		LDA	DECK	LOAD A w DECK #
Ø14 123	366 26Ø		ORI	26Ø	CONVERT TO ASCII
Ø14 125	Ø62 1ØØ Ø14		STA	Ø14 1ØØ	STORE IN MESSAGE
Ø14 13Ø	315 Ø45 ØØ2		CALL	TVEDIT	CALL TV EDITOR
Ø14 133	333 ØØØ	IN	IN	Ø	INPUT FROM KEYBOARD
Ø14 135	376 264		CPI	264	> '3' ?
Ø14 137	322 162 Ø14		JPC	DONE	YES
Ø14 142	376 26Ø		CPI	26Ø	< 'Ø' ?
Ø14 144	332 133 Ø14		JPC	IN	YES
Ø14 147	Ø62 342 ØØ7		STA	ØØ7 342	PLACE NUMBER IN MESSAGE
Ø14 152	346 ØØ3		ANI	3	
Ø14 154	Ø62 26Ø Ø12		STA	DECK	STORE DECK #
Ø14 157	3Ø3 115 Ø14		JMP	TV	JUMP TO MESSAGE
Ø14 162	366 Ø4Ø	DONE	ORI	Ø4Ø	CONVERT TO LOWER CASE
Ø14 164	376 371		CPI	371	'y' ?
Ø14 16Ø	3Ø2 115 Ø14		JNZ	TV	NO
Ø14 171	317		RST	Ø1Ø	YES

8Ø8Ø DRIVER SOFTWARE (HEX)

```
LOC   OBJ      LABEL     OP      OPERAND     COMMENTS

                 *               RECORD (UNTIL COUNT EXHAUSTED)
                 *               DECK IS STOPPED AFTER RETURN
                 *               INPUT:
                 *                     DECK - DECK NUMBER LOCATED IN MEMORY
                 *                     POINTW   - LOCATED IN MEMORY
                 *                                (FIRST DATA BYTE)
                 *                     IDW - LOCATED IN MEMORY (FIRST BLOCK)
                 *                     COUNT - REGISTER H,L
                 *               OUTPUT:
                 *                     POINTW   - LOCATED IN MEMORY
                 *                                (LAST DATA BYTE + 1)
                 *                     ERROR - REGISTER A
                 *                             Ø - NO ERRORS
                 *                             1 - CRC ERROR IN BLOCK
                 *                                 IDW - 1
                 *                             2 - BLOCK IDW-1 NOT FOUND
                 *                             3 - TAPE END OR JAM
                 *                     IDW - LOCATED IN MEMORY
                 *                           (LAST BLOCK + 1)
                 *               ALTERED
                 *                     REGISTERS - A,B,C,D,E,H,L,IDR, POINTR
ØØØØ  16Ø1     RECORD    MVI     D,1         ERASE = 1
ØØØ2  1EØ5               MVI     E,5         STOPS = 5
ØØØ4  E5                 PUSH    H           COUNT
ØØØ5  D5       RCD2O     PUSH    D           ERASE, STOPS
ØØØ6  2AB5ØA             LHLD    IDW
ØØØ9  2B                 DCX     H           IDR = IDW -1
ØØØA  22B1ØA             SHLD    IDR
ØØØD  23                 INX     H
ØØØE  7D                 MOV     A,L         IDW = Ø ?
ØØØF  B4                 ORA     H
Ø01Ø  CA29Ø9             JZ      RCD1O       YES
Ø013  16ØB               MVI     D,11        RETRIES = 1O
Ø015  1EØ1               MVI     E,1         CHECK MODE
Ø017  CD7BØB             CALL    ALTRD
Ø01A  3C                 INR     A           ERROR?
Ø01B  3D                 DCR     A
Ø01C  CA36Ø9             JZ      RCD13       NO
Ø01F  D1       RCD12     POP     D           ERASE, STOPS
Ø02Ø  E1       RCD21     POP     H           COUNT
Ø021  ØE9Ø     RCD27     MVI     C,9OH       STOP
Ø023  47                 MOV     B,A         SAVE ERROR
Ø024  CD9BØA             CALL    CMDOUT
Ø027  78                 MOV     A,B         RESTORE ERROR
Ø028  C9                 RET
Ø029  CD4FØA   RCD1O     CALL    REWIND
Ø02C  ØEEC               MVI     C,ECH       ERASE
```

LOC	OBJ	LABEL	OP	OPERAND	COMMENT
Ø92E	CD9BØA		CALL	CMDOUT	
Ø931	3E28		MVI	A,4O	4 SECONDS
Ø933	CD81ØA		CALL	DELAY	
Ø936	D1	RCD13	POP	D	ERASE, STOPS
Ø937	D5		PUSH	D	
Ø938	15	RCD15	DCR	D	ERASE (ERASE - 1) BLOCKS
Ø939	CA49Ø9		JZ	RCD14	
Ø93C	ØEEC		MVI	C,ECH	ERASE
Ø93E	CD9BØA		CALL	CMDOUT	
Ø941	D5		PUSH	D	
Ø942	CDDAØ9		CALL	RECRD1	
Ø945	D1		POP	D	
Ø946	C338Ø9		JMP	RCD15	
Ø949	E1	RCD14	POP	H	ERASE, STOPS
Ø94A	D1		POP	D	COUNT
Ø94B	D5		PUSH	D	
Ø94C	E5		PUSH	H	
Ø94D	2AB7ØA		LHLD	POINTW	POINTER
Ø950	15	RCD19	DCR	D	COUNT HIGH = Ø?
Ø951	14		INR	D	
Ø952	C2D4Ø9		JNZ	RCD16	NO
Ø955	1D		DCR	E	
Ø956	1C		INR	E	
Ø957	CA81Ø9		JZ	RCD17	YES
Ø95A	43		MOV	B,E	COUNT = COUNTL
Ø95B	1EØØ		MVI	E,Ø	COUNTL = Ø
Ø95D	D5	RCD18	PUSH	D	SAVE COUNT
Ø95E	EB		XCHG		
Ø95F	2AB1ØA		LHLD	IDR	
Ø962	23		INX	H	
Ø963	22B1ØA		SHLD	IDR	
Ø966	EB		XCHG		
Ø967	ØEE8		MVI	C,E8H	RECORD
Ø969	CD9BØA		CALL	CMDOUT	
Ø96C	CDDAØ9		CALL	RECRD1	
Ø96F	DBØ2		IN	TAPEIN	ERROR?
Ø971	E6ØD		ANI	ØDH	
Ø973	D1		POP	D	GET COUNT
Ø974	CA5ØØ9		JZ	RCD19	NO
Ø977	D1		POP	D	DCR STOPS
Ø978	1D		DCR	E	Ø?
Ø979	C2Ø5Ø9		JNZ	RCD20	NO
Ø97C	3EØ3		MVI	A,3	ERROR = 3
Ø97E	C32ØØ9		JMP	RCD21	
Ø981	3EØ5	RCD17	MVI	A,5	APPROXIMATELY 10 BLOCKS
Ø983	CD68ØA		CALL	FR	
Ø986	E1		POP	H	ERASE, STOPS
Ø987	D1		POP	D	COUNT
Ø988	D5	RCD26	PUSH	D	
Ø989	E5		PUSH	H	
Ø98A	97		SUB	A	COUNT = Ø?

```
LOC   OBJ       LABEL    OP       OPERAND    COMMENT

Ø98B  82                 ADD      D
Ø98C  C293Ø9             JNZ      RCD22      NO
Ø98F  83                 ADD      E
Ø99Ø  CA1FØ9             JZ       RCD12      YES
Ø993  2AB5ØA   RCD22     LHLD     IDW
Ø996  22B1ØA             SHLD     IDR
Ø999  16Ø6               MVI      D,6        RETRIES = 6
Ø99B  1EØ1               MVI      E,1        CHECK MODE
Ø99D  CDBBØA             CALL     ALTRD2
Ø9AØ  3C                 INR      A          ERROR?
Ø9A1  3D                 DCR      A
Ø9A2  D1                 POP      D
Ø9A3  CAAAØ9             JZ       RCD24      NO
Ø9A6  14                 INR      D          INCREMENT ERASE
Ø9A7  C3Ø5Ø9             JMP      RCD20
Ø9AA  16Ø1     RCD24     MVI      D,1        ERASE = 1
Ø9AC  2AB5ØA             LHLD     IDW        INCREMENT IDW
Ø9AF  23                 INX      H
Ø9BØ  22B5ØA             SHLD     IDW
Ø9B3  EB                 XCHG
Ø9B4  D1                 POP      D
Ø9B5  14                 INR      D          COUNTH = Ø?
Ø9B6  15                 DCR      D
Ø9B7  CAC7Ø9             JZ       RCD25      YES
Ø9BA  15                 DCR      D          DECREMENT COUNTH
Ø9BB  E5                 PUSH     H
Ø9BC  2AB7ØA             LHLD     POINTW
Ø9BF  24                 INR      H
Ø9CØ  22B7ØA             SHLD     POINTW
Ø9C3  E1                 POP      H
Ø9C4  C388Ø9             JMP      RCD26
Ø9C7  2AB7ØA   RCD25     LHLD     POINTW     ADD COUNTL TO POINTER
Ø9CA  16ØØ               MVI      D,Ø
Ø9CC  19                 DAD      D
Ø9CD  22B7ØA             SHLD     POINTW
Ø9DØ  97                 SUB      A          ERROR = Ø
Ø9D1  C321Ø9             JMP      RCD27
Ø9D4  15       RCD16     DCR      D          DECREMENT COUNTH
Ø9D5  Ø6ØØ               MVI      B,Ø        COUNT = Ø
Ø9D7  C35DØ9             JMP      RCD18
                *        RECRD1   (RECORD ONE BLOCK)
                *              RECORD OR ERASE COMMAND MUST BE ISSUED
                *                BEFORE CALLING.
                *              UNDERRUN AND STOP SHOULD BE CHECKED
                *                AFTER RETURN.
                *              INPUTS:
                *                DECK - DECK NUMBER LOCATED
                *                       IN MEMORY
                *                ID - REGISTER D,E
                *                COUNT - REGISTER B
                *                        (Ø1=1 BYTE, ØØ=256 BYTES)
```

```
LOC   OBJ        LABEL     OP       OPERAND     COMMENT

                 *                   POINTER - REGISTER H,L
                 *                             (FIRST DATA BYTE)
                 *                 OUTPUT:
                 *                   POINTER - REGISTER H,L
                 *                             (LAST DATA BYTE + 1)
                 *                 ALTERED
                 *                   REGISTERS - A,B,C,D,E,H,L
Ø9DA   E5        RECRD1    PUSH      H           PUSH POINTER
Ø9DB   21 ØØØØ             LXI       H,Ø         RESET CRC
Ø9DE   4A                   MOV       C,D         ID HIGH
Ø9DF   CD 49ØA              CALL      ALTPUT
Ø9E2   4B                   MOV       C,E         ID LOW
Ø9E3   CD42ØA               CALL      PUT
Ø9E6   48                   MOV       C,B         COUNT
Ø9E7   CD42ØA               CALL      PUT
Ø9EA   54                   MOV       D,H         SAVE CRC2
Ø9EB   4D                   MOV       C,L         CRC1
Ø9EC   CD42ØA               CALL      PUT
Ø9EF   4A                   MOV       C,D         CRC2
Ø9FØ   CD42ØA               CALL      PUT
Ø9F3   58                   MOV       E,B         SAVE COUNT
Ø9F4   E3        RECD1      XTHL                  SWITCH CRC, POINTER
Ø9F5   4E                   MOV       C,M         LOAD DATA
Ø9F6   23                   INX       H           INCREMENT POINTER
Ø9F7   E3                   XTHL                  SWITCH CRC, POINTER
Ø9F8   CD42ØA               CALL      PUT
Ø9FB   O5                   DCR       B           DECREMENT COUNT
Ø9FC   C2F4Ø9               JNZ       RECD1       NOT ZERO
Ø9FF   54                   MOV       D,H         SAVE CRC2
ØAØØ   4D                   MOV       C,L         CRC1
ØAØ1   CD42ØA               CALL      PUT
ØAØ4   4A                   MOV       C,D         CRC2
ØAØ5   CD42ØA               CALL      PUT
ØAØ8   1D                   DCR       E           DECREMENT SAVED COUNT
ØAØ9   CD42ØA    RECD3      CALL      PUT
ØAØC   1C                   INR       E           INCREMENT SAVED COUNT
ØAØD   C2Ø9ØA               JNZ       RECD3       NOT ZERO
ØA1Ø   CD42ØA               CALL      PUT
ØA13   E1                   POP       H           POP POINTER
ØA14   C9                   RET
                 *          GET
                 *          CRC IN H,L
                 *          DATA RETURNED INC
                 *          A,C,H,L, ALTERED
ØA15   DBØ2      GET        IN        TAPEIN      STATUS
ØA17   E6ØF                 ANI       ØFH
ØA19   CA15ØA               JZ        GET
ØA1C   CD8FØA               CALL      DIN
ØA1F   D5        CRC        PUSH      D
ØA2Ø   79                   MOV       A,C
ØA21   AD                   XRA       L
```

```
LOC   OBJ       LABEL     OP      OPERAND     COMMENT

ØA22  6F                  MOV     L,A
ØA23  1EØ7                MVI     E,7         007 TIMES
ØA25  17        CRCA      RAL
ØA26  AD                  XRA     L
ØA27  1D                  DCR     E
ØA28  C225ØA              JNZ     CRCA        DONE?
ØA2B  6F                  MOV     L,A         YES
ØA2C  ØF                  RRC
ØA2D  ØF                  RRC
ØA2E  5F                  MOV     E,A         SAVE 1
ØA2F  E6CØ                ANI     CØH
ØA31  AC                  XRA     H
ØA32  57                  MOV     D,A         SAVE 2
ØA33  7B                  MOV     A,E         RESTORE 1
ØA34  E63F                ANI     3FH
ØA36  AD                  XRA     L
ØA37  67                  MOV     H,A         CRC HIGH DONE
ØA38  17                  RAL                 TEST BIT 7
ØA39  7A                  MOV     A,D         RESTORE 2
ØA3A  D23FØA              JNC     CRCFIN      BIT 7 WAS 1?
ØA3D  EEØ1                XRI     1           YES
ØA3F  6F        CRCFIN    MOV     L,A         CRC LOW DONE
ØA4Ø  D1                  POP     D
ØA41  C9                  RET
              *           PUT
              *           DATA IN REGISTER C
              *           CRC IN H,L
              *           A,H,L ALTERED
ØA42  DBØ2      PUT       IN      TAPEIN      STATUS
ØA44  E6ØF                ANI     ØFH
ØA46  CA42ØA              JZ      PUT
ØA49  CDA8ØA    ALTPUT    CALL    DOUT
ØA4C  C31FØA              JMP     CRC
              *           REWIND
              *           REGISTER A, C ALTERED
              *           THIS ROUTINE WILL GUARANTEE
              *           DECK SELECTION
ØA4F  OE9Ø      REWIND    MVI     C,9ØH       STOP
ØA51  CD9BØA              CALL    CMDOUT
ØA54  DBØ2      REWB      IN      TAPEIN
ØA56  E6Ø8                ANI     O8H
ØA58  CA54ØA              JZ      REWB
ØA5B  OE8Ø                MVI     C,8ØH       FR
ØA5D  CD9BØA              CALL    CMDOUT
ØA6Ø  DBØ2      REWA      IN      TAPEIN
ØA62  E6Ø8                ANI     8
ØA64  CA6ØØA              JZ      REWA
ØA67  C9                  RET
              *           FAST REVERSE, FAST FORWARD
              *           REGISTER A CONTAINS MULTIPLE
              *           OF 100 MILLI-SECONDS DELAY
              *           REGISTER A ALTERED
```

```
LOC   OBJ       LABEL    OP        OPERAND     COMMENT

ØA68  C5        FR       PUSH      B
ØA69  F5                 PUSH      PSW
ØA6A  ØE8O               MVI       C,8OH
ØA6C  CD9BØA     FRA      CALL      CMDOUT
ØA6F  F1                 POP       PSW
ØA7Ø  CD81ØA             CALL      DELAY
ØA73  ØE9Ø               MVI       C,9OH
ØA75  CD9BØA             CALL      CMDOUT
ØA78  C1                 POP       B
ØA79  C9                 RET
ØA7A  C5         FF      PUSH      B
ØA7B  F5                 PUSH      PSW
ØA7C  ØEAØ               MVI       C,AØH
ØA7E  C36CØA             JMP       FRA
                 *        DELAY MULTIPLE OF 100 MS IN REGISTER A.
                 *        REGISTERS A,B,C ALTERED
ØA81  O1OO2O     DELAY    LXI       B,2OOOH
ØA84  OB         D1       DCX       B
ØA85  O4                  INR       B
ØA86  O5                  DCR       B
ØA87  C284ØA              JNZ       D1
ØA8A  3D                  DCR       A
ØA8B  C281ØA              JNZ       DELAY
ØA8E  C9                  RET
                 *        INPUT DATA BYTE (DATA RETURNED IN C)
                 *        REGISTER A IS ALTERED
ØA8F  3EEF       DIN      MVI       A,EFH
ØA91  D3O1                OUT       STROBE
ØA93  DBO2                IN        TAPEIN
ØA95  4F                  MOV       C,A
ØA96  3EDF       DINA     MVI       A,DFH
ØA98  D3O1                OUT       STROBE
ØA9A  C9                  RET
                 *        OUTPUT COMMAND (DATA IN REGISTER C)
                 *        DECK IS OR'D WITH DATA
                 *        REGISTER A IS ALTERED
ØA9B  3ABØØA     CMDOUT   LDA       DECK
ØA9E  B1                  ORA       C
ØA9F  D302                OUT       TAPOUT
ØAA1  3E9F                MVI       A,9FH
ØAA3  D301       CMDA     OUT       STROBE
ØAA5  C396ØA              JMP       DINA
                 *        OUTPUT DATA (DATA IN REGISTER C)
                 *        REGISTER A IS ALTERED
ØAA8  79         DOUT     MOV       A,C
ØAA9  D302                OUT       TAPOUT
ØAAB  3E5F                MVI       A,5FH
ØAAD  C3A3ØA              JMP       CMDA
                 *        VARIABLE DATA AREA
ØABØ  OO         DECK     DS        1           DECK NUMBER TO BE USED
ØAB1  OO OO      IDR      DS        2           READ ID
```

```
LOC    OBJ        LABEL     OP        OPERAND     COMMENT

ØAB3   OO OO      POINTR    DS        2           READ POINTER
ØAB5   OO OO      IDW       DS        2           WRITE ID
ØAB7   OO OO      POINTW    DS        2           WRITE POINTER
                  *         READ ONE BLOCK
                  *           DECK REMAINS RUNNING AFTER RETURN
                  *         INPUT:
                  *           DECK - DECK NUMBER LOCATED IN MEMORY
                  *           POINTR   - LOCATED IN MEMORY
                  *                      (FIRST BYTE)
                  *           IDR - LOCATED IN MEMORY
                  *           RETRYS   - REGISTER D
                  *                      (ALTRD   ONLY)
                  *           MODE - REGISTER E
                  *                  Ø=READ
                  *                  1=CHECK
                  *         OUTPUT:
                  *           DECK, POINTER, IDR UNCHANGED
                  *           REGISTER - A,B,C,D,H,L ALTERED
                  *           COUNT - REGISTER B
                  *                   Ø1=1 BYTE
                  *                   ØØ=256 BYTES
                  *           ERROR - REGISTER A
                  *                   Ø - NO ERRORS
                  *                   1 - CRC ERROR
                  *                   2 - BLOCK NOT FOUND
                  *                   3 - END OF TAPE OR JAM
                  *         ENTRY POINTS:
                  *           READ - NORMAL ENTRY
                  *           ALTRD    - DECK WILL BACKSPACE
                  *                      FIRST, USER MUST SUPPLY RETRIES.
                  *           ALTRD2   - NORMAL, EXCEPT USER MUST
                  *                      SUPPLY RETRIES.
ØAB9   16ØA       READ      MVI       D,RETRYS
ØABB   D5         RD54      PUSH      D           RETRIES, MODE
                  ALTRD2    EQU       RD54
ØABC   21ØØØØ     RD5       LXI       H,Ø         RESET CRC
ØABF   DBØ2                 IN        TAPEIN      STATUS
ØAC1   57                   MOV       D,A
ØAC2   ØEEØ       RD51      MVI       C,EØH       READ
ØAC4   CD9BØA               CALL      CMDOUT
ØAC7   7A                   MOV       A,D         STOP?
ØAC8   E6Ø4                 ANI       Ø4H
ØACA   CAD7ØA               JZ        RD5Ø        NO
ØACD   3EØ4                 MVI       A,4          4 SECONDS
ØACF   CD81ØA               CALL      DELAY
ØAD2   16ØØ                 MVI       D,Ø         STATUS = Ø
ØAD4   C3C2ØA               JMP       RD51
ØAD7   0630       RD5O      MVI       B,3OH       8 SECOND TIMEOUT
ØAD9   5Ø         RD57      MOV       D,B
ØADA   DBØ2       RD53      IN        TAPEIN      STATUS
```

```
LOC   OBJ        LABEL     OP        OPERAND    COMMENT

ØADC  E6ØF               ANI       ØFH        READY?
ØADE  C29ØØB             JNZ       RD1Ø       YES
ØAE1  1B                 DCX       D
ØAE2  14                 INR       D
ØAE3  15                 DCR       D
ØAE4  C2DAØA             JNZ       RD53
ØAE7  Ø5                 DCR       B
ØAE8  C2D9ØA             JNZ       RD57
ØAEB  CD4FØA             CALL      REWIND
ØAEE  3EØ2       RD2     MVI       A,2        ERROR = 2
ØAFØ  D1                 POP       D          RETRIES, MODE
ØAF1  15         RD8     DCR       D
ØAF2  C2BBØA             JNZ       RD54
ØAF5  C9                 RET
ØAF6  CD15ØA     RD52    CALL      GET        IDH
ØAF9  41                 MOV       B,C
ØAFA  CD15ØA             CALL      GET        IDL
ØAFD  59                 MOV       E,C
ØAFE  CD15ØA             CALL      GET        COUNT
ØBØ1  51                 MOV       D,C
ØBØ2  CD15ØA             CALL      GET        CRC1
ØBØ5  CD15ØA             CALL      GET        CRC2
ØBØ8  97                 SUB       A          CRC = Ø?
ØBØ9  84                 ADD       H
ØBØA  C2BCØA             JNZ       RD5        NO
ØBØD  85                 ADD       L
ØBØE  C2BCØA             JNZ       RD5        NO
                 *        COMPUTE              BE TAPEID
                 *                             -HL IDR
                 *                             XY
ØB11  7B                 MOV       A,E
ØB12  2AB1ØA             LHLD      IDR
ØB15  95                 SUB       L
ØB16  5F                 MOV       E,A        REGISTER E CONTAINS Y
ØB17  6F                 MOV       L,A
ØB18  78                 MOV       A,B
ØB19  9C                 SBB       H          REGISTER A CONTAINS X
ØB1A  67                 MOV       H,A        H = XY/8
ØB1B  29                 DAD       H
ØB1C  29                 DAD       H
ØB1D  29                 DAD       H
ØB1E  29                 DAD       H
ØB1F  29                 DAD       H
ØB2Ø  7C                 MOV       A,H
ØB21  CA38ØB             JZ        ID1
ØB24  F23DØB             JP        ID2
ØB27  2F                 CMA                  COMPUTE FF DELAY
ØB28  C6O2               ADI       2          ADD 1+1 FOR 2'S COMP
ØB2A  FA32ØB             JM        ID3
ØB2D  FEØ4               CPI       4          GREATER THAN THRESHOLD?
```

LOC	OBJ	LABEL	OP	OPERAND	COMMENT
ØB2F	FABCØA		JM	RD5	NO
ØB32	CD7AØA	ID3	CALL	FF	
ØB35	C3BCØA		JMP	RD5	
ØB38	1C	ID1	INR	E	Y = Ø?
ØB39	1D		DCR	E	
ØB3A	CA45ØB		JZ	RD6	YES
ØB3D	C6Ø6	ID2	ADI	6	
ØB3F	CD68ØA		CALL	FR	
ØB42	C3EEØA		JMP	RD2	
ØB45	42	RD6	MOV	B,D	COUNT
ØB46	D1		POP	D	RETRIES, MODE
ØB47	C5		PUSH	B	COUNT
ØB48	2AB3ØA		LHLD	POINTR	
ØB4B	E5		PUSH	H	
ØB4C	21ØØØØ		LXI	H,Ø	RESET CRC
ØB4F	CD15ØA	RD56	CALL	GET	
ØB52	1C		INR	E	
ØB53	1D		DCR	E	
ØB54	C25BØB		JNZ	RD55	
ØB57	E3		XTHL		SWITCH CRC, POINTER
ØB58	71		MOV	M,C	STORE DATA
ØB59	23		INX	H	BUMP POINTER
ØB5A	E3		XTHL		SWITCH CRC, POINTER
ØB5B	Ø5	RD55	DCR	B	DECREMENT COUNT
ØB5C	C24FØB		JNZ	RD56	
ØB5F	C1		POP	B	ADJUST STACK POINTER
ØB6Ø	C1		POP	B	COUNT
ØB61	CD15ØA		CALL	GET	
ØB64	CD15ØA		CALL	GET	
ØB67	DBØ2		IN	TAPEIN	STATUS
ØB69	1F		RAR		OVERRUN?
ØB6A	DA7BØB		JC	ALTRD	YES
ØB6D	1F		RAR		
ØB6E	1F		RAR		STOP?
ØB6F	DA96ØB		JC	RD11	YES
ØB72	97		SUB	A	
ØB73	84		ADD	H	
ØB74	C27BØB		JNZ	ALTRD	NO
ØB77	85		ADD	L	
ØB78	CA85ØB		JZ	RD19	
ØB7B	3EØ5	ALTRD	MVI	A,5	GREATER THAN 1 BLOCK
ØB7D	CD68ØA		CALL	FR	
ØB8Ø	3EØ1		MVI	A,1	ERROR = 1
ØB82	C3F1ØA		JMP	RD8	
ØB85	5Ø	RD19	MOV	D,B	SAVE COUNT
ØB86	15		DCR	D	DECREMENT SAVED COUNT
ØB87	CD15ØA	RD9	CALL	GET	
ØB8A	14		INR	D	INCREMENT SAVED COUNT
ØB8B	C287ØB		JNZ	RD9	
ØB8E	97		SUB	A	ERROR = Ø

```
LOC     OBJ         LABEL       OP          OPERAND     COMMENT

ØB8F    C9                      RET
ØB9Ø    E6Ø4        RD10        ANI         Ø4H         STOP?
ØB92    CAF6ØA                  JZ          RD52        NO
ØB95    D1                      POP         D           RETRIES, MODE
ØB96    CD4FØA      RD11        CALL        REWIND
ØB99    3EØ3                    MVI         A,3         ERROR = 3
ØB9B    C3F1ØA                  JMP         RD8
                                END
```


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8Ø8Ø DRIVER SOFTWARE (OCTAL)

```
LOC      OBJ          LABEL    OP      OPERAND        COMMENTS

                      *        RECORD (UNTIL COUNT EXHAUSTED)
                      *        DECK IS STOPPED AFTER RETURN
                      *        INPUT:
                      *              DECK - DECK NUMBER LOCATED IN MEMORY
                      *              POINTW    - LOCATED IN MEMORY
                      *                          (FIRST DATA BYTE)
                      *              IDW - LOCATED IN MEMORY (FIRST BLOCK)
                      *              COUNT - REGISTER H,L
                      *        OUTPUT:
                      *              POINTW    - LOCATED IN MEMORY
                      *                          (LAST DATA BYTE + 1)
                      *              ERROR - REGISTER A
                      *                      Ø - NO ERRORS
                      *                      1 - CRC ERROR IN BLOCK
                      *                          IDW - 1
                      *                      2 - BLOCK IDW-1 NOT FOUND
                      *                      3 - TAPE END OR JAM
                      *              IDW - LOCATED IN MEMORY
                      *                    (LAST BLOCK + 1)
                      *        ALTERED
                      *              REGISTERS - A,B,C,D,E,H,L,IDR, POINTR
Ø11 ØØØ   Ø26 ØØ1     RECORD   MVI     D,1            ERASE = 1
Ø11 ØØ2   Ø36 Ø05              MVI     E,5            STOPS = 5
Ø11 ØØ4   345                  PUSH    H              COUNT
Ø11 ØØ5   325          RCD2Ø   PUSH    D              ERASE, STOPS
Ø11 ØØ6   Ø52 265 Ø12          LHLD    IDW
Ø11 Ø11   Ø53                  DCX     H              IDR = IDW -1
Ø11 Ø12   Ø42 261 Ø12          SHLD    IDR
Ø11 Ø15   Ø43                  INX     H
Ø11 Ø16   175                  MOV     A,L            IDW = Ø ?
Ø11 Ø17   264                  ORA     H
Ø11 Ø2Ø   312 Ø51 Ø11          JZ      RCD1Ø          YES
Ø11 Ø23   Ø26 Ø13              MVI     D,11           RETRIES = 1Ø
Ø11 Ø25   Ø36 ØØ1              MVI     E,1            CHECK MODE
Ø11 Ø27   315 173 Ø13          CALL    ALTRD
Ø11 Ø32   Ø74                  INR     A              ERROR?
Ø11 Ø33   Ø75                  DCR     A
Ø11 Ø34   312 Ø66 Ø11          JZ      RCD13          NO
Ø11 Ø37   321          RCD12   POP     D              ERASE, STOPS
Ø11 Ø4Ø   341          RCD21   POP     H              COUNT
Ø11 Ø41   Ø16 22Ø      RCD27   MVI     C,9ØH          STOP
Ø11 Ø43   1Ø7                  MOV     B,A            SAVE ERROR
Ø11 Ø44   315 233 Ø12          CALL    CMDOUT
Ø11 Ø47   17Ø                  MOV     A,B            RESTORE ERROR
Ø11 Ø5Ø   311                  RET
Ø11 Ø51   315 117 Ø12  RCD1Ø   CALL    REWIND
Ø11 Ø54   Ø16 354              MVI     C,ECH          ERASE
```

```
LOC      OBJ          LABEL   OP      OPERAND     COMMENT

Ø11 Ø56  315 233 Ø12          CALL    CMDOUT
Ø11 Ø61  Ø76 Ø5Ø              MVI     A,4Ø        4 SECONDS
Ø11 Ø63  315 2Ø1 Ø12          CALL    DELAY
Ø11 Ø66  321          RCD13   POP     D           ERASE, STOPS
Ø11 Ø67  325                  PUSH    D
Ø11 Ø7Ø  Ø25          RCD15   DCR     D           ERASE (ERASE-1) BLOCKS
Ø11 Ø71  312 111 Ø11          JZ      RCD14
Ø11 Ø74  Ø16 354              MVI     C,ECH       ERASE
Ø11 Ø76  315 233 Ø12          CALL    CMDOUT
Ø11 1Ø1  325                  PUSH    D
Ø11 1Ø2  315 332 Ø11          CALL    RECRD1
Ø11 1Ø5  321                  POP     D
Ø11 1Ø6  3Ø3 Ø7Ø Ø11          JMP     RCD15
Ø11 111  341          RCD14   POP     H           ERASE, STOPS
Ø11 112  321                  POP     D           COUNT
Ø11 113  325                  PUSH    D
Ø11 114  345                  PUSH    H
Ø11 115  Ø52 267 Ø12          LHLD    POINTW      POINTER
Ø11 12Ø  Ø25          RCD19   DCR     D           COUNT HIGH = Ø?
Ø11 121  Ø24                  INR     D
Ø11 122  3Ø2 324 Ø11          JNZ     RCD16       NO
Ø11 125  Ø35                  DCR     E
Ø11 126  Ø34                  INR     E
Ø11 127  312 2Ø1 Ø11          JZ      RCD17       YES
Ø11 132  1Ø3                  MOV     B,E         COUNT = COUNTL
Ø11 133  Ø36 ØØØ              MVI     E,Ø         COUNTL = Ø
Ø11 135  325          RCD18   PUSH    D           SAVE COUNT
Ø11 136  353                  XCHG
Ø11 137  Ø52 261 Ø12          LHLD    IDR
Ø11 142  Ø43                  INX     H
Ø11 143  Ø42 261 Ø12          SHLD    IDR
Ø11 146  353                  XCHG
Ø11 147  Ø16 35Ø              MVI     C,E8H       RECORD
Ø11 151  315 233 Ø12          CALL    CMDOUT
Ø11 154  315 332 Ø11          CALL    RECRD1
Ø11 157  333 ØØ2              IN      TAPEIN      ERROR?
Ø11 161  346 Ø15              ANI     ØDH
Ø11 163  321                  POP     D           GET COUNT
Ø11 164  312 12Ø Ø11          JZ      RCD19       NO
Ø11 167  321                  POP     D           DCR STOPS
Ø11 17Ø  Ø35                  DCR     E           Ø?
Ø11 171  3Ø2 ØØ5 Ø11          JNZ     RCD2Ø       NO
Ø11 174  Ø76 ØØ3              MVI     A,3         ERROR = 3
Ø11 176  3Ø3 Ø4Ø Ø11          JMP     RCD21
Ø11 2Ø1  Ø76 ØØ5      RCD17   MVI     A,5         APPROXIMATELY 1Ø BLOCKS
Ø11 2Ø3  315 15Ø Ø12          CALL    FR
Ø11 2Ø6  341                  POP     H           ERASE, STOPS
Ø11 2Ø7  321                  POP     D           COUNT
Ø11 21Ø  325          RCD26   PUSH    D
Ø11 211  345                  PUSH    H
Ø11 212  227                  SUB     A           COUNT = Ø?
```

```
LOC       OBJ          LABEL   OP      OPERAND     COMMENT

Ø11 213   2Ø2                  ADD     D
Ø11 214   3Ø2 223 Ø11          JNZ     RCD22       NO
Ø11 217   2Ø3                  ADD     E
Ø11 22Ø   312 Ø37 Ø11          JZ      RCD12       YES
Ø11 223   Ø52 265 Ø12  RCD22   LHLD    IDW
Ø11 226   Ø42 261 Ø12          SHLD    IDR
Ø11 231   Ø26 ØØ6              MVI     D,6         RETRIES = 6
Ø11 233   Ø36 ØØ1              MVI     E,1         CHECK MODE
Ø11 235   315 273 Ø12          CALL    ALTRD2
Ø11 24Ø   Ø74                  INR     A           ERROR?
Ø11 241   Ø75                  DCR     A
Ø11 242   321                  POP     D
Ø11 243   312 252 Ø11          JZ      RCD24       NO
Ø11 246   Ø24                  INR     D           INCREMENT ERASE
Ø11 247   3Ø3 ØØ5 Ø11          JMP     RCD2Ø
Ø11 252   Ø26 ØØ1      RCD24   MVI     D,1         ERASE = 1
Ø11 254   Ø52 265 Ø12          LHLD    IDW         INCREMENT IDW
Ø11 257   Ø43                  INX     H
Ø11 26Ø   Ø42 265 Ø12          SHLD    IDW
Ø11 263   353                  XCHG
Ø11 264   321                  POP     D
Ø11 265   Ø24                  INR     D           COUNTH = Ø?
Ø11 266   Ø25                  DCR     D
Ø11 267   312 3Ø7 Ø11          JZ      RCD25       YES
Ø11 272   Ø25                  DCR     D           DECREMENT COUNTH
Ø11 273   345                  PUSH    H
Ø11 274   Ø52 267 Ø12          LHLD    POINTW
Ø11 277   Ø44                  INR     H
Ø11 3ØØ   Ø42 267 Ø12          SHLD    POINTW
Ø11 3Ø3   341                  POP     H
Ø11 3Ø4   3Ø3 21Ø Ø11          JMP     RCD26
Ø11 3Ø7   Ø52 267 Ø12  RCD25   LHLD    POINTW      ADD COUNTL TO POINTER
Ø11 312   Ø26 ØØØ              MVI     D,Ø
Ø11 314   Ø31                  DAD     D
Ø11 315   Ø42 267 Ø12          SHLD    POINTW
Ø11 32Ø   227                  SUB     A           ERROR = Ø
Ø11 321   3Ø3 Ø41 Ø11          JMP     RCD27
Ø11 324   Ø25          RCD16   DCR     D           DECREMENT COUNTH
Ø11 325   ØØ6 ØØØ              MVI     B,Ø         COUNT =Ø
Ø11 327   3Ø3 135 Ø11          JMP     RCD18

*                      RECRD1   (RECORD ONE BLOCK)
*                             RECORD OR ERASE COMMAND MUST BE ISSUED
*                               BEFORE CALLING.
*                             UNDERRUN AND STOP SHOULD BE CHECKED
*                               AFTER RETURN.
*                             INPUTS:
*                               DECK - DECK NUMBER LOCATED
*                                      IN MEMORY
*                               ID - REGISTER D,E
*                               COUNT - REGISTER B
*                                       (Ø1=1 BYTE, ØØ=256 BYTES)
```

```
LOC        OBJ          LABEL    OP      OPERAND       COMMENT

                        *                POINTER - REGISTER H,L
                        *                          (FIRST DATA BYTE)
                        *           OUTPUT:
                        *                POINTER - REGISTER H,L
                        *                          (LAST DATA BYTE + 1)
                        *           ALTERED
                        *                REGISTERS - A,B,C,D,E,H,L
Ø11 332    345          RECRD1   PUSH    H             PUSH POINTER
Ø11 333    Ø41 ØØØ ØØØ          LXI     H,Ø           RESET CRC
Ø11 336    112                  MOV     C,D           ID HIGH
Ø11 337    315 111 Ø12          CALL    ALTPUT
Ø11 342    113                  MOV     C,E           ID LOW
Ø11 343    315 1Ø2 Ø12          CALL    PUT
Ø11 346    11Ø                  MOV     C,B           COUNT
Ø11 347    315 1Ø2 Ø12          CALL    PUT
Ø11 352    124                  MOV     D,H           SAVE CRC2
Ø11 353    115                  MOV     C,L           CRC1
Ø11 354    315 1Ø2 Ø12          CALL    PUT
Ø11 357    112                  MOV     C,D           CRC2
Ø11 36Ø    315 1Ø2 Ø12          CALL    PUT
Ø11 363    13Ø                  MOV     E,B           SAVE COUNT
Ø11 364    343          RECD1   XTHL                  SWITCH CRC, POINTER
Ø11 365    116                  MOV     C,M           LOAD DATA
Ø11 366    Ø43                  INX     H             INCREMENT POINTER
Ø11 367    343                  XTHL                  SWITCH CRC, POINTER
Ø11 37Ø    315 1Ø2 Ø12          CALL    PUT
Ø11 373    ØØ5                  DCR     B             DECREMENT COUNT
Ø11 374    3Ø2 364 Ø11          JNZ     RECD1         NOT ZERO
Ø11 377    124                  MOV     D,H           SAVE CRC2
Ø12 ØØØ    115                  MOV     C,L           CRC1
Ø12 ØØ1    315 1Ø2 Ø12          CALL    PUT
Ø12 ØØ4    112                  MOV     C,D           CRC2
Ø12 ØØ5    315 1Ø2 Ø12          CALL    PUT
Ø12 Ø1Ø    Ø35                  DCR     E             DECREMENT SAVED COUNT
Ø12 Ø11    315 1Ø2 Ø12  RECD3   CALL    PUT
Ø12 Ø14    Ø34                  INR     E             INCREMENT SAVED COUNT
Ø12 Ø15    3Ø2 Ø11 Ø12          JNZ     RECD3         NOT ZERO
Ø12 Ø2Ø    315 1Ø2 Ø12          CALL    PUT
Ø12 Ø23    341                  POP     H             POP POINTER
Ø12 Ø24    311                  RET
                        *        GET
                        *        CRC IN H,L
                        *        DATA RETURNED IN C
                        *        A,C,H,L, ALTERED
Ø12 Ø25    333 ØØ2      GET     IN      TAPEIN        STATUS
Ø12 Ø27    346 Ø17              ANI     ØFH
Ø12 Ø31    312 Ø25 Ø12          JZ      GET
Ø12 Ø34    315 217 Ø12          CALL    DIN
Ø12 Ø37    325          CRC     PUSH    D
Ø12 Ø4Ø    171                  MOV     A,C
Ø12 Ø41    255                  XRA     L
```

```
LOC      OBJ          LABEL    OP       OPERAND        COMMENT

Ø12 Ø42  157                   MOV      L,A
Ø12 Ø43  Ø36 ØØ7               MVI      E,7            ØØ7 TIMES
Ø12 Ø45  Ø27          CRCA     RAL
Ø12 Ø46  255                   XRA      L
Ø12 Ø47  Ø35                   DCR      E
Ø12 Ø5Ø  3Ø2 Ø45 Ø12           JNZ      CRCA           DONE?
Ø12 Ø53  157                   MOV      L,A            YES
Ø12 Ø54  Ø17                   RRC
Ø12 Ø55  Ø17                   RRC
Ø12 Ø56  137                   MOV      E,A            SAVE 1
Ø12 Ø57  346 3ØØ               ANI      CØH
Ø12 Ø61  254                   XRA      H
Ø12 Ø62  127                   MOV      D,A            SAVE 2
Ø12 Ø63  173                   MOV      A,E            RESTORE 1
Ø12 Ø64  346 Ø77               ANI      3FH
Ø12 Ø66  255                   XRA      L
Ø12 Ø67  147                   MOV      H,A            CRC HIGH DONE
Ø12 Ø7Ø  Ø27                   RAL                     TEST BIT 7
Ø12 Ø71  172                   MOV      A,D            RESTORE 2
Ø12 Ø72  322 Ø77 Ø12           JNC      CRCFIN         BIT 7 WAS 1?
Ø12 Ø75  356 ØØ1               XRI      1              YES
Ø12 Ø77  157          CRCFIN   MOV      L,A            CRC LOW DONE
Ø12 1ØØ  321                   POP      D
Ø12 1Ø1  311                   RET
                       *       PUT
                       *       DATA IN REGISTER C
                       *       CRC IN H,L
                       *       A,H,L ALTERED
Ø12 1Ø2  333 ØØ2       PUT     IN       TAPEIN         STATUS
Ø12 1Ø4  346 Ø17               ANI      ØFH
Ø12 1Ø6  312 1Ø2 Ø12           JZ       PUT
Ø12 111  315 25Ø Ø12   ALTPUT  CALL     DOUT
Ø12 114  3Ø3 Ø37 Ø12           JMP      CRC
                       *       REWIND
                       *       REGISTER A, C ALTERED
                       *       THIS ROUTINE WILL GUARANTEE
                       *       DECK SELECTION
Ø12 117  Ø16 22Ø       REWIND  MVI      C,9ØH          STOP
Ø12 121  315 233 Ø12           CALL     CMDOUT
Ø12 124  333 ØØ2       REWB    IN       TAPEIN
Ø12 126  346 Ø1Ø               ANI      Ø8H
Ø12 13Ø  312 124 Ø12           JZ       REWB
Ø12 133  Ø16 2ØØ               MVI      C,8ØH          FR
Ø12 135  315 233 Ø12           CALL     CMDOUT
Ø12 14Ø  333 ØØ2       REWA    IN       TAPEIN
Ø12 142  346 Ø1Ø               ANI      8
Ø12 144  312 14Ø Ø12           JZ       REWA
Ø12 147  311                   RET
                       *       FAST REVERSE, FAST FORWARD
                       *       REGISTER A CONTAINS MULTIPLE
                       *       OF 1ØØ MILLI-SECONDS DELAY
                       *       REGISTER A ALTERED
```

```
LOC       OBJ            LABEL   OP      OPERAND       COMMENT

Ø12 15Ø   3Ø5            FR      PUSH    B
Ø12 151   365                    PUSH    PSW
Ø12 152   Ø16 2ØØ               MVI     C,8ØH
Ø12 154   315 233 Ø12    FRA     CALL    CMDOUT
Ø12 157   361                    POP     PSW
Ø12 16Ø   315 2Ø1 Ø12            CALL    DELAY
Ø12 163   Ø16 22Ø               MVI     C,9ØH
Ø12 165   315 233 Ø12            CALL    CMDOUT
Ø12 17Ø   3Ø1                    POP     B
Ø12 171   311                    RET
Ø12 172   3Ø5            FF      PUSH    B
Ø12 173   365                    PUSH    PSW
Ø12 174   Ø16 24Ø               MVI     C,AØH
Ø12 176   3Ø3 154 Ø12           JMP     FRA
                          *       DELAY MULTIPLE OF 1ØØ MS IN REGISTER A.
                          *       REGISTERS A,B,C ALTERED
Ø12 2Ø1   ØØ1 ØØØ Ø4Ø    DELAY   LXI     B,2ØØØH
Ø12 2Ø4   Ø13            D1      DCX     B
Ø12 2Ø5   ØØ4                    INR     B
Ø12 2Ø6   ØØ5                    DCR     B
Ø12 2Ø7   3Ø2 2Ø4 Ø12            JNZ     D1
Ø12 212   Ø75                    DCR     A
Ø12 213   3Ø2 2Ø1 Ø12            JNZ     DELAY
Ø12 216   311                    RET
                          *       INPUT DATA BYTE (DATA RETURNED IN C)
                          *       REGISTER A IS ALTERED
Ø12 217   Ø76 357        DIN     MVI     A,EFH
Ø12 221   323 ØØ1                OUT     STROBE
Ø12 223   333 ØØ2                IN      TAPEIN
Ø12 225   117                    MOV     C,A
Ø12 226   Ø76 337        DINA    MVI     A,DFH
Ø12 23Ø   323 ØØ1                OUT     STROBE
Ø12 232   311                    RET
                          *       OUTPUT COMMAND (DATA IN REGISTER C)
                          *       DECK IS OR'D WITH DATA
                          *       REGISTER A IS ALTERED
Ø12 233   Ø72 26Ø Ø12    CMDOUT  LDA     DECK
Ø12 236   261                    ORA     C
Ø12 237   323 ØØ2                OUT     TAPOUT
Ø12 241   Ø76 237                MVI     A,9FH
Ø12 243   323 ØØ1        CMDA    OUT     STROBE
Ø12 245   3Ø3 226 Ø12            JMP     DINA
                          *       OUTPUT DATA (DATA IN REGISTER C)
                          *       REGISTER A IS ALTERED
Ø12 25Ø   171            DOUT    MOV     A,C
Ø12 251   323 ØØ2                OUT     TAPOUT
Ø12 253   Ø76 137                MVI     A,5FH
Ø12 255   3Ø3 243 Ø12            JMP     CMDA
                          *       VARIABLE DATA AREA
Ø12 26Ø   ØØØ            DECK    DS      1             DECK NUMBER TO BE USED
Ø12 261   ØØØ ØØØ        IDR     DS      2             READ ID
```

```
LOC        OBJ          LABEL    OP       OPERAND      COMMENT

Ø12 263    ØØØ ØØØ      POINTR   DS       2            READ POINTER
Ø12 265    ØØØ ØØØ      IDW      DS       2            WRITE ID
Ø12 267    ØØØ ØØØ      POINTW   DS       2            WRITE POINTER
                        *        READ ONE BLOCK
                        *          DECK REMAINS RUNNING AFTER RETURN
                        *        INPUT:
                        *          DECK - DECK NUMBER LOCATED IN MEMORY
                        *          POINTR     - LOCATED IN MEMORY
                        *                       (FIRST BYTE)
                        *          IDR - LOCATED IN MEMORY
                        *          RETRYS     - REGISTER D
                        *                       ( ALTRD    ONLY)
                        *          MODE - REGISTER E
                        *                 Ø=READ
                        *                 1=CHECK
                        *        OUTPUT:
                        *          DECK, POINTER, IDR UNCHANGED
                        *          REGISTER - A,B,C,D,H,L ALTERED
                        *          COUNT - REGISTER B
                        *                  Ø1=1 BYTE
                        *                  ØØ=256 BYTES
                        *          ERROR - REGISTER A
                        *                  Ø - NO ERRORS
                        *                  1 - CRC ERROR
                        *                  2 - BLOCK NOT FOUND
                        *                  3 - END OF TAPE OR JAM
                        *        ENTRY POINTS:
                        *          READ - NORMAL ENTRY
                        *          ALTRD      - DECK WILL BACKSPACE
                        *                       FIRST, USER MUST SUPPLY RETRIES.
                        *          ALTRD2     - NORMAL, EXCEPT USER MUST
                        *                       SUPPLY RETRIES
Ø12 271    Ø26 Ø12      READ     MVI      D, RETRYS
Ø12 273    325          RD54     PUSH     D            RETRIES, MODE
                        ALTRD2   EQU      RD54
Ø12 274    Ø41 ØØØ ØØØ  RD5      LXI      H,Ø          RESET CRC
Ø12 277    333 ØØ2               IN       TAPEIN       STATUS
Ø12 3Ø1    127                   MOV      D,A
Ø12 3Ø2    Ø16 34Ø      RD51     MVI      C,EØH        READ
Ø12 3Ø4    315 233 Ø12           CALL     CMDOUT
Ø12 3Ø7    172                   MOV      A,D          STOP?
Ø12 31Ø    346 ØØ4               ANI      Ø4H
Ø12 312    312 327 Ø12           JZ       RD5Ø         NO
Ø12 315    Ø76 ØØ4               MVI      A,4          .4 SECONDS
Ø12 317    315 2Ø1 Ø12           CALL     DELAY
Ø12 322    Ø26 ØØØ               MVI      D,Ø          STATUS = Ø
Ø12 324    3Ø3 3Ø2 Ø12           JMP      RD51
Ø12 327    ØØ6 Ø6Ø      RD5Ø     MVI      B,3ØH        8 SECOND TIMEOUT
Ø12 331    12Ø          RD57     MOV      D,B
Ø12 332    333 ØØ2      RD53     IN       TAPEIN       STATUS
```

```
LOC        OBJ              LABEL   OP        OPERAND      COMMENTS

Ø12 334    346 Ø17                  ANI       ØFH          READY?
Ø12 336    3Ø2 22Ø Ø13              JNZ       RD1Ø         YES
Ø12 341    Ø33                      DCX       D
Ø12 342    Ø24                      INR       D
Ø12 343    Ø25                      DCR       D
Ø12 344    3Ø2 332 Ø12              JNZ       RD53
Ø12 347    ØØ5                      DCR       B
Ø12 35Ø    3Ø2 331 Ø12              JNZ       RD57
Ø12 353    315 117 Ø12              CALL      REWIND
Ø12 356    Ø76 ØØ2         RD2      MVI       A,2          ERROR = 2
Ø12 36Ø    321                      POP       D            RETRIES, MODE
Ø12 361    Ø25             RD8      DCR       D
Ø12 362    3Ø2 273 Ø12              JNZ       RD54
Ø12 365    311                      RET
Ø12 366    315 Ø25 Ø12     RD52     CALL      GET          IDH
Ø12 371    1Ø1                      MOV       B,C
Ø12 372    315 Ø25 Ø12              CALL      GET          IDL
Ø12 375    131                      MOV       E,C
Ø12 376    315 Ø25 Ø12              CALL      GET          COUNT
Ø13 ØØ1    121                      MOV       D,C
Ø13 ØØ2    315 Ø25 Ø12              CALL      GET          CRC1
Ø13 ØØ5    315 Ø25 Ø12              CALL      GET          CRC2
Ø13 Ø1Ø    227                      SUB       A            CRC = Ø?
Ø13 Ø11    2Ø4                      ADD       H
Ø13 Ø12    3Ø2 274 Ø12              JNZ       RD5          NO
Ø13 Ø15    2Ø5                      ADD       L
Ø13 Ø16    3Ø2 274 Ø12              JNZ       RD5          NO
                           *        COMPUTE                BE TAPEID
                           *                               -HL IDR
                           *                                XY
Ø13 Ø21    173                      MOV       A,E
Ø13 Ø22    Ø52 261 Ø12              LHLD      IDR
Ø13 Ø25    225                      SUB       L
Ø13 Ø26    137                      MOV       E,A          REGISTER E CONTAINS Y
Ø13 Ø27    157                      MOV       L,A
Ø13 Ø3Ø    17Ø                      MOV       A,B
Ø13 Ø31    234                      SBB       H            REGISTER A CONTAINS X
Ø13 Ø32    147                      MOV       H,A          H = XY/8
Ø13 Ø33    Ø51                      DAD       H
Ø13 Ø34    Ø51                      DAD       H
Ø13 Ø35    Ø51                      DAD       H
Ø13 Ø36    Ø51                      DAD       H
Ø13 Ø37    Ø51                      DAD       H
Ø13 Ø4Ø    174                      MOV       A,H
Ø13 Ø41    312 Ø7Ø Ø13              JZ        ID1
Ø13 Ø44    362 Ø7Ø Ø13              JP        ID2
Ø13 Ø47    Ø57                      CMA                    COMPUTE FF DELAY
Ø13 Ø5Ø    3Ø6 ØØ2                  ADI       2            ADD 1+1 FOR 2'S COMP
Ø13 Ø52    372 Ø62 Ø13              JM        ID3
Ø13 Ø55    376 ØØ4                  CPI       4            GREATER THAN THRESHOLD?
```

LOC	OBJ	LABEL	OP	OPERAND	COMMENT
Ø13 Ø57	372 274 Ø12		JM	RD5	NO
Ø13 Ø62	315 172 Ø12	ID3	CALL	FF	
Ø13 Ø65	3Ø3 274 Ø12		JMP	RD5	
Ø13 Ø7Ø	Ø34	ID1	INR	E	Y = Ø?
Ø13 Ø71	Ø35		DCR	E	
Ø13 Ø72	312 1Ø5 Ø13		JZ	RD6	YES
Ø13 Ø75	3Ø6 ØØ6	ID2	ADI	6	
Ø13 Ø77	315 15Ø Ø12		CALL	FR	
Ø13 1Ø2	3Ø3 356 Ø12		JMP	RD2	
Ø13 1Ø5	1Ø2	RD6	MOV	B,D	COUNT
Ø13 1Ø6	321		POP	D	RETRIES, MODE
Ø13 1Ø7	3Ø5		PUSH	B	COUNT
Ø13 11Ø	Ø52 263 Ø12		LHLD	POINTR	
Ø13 113	345		PUSH	H	
Ø13 114	Ø41 ØØØ ØØØ		LXI	H,Ø	RESET CRC
Ø13 117	315 Ø25 Ø12	RD56	CALL	GET	
Ø13 122	Ø34		INR	E	
Ø13 123	Ø35		DCR	E	
Ø13 124	3Ø2 133 Ø13		JNZ	RD55	
Ø13 127	343		XTHL		SWITCH CRC, POINTER
Ø13 13Ø	161		MOV	M,C	STORE DATA
Ø13 131	Ø43		INX	H	BUMP POINTER
Ø13 132	343		XTHL		SWITCH CRC, POINTER
Ø13 133	ØØ5	RD55	DCR	B	DECREMENT COUNT
Ø13 134	3Ø2 117 Ø13		JNZ	RD56	
Ø13 137	3Ø1		POP	B	ADJUST STACK POINTER
Ø13 14Ø	3Ø1		POP	B	COUNT
Ø13 141	315 Ø25 Ø12		CALL	GET	
Ø13 144	315 Ø25 Ø12		CALL	GET	
Ø13 147	333 ØØ2		IN	TAPEIN	STATUS
Ø13 151	Ø37		RAR		OVERRUN?
Ø13 152	332 173 Ø13		JC	ALTRD	YES
Ø13 155	Ø37		RAR		
Ø13 156	Ø37		RAR		STOP?
Ø13 157	332 226 Ø13		JC	RD11	YES
Ø13 162	227		SUB	A	
Ø13 163	2Ø4		ADD	H	
Ø13 164	3Ø2 173 Ø13		JNZ	ALTRD	NO
Ø13 167	2Ø5		ADD	L	
Ø13 17Ø	312 2Ø5 Ø13		JZ	RD19	
Ø13 173	Ø76 ØØ5	ALTRD	MVI	A,5	GREATER THAN 1 BLOCK
Ø13 175	315 15Ø Ø12		CALL	FR	
Ø13 2ØØ	Ø76 ØØ1		MVI	A,1	ERROR = 1
Ø13 2Ø2	3Ø3 361 Ø12		JMP	RD8	
Ø13 2Ø5	12Ø	RD19	MOV	D,B	SAVE COUNT
Ø13 2Ø6	Ø25		DCR	D	DECREMENT SAVED COUNT
Ø13 2Ø7	315 Ø25 Ø12	RD9	CALL	GET	
Ø13 212	Ø24		INR	D	INCREMENT SAVED COUNT
Ø13 213	3Ø2 2Ø7 Ø13		JNZ	RD9	
Ø13 216	227		SUB	A	ERROR = Ø

```
LOC       OBJ            LABEL   OP      OPERAND     COMMENT

Ø13 217   311                    RET
Ø13 22Ø   346 ØØ4        RD1Ø    ANI     Ø4H         STOP?
Ø13 222   312 366 Ø12             JZ      RD52        NO
Ø13 225   321                    POP     D           RETRIES, MODE
Ø13 226   315 117 Ø12   RD11    CALL    REWIND
Ø13 231   Ø76 ØØ3                MVI     A,3         ERROR = 3
Ø13 233   3Ø3 361 Ø12             JMP     RD8
```

K. PHI-DECK MAINTENANCE

Recommended Field Maintenance

This maintenance schedule consists of recommended maintenance operations to be performed in the field by operating personnel and service technicians. Schedule A consists of cleaning operations that should be performed every ten to twenty hours of operating time. Since the accumulation of dirt and tape oxide is highly dependent upon operating environment and the quality of tape used, the time interval for Schedule A can be varied according to system experience. The Schedule A cleaning operations are simple enough that they can be performed by operating personnel in many systems.

The items in Schedule B should be performed by technically skilled personnel.

Required Equipment

For Schedule A

1. Tape head cleaner or pure isopropyl alcohol
2. Rubber drive cleaner
3. Cotton tip wood swabs (Q-Tips)
4. Soft bristled brush
5. Tape head demagnetizer

Additional Equipment for Schedule B

1. Lightweight machine oil
2. SAE 10 wt. oil
3. Speed test tape
4. Oscilloscope, frequency counter or wow and flutter meter with speed check capability

Schedule A (10 to 20 hour intervals)

1. Remove accumulated dust, tape oxide particles, etc. with a soft bristled brush.
2. Clean magnetic head and tape guides with tape head cleaner or isopropyl alcohol.
3. Clean the capstan shaft with a cotton tip swap moistened with tape head cleaner. Do not allow tape head cleaner to run down the capstan shaft into the capstan bearing. Use only enough cleaning liquid on the cotton tip swab to remove tape oxide from the exposed portion of the capstan shaft.
4. Clean pinch roller with rubber drive cleaner or isopropyl alcohol.
5. Demagnetize the tape head using a tape head demagnetizer.

Schedule B (500 hour intervals)

1. Perform Schedule A.
2. Oil the capstan bearing using a drop of lightweight machine oil. Clean excess oil off the capstan shaft.
3. Oil the headbar pivot bushings with a drop or two of SAE 10 weight oil.
4. Check and adjust tape speed as described in the Motor Speed Calibration paragraph in section VI.

Maintenance Guide

This maintenance schedule consists of recommended maintenance checks and operations to be performed in a facility equipped for tape deck repairs and maintenance. For greatest system reliability, this procedure should be performed on a regular basis at intervals of approximately 1,000 hours of tape deck operating time. Where such maintenance is not performed on a scheduled basis, this routine should be performed whenever a tape deck is returned to a repair facility for repairs.

Required Equipment

1. Tape head cleaner or pure isopropyl alcohol
2. Rubber drive cleaner
3. Lightweight machine oil
4. SAE 10 wt. oil
5. Cotton tip wood swabs (Q-Tips)
6. Soft bristled brush
7. Tape head demagnetizer
8. Information Terminals M-300 Tape head and guide gauge set
9. Oscilloscope
10. Test tapes
11. Miscellaneous hand tools
12. Frequency counter

Cleaning

1. Clean Phi-Deck thoroughly. Remove accumulated dust, tape oxide particles and lint with air hose or brush.
2. Demagnetize tape head.
3. Clean tape head and tape guides with liquid cleaner and cotton swab. Use only a commercial tape head cleaning fluid or pure isopropyl alcohol.
4. Clean capstan shaft with a cotton tip wood swab moistened with tape head cleaner. Do not allow tape head cleaner to run down the capstan shaft into the capstan bearing. Use only enough cleaning liquid on the cotton swab to remove tape oxide from the exposed portion of the capstan shaft.
5. Clean capstan drive rubber roller. Use rubber drive roller cleaner or pure isopropyl alcohol.

Lubrication

1. Oil the headbar pivot bushings using a drop or two of SAE 10 weight oil. Wipe off excess oil.
2. Apply a drop of lightweight machine oil to the capstan bearing where the capstan shaft enters the bearing. Clean any excess oil from the capstan shaft.

Drive Belts

1. Remove the plastic cassette well and check the two reel drive belts. The belts should be replaced if there are any signs of splitting, cracking, or wear.
2. Check the belts for slippage by stalling the associated reel post while in the Fast Forward mode for the takeup reel and Rewind mode for the rewind reel. The belts should be replaced and the pulleys cleaned if there is belt slippage during the stalled condition.
3. Check the capstan flywheel drive belt for cracking, splitting, or wear. Replace if necessary.

Alignment Checks and Adjustments

1. Using the Information Terminals M-300 gauge set and with the headbar engaged, check head depth of penetration, zenith and guide height. The parameters being out of tolerance indicate that the gearbox positioning may need to be adjusted to compensate for starwheel assembly wear.
2. If the previous checks indicate head misalignment due to gearbox positioning, perform gearbox assembly alignment procedure. If head alignment is correct, do not perform adjustment.
3. Check gearbox starwheel to headbar engage-disengage positioning. Adjust starwheel position sensing micro-switch for correct positioning if necessary.
4. Check pinch roller pressure and adjust if necessary.
5. Using a high quality tape with a continuously recorded tone or flux reversal pattern, check the play or read head output for signal levels and quality. Incorrect signals are indicative of head wear, head alignment or tape tracking problems.
6. Check tape speed and adjust as described in the Motor Speed Calibration paragraph in section VI.

the digital group
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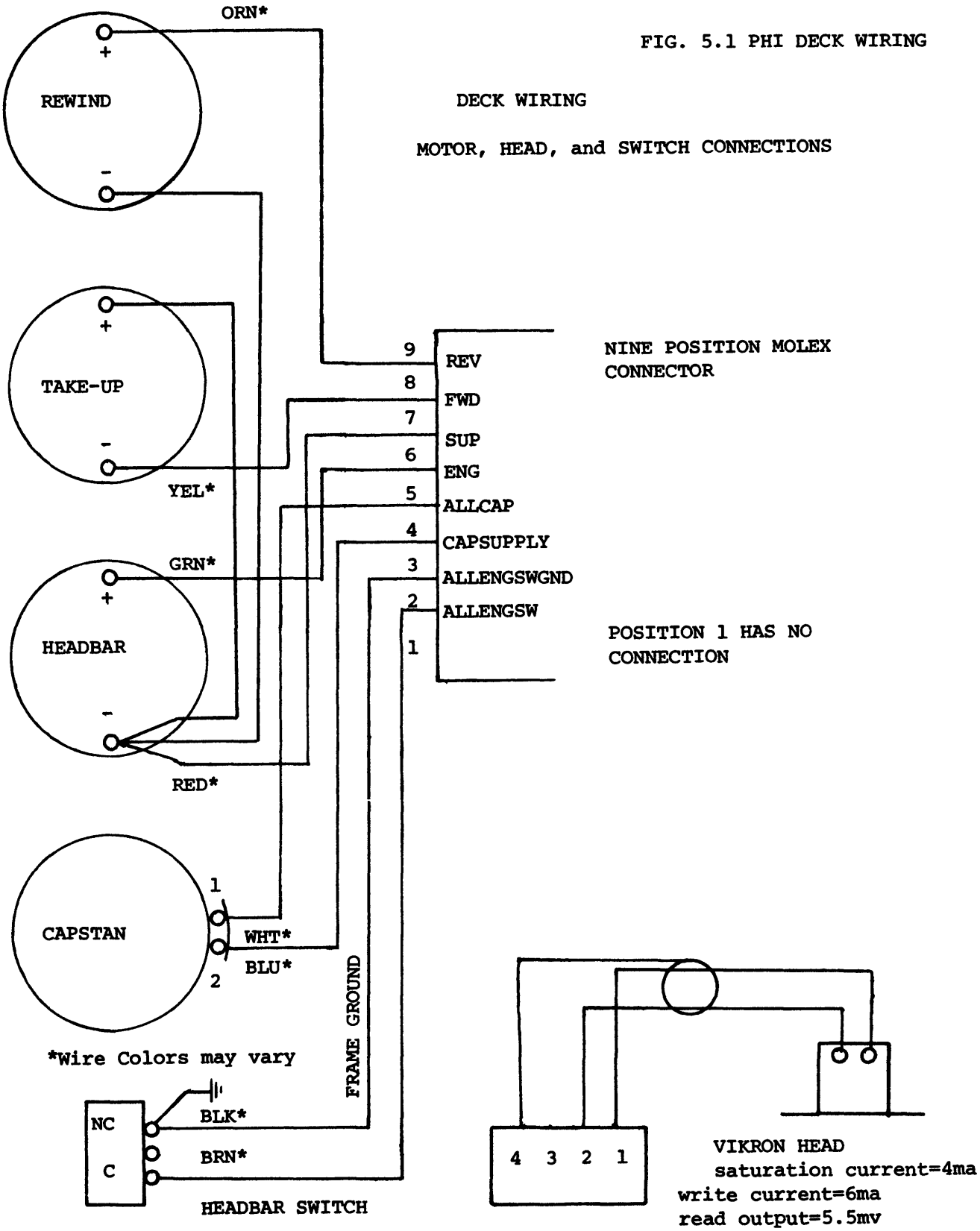
FIG. 5.1 PHI DECK WIRING

DECK WIRING

MOTOR, HEAD, and SWITCH CONNECTIONS



NOTE: Four position molex connector may be cut between 2 & 4 to separate HDGND from HDB and HDA.

1. HDB
2. HDA
3. No Connection
4. HDGRND (Shield)

The Digital Group Cassette Storage System

System Improvements

The following suggestions consist of various hardware and software improvements that may be made to the Cassette Storage System. Each modification should be examined to verify that it has not already been implemented.

NOTE: The hardware modifications are applicable only to The Digital Group B and C version controller cards. This board is identified by part number DG-0006-B or DG-0006-C on the right edge of the card. It is suggested that owners of A-version cards (DG-0006-A) purchase the controller upgrade kit. Refer to the schematic and parts placement diagram of the Cassette Storage System when making the hardware modifications.

Problems and associated modifications:

I. A. Symptom: The Phideck head may attempt to engage when power is initially applied to the system.

B. Modification (applicable only for B-version cards):
1. Replace R42 with a 22K ohm resistor.
2. Install a 4.7mfd, or greater tantalum capacitor from pin B ($\overline{\text{MANSTOP}}$) on the dual 36-pin edge to GND.

II. A. Symptom: The head will not engage properly or at all if a slow forward command is issued while the tape is moving in a fast forward mode.

B. Modification (applicable only for B-version cards): See Fig. 1
1. Cut the printed circuit trace leading to pin 4 of IC17 on the component side of the card.
2. Solder a short piece of wire between pin 4 and 5 of IC17 on the circuit side of the card.

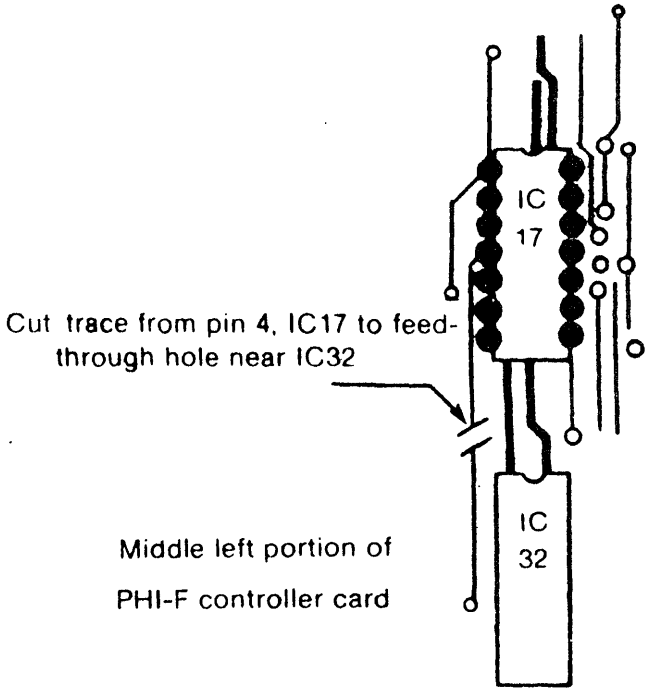


FIGURE 1

III. A. Symptom: Abnormally high soft error rate with some types of tapes or cassettes.

NOTE: This modification will reduce the speed tolerance from 20% to approximately 15%, which should be sufficient for most applications.

B. Modification:
1. Replace R50 with a 33K ohm resistor.
2. Replace C27 with a 4.7mfd tantalum capacitor.

IV. A. Symptom: Several problems have arisen with the use of some cassette tapes, such as: long leaders, C60 or longer tapes with abnormally low drag, and tape jumping off the internal guides of the cassette, thus creasing the tape.

B. Modification: Figures 1 and 2 contain software modifications that should be made to the system. There are two listings, one for the driver routines located at octal 011000 and another for the same driver routines located at octal 344000 in PHIMON. These changes will cure the above symptom and also provide a slight improvement in the access time of the Cassette Storage System.

C. Procedure for modifying PHIMON:
1. Power on system.
2. Type DTO, then hit RETURN.
3. Make the modifications shown in Figure 1 to the driver routines using DTO.
4. Return to PHIMON using the reset button.
5. Place a blank tape in drive #1.
6. Type ZE!#1, then hit RETURN.
7. Type BU#1, then hit RETURN.
8. When the operation is finished, drive #1 will contain a system tape with the modifications.
9. This new tape may now be used as your new system tape for all future operations.

WARNING: Do not use the modified version of PHIMON to save data or tapes with unmodified PHIMON or the directory will be lost. It is recommended that new tapes be generated using the modified PHIMON, and PIP be used transfer the data on the old tapes to the new ones.

V. A. Symptom: The head on a Phideck may bang in and out when power is turned on or after a static discharge to the system cabinet or electronics.

B. Solution:
1. Immediately turn off power to the system.
2. Move the system to an area that does not have a carpet or other static-producing media.
3. Inspect all drives to be sure all the heads are disengaged. If one is engaged, turn the engage cam on the left side of the drive *counter clockwise* until the head is disengaged.

VI. A. Symptom: Excessive errors on tapes due to contamination resulting from removing tapes from the drives without the tapes being rewound.

B. Solution: Rewind all tapes before removing them from the drives. The following HOME command should be added to the PHIMON operating system tape to aid the user in rewinding tapes.

C. HOME Command
1. Usage
The HOme command allows the user to quickly rewind any Phideck drive. The command is executed by typing:
<HO#N or
<HOME#N
The "<" indicates the prompt on the monitor. N is the drive number (0-3). Drive number 0 will be rewound if N is not specified.
2. Inserting the HOME Routine
a. Load PHIMON as usual.
b. Type AL #10, then hit RETURN.
c. Type DTO, then hit RETURN.
d. Type 010207 Octal.
e. Using DTO and referring to Figure 2, type Overlay 10 into memory.
f. Press the (ESC) key.
g. Type IN#10, then hit RETURN.
h. Type DTO, then hit RETURN.

i. Using DTO and referring to Figure 4, type in the changes to the command table and the Home Routine.
j. Press the (ESC) Key.
k. Type BUILD, then hit RETURN.
l. Modifications to PHIMON are now complete.

VII. A. Symptom: Poor performance due to type of tape being used.

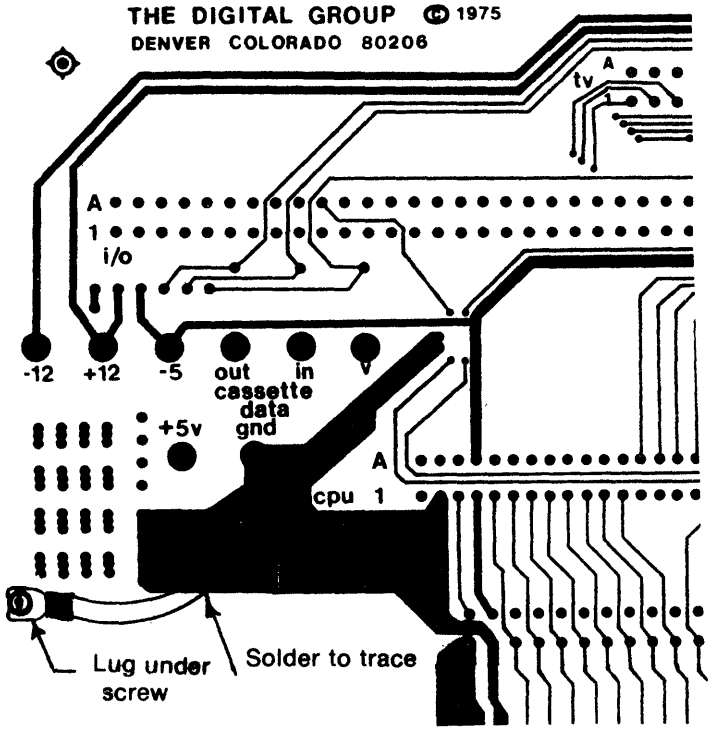
B. Solution: Use only types of tape recommended by the Digital Group.
1. Digital Group audio cassettes are available in quantities of 1, 5 or 10 cassettes. Order number Cassette10 for 10 tapes, Cassette5 for 5 tapes.
2. Use only high quality, low noise audio cassettes. Avoid high-output, chromium dioxide or any other special purpose tapes.

VIII. A. Symptom: Excessive noise caused by a ground loop in system ground, resulting in excessive soft errors during read.

B. Solution: Modify your system by grounding the system motherboard to the chassis. For a Digital Group system, this is best accomplished by soldering a short piece of 14 gauge wire to the ground plane on the top side of the motherboard and connecting the other end under a motherboard mounting screw with a lug affixed to the wire.

See the accompanying figure below.

NOTE: If, after accomplishing all the modifications and following all our suggestions, you are still unable to get satisfactory operation of your Phideck system, send your Phideck components or, for best results, your complete system, to us for repair and/or evaluation. It will be returned to you operational and with an extended 90-day warranty. Consult the Digital Group repair fee schedule for the cost of this service.



PATCH SHEET FOR PHIMON

Figure 1 — Modifications to PHIMON

```
ADDRESS  OBJECT CODE
064265                    0100 ORG    EQU  344000
344062                    0110        ST   ORG+62
344062                    0120 **** FIVE SECOND DELAY FOR BLOCK 0. ****
344062                    0130        DB   062
  062
344202                    0140        ST   ORG+202
344202                    0150 **** BACKSPACE SEVERAL BLOCKS BEFORE CHECK READ
344202                    0160        DB   003
  003
345165                    0170        ST   ORG+1165
345165                    0180 **** JUMP TO STOP. ****
345165 303 302 345        0190        JP   STOP
345277                    0200        ST   ORG+1277
345277                    0210 **** STOP ROUTINE AND FAST REVERSE CORRECTION.
345277 303 322 345        0220        JP   RD51
345302 315 233 345        0230 STOP   CALL CMDOUT STOP ROUTINE
345305 076 001            0240        LD   A,1 .1 SECOND
345307 315 201 345        0250        CALL DELAY
345312 301                0260        POP  BC
345313 311                0270        RET
345314 315 150 345        0280 FRCOR  CALL FR FAST REVERSE CORRECTION
345317 303 356 345        0290        JP   RD2
345322 016 340            0300 RD51   LD   C,0E0H READ
345324 315 233 345        0310        CALL CMDOUT
345327 006 110            0320 RD50   LD   B,110 14 SECONDS
346036                    0330        ST   ORG+2036
346036                    0340 **** SEARCH IMPROVEMENT. ****
346036 174                0350        LD   A,H
346037 051                0360        ADD  HL,HL
346040 312 070 346        0370        JP   Z,ID1
346043 362 075 346        0380        JP   P,ID2
346046 204                0390        ADD  H
346051                    0400        ST   ORG+2051
346051                    0410 **** MORE SEARCH IMPROVEMENT. ****
346051                    0420        DB   1
  001
346056                    0430        ST   ORG+2056
346056                    0440 **** MORE SEARCH IMPROVEMENT. ****
346056                    0450        DB   3
  003
346075                    0460        ST   ORG+2075
346075                    0470 **** MORE SEARCH IMPROVEMENT. ****
346075 204                0480 ID2    ADD  H
346076 007                0490        RLCA
346077 306 005            0500        ADD  5
346101 303 314 345        0510        JP   FRCOR
346174                    0520        ST   ORG+2174
346174                    0530 **** LAST OF SEARCH IMPROVEMENT. ****
346174                    0540        DB   3
  003
346175                    0550 **** EXTERNAL REFERENCES. ****
346175                    0560 CMDOUT EQU  ORG+1233
346175                    0570 DELAY  EQU  ORG+1201
346175                    0580 FR     EQU  ORG+1150
346175                    0590 ID1    EQU  ORG+2070
346175                    0600 RD2    EQU  ORG+1356
346175                    0610        END
```

PATCH SHEET FOR PHIDECK DRIVER

Figure 2 — Modifications to the Phi-Deck Driver Routines

```
ADDRESS
064240  OBJECT CODE      0100 ORG     EQU  011000
011062                   0110         ST   ORG+62
011062                   0120 **** FIVE SECOND DELAY FOR BLOCK 0. ****
011062                   0130         DB   062
  062
011202                   0140         ST   ORG+202
011202                   0150 **** BACKSPACE SEVERAL BLOCKS BEFORE CHECK READ.
011202                   0160         DB   003
  003
012165                   0170         ST   ORG+1165
012165                   0180 **** JUMP TO STOP. ****
012165 303 302 012       0190         JP   STOP
012277                   0200         ST   ORG+1277
012277                   0210 **** STOP ROUTINE AND FAST REVERSE CORRECTION.
012277 303 322 012       0220         JP   RD51
012302 315 233 012       0230 STOP    CALL CMDOUT STOP ROUTINE
012305 076 001           0240         LD   A,1 .1 SECOND
012307 315 201 012       0250         CALL DELAY
012312 301               0260         POP  BC
012313 311               0270         RET
012314 315 150 012       0280 FRCOR   CALL FR FAST REVERSE CORRECTION
012317 303 356 012       0290         JP   RD2
012322 016 340           0300 RD51    LD   C,0E0H READ
012324 315 233 012       0310         CALL CMDOUT
012327 006 110           0320 RD50    LD   B,110 14 SECONDS
013036                   0330         ST   ORG+2036
013036                   0340 **** SEARCH IMPROVEMENT. ****
013036 174               0350         LD   A,H
013037 051               0360         ADD  HL,HL
013040 362 070 013       0370         JP   Z,ID1
013043 362 075 013       0380         JP   P,ID2
013046 204               0390         ADD  H
013051                   0400         ST   ORG+2051
013051                   0410 **** MORE SEARCH IMPROVEMENT. ****
013051                   0420         DB   1
  001
013056                   0430         ST   ORG+2056
013056                   0440 **** MORE SEARCH IMPROVEMENT. ****
013056                   0450         DB   3
  003
013075                   0460         ST   ORG+2075
013075                   0470 **** MORE SEARCH IMPROVEMENT. ****
013075 204               0480 ID2     ADD  H
013076 007               0490         RLCA
013077 306 005           0500         ADD  5
013101 303 314 012       0510         JP   FRCOR
013174                   0520         ST   ORG+2174
013174                   0530 **** LAST OF SEARCH IMPROVEMENT. ****
013174                   0540         DB   3
  003
013177                   0550 **** EXTERNAL REFERENCES. ****
013175                   0560 CMDOUT  EQU  ORG+1233
013175                   0570 DELAY   EQU  ORG+1201
013175                   0580 FR      EQU  ORG+1150
013175                   0590 ID1     EQU  ORG+2070
013175                   0600 RD2     EQU  ORG+1356
013175                   0610         END
```

PHIMON HOME COMMAND

```
LOCATION
010207 OBJECT CODE      0100         ST   010207
010207                  0110 * PATCHES TO OVERLAY 10 FOR HOME COMMAND
010207 310 317          0120         DC   'HO'

010211 355 345          0130         DW   345355

010213 016              0140         DB   016

010214 332 305          0150         DC   'ZE'

010216 362 357          0160         DW   357362

010220 012              0170         DB   012

010221 311 316          0180         DC   'IN'

010223 363 345          0190         DW   345363

010225 362 364          0210         DW   364362

010227 065              0220         DB   065

010230 000              0230         DB   000
```

FIGURE 3 -- Patches to Help Overlay

```
LOCATION

340146 OBJECT CODE      0240         ST   340146
340146                  0250 * MODIFICATION TO PHIMON TO ADD 'HOME'
340146                  0260 * COMMAND, WHICH WILL REWIND THE SPECIFIED
340146                  0270 * PHIDECK DRIVE UNIT.  BY TOM COX
340146                  0280 *
340146                  0290 * FORMAT >HOME#N
340146                  0300 *
340146                  0310 * NEW ENTRY FOR COMMAND TABLE
340146 020              0320 COMTAB DB   020

340262                  0330         ST   340262
340262 310 317          0340         DC   'HO'

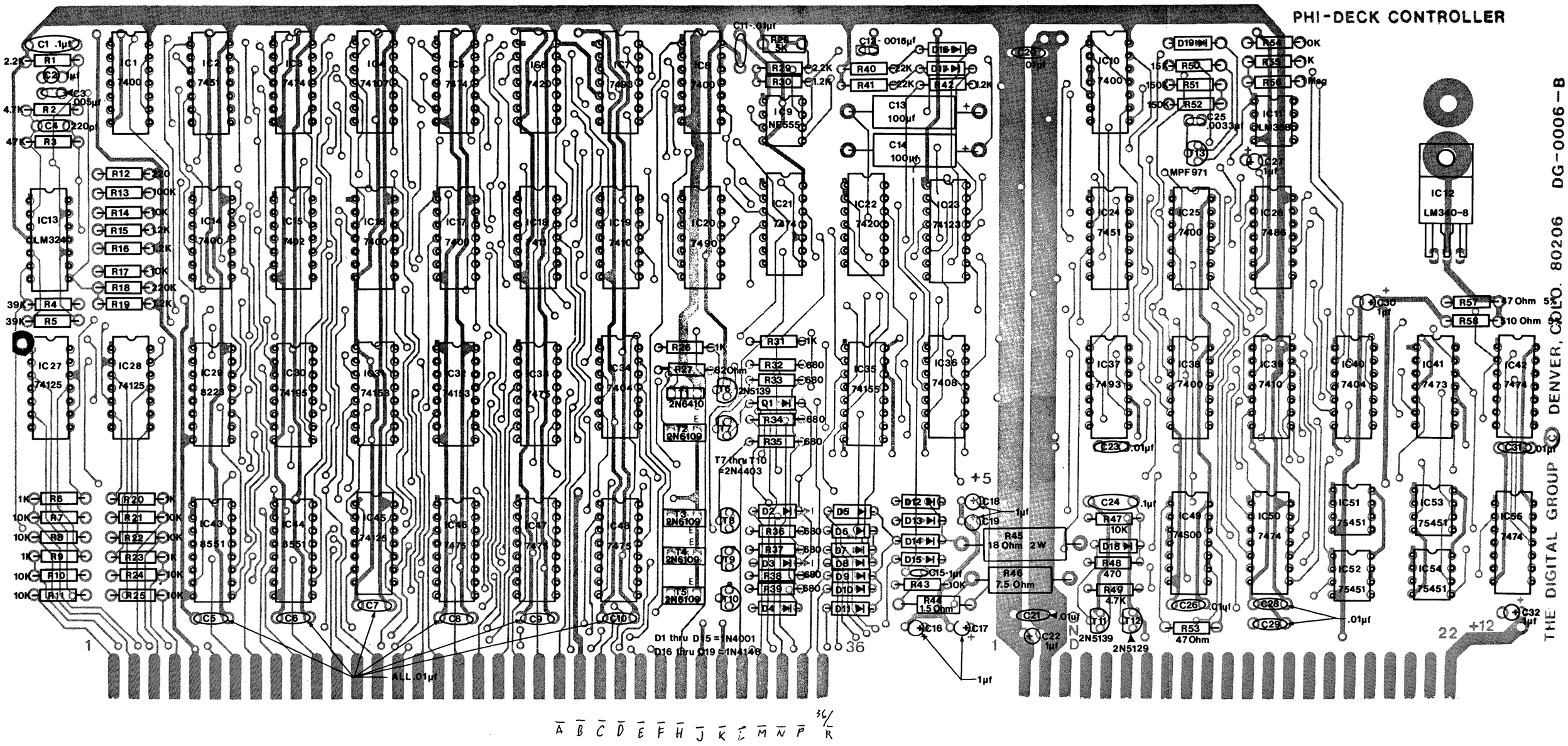
340264 352 343          0350         DW   HOME

340266 000              0360         DB   0

343352                  0370         ST   343352
343352                  0380 * ROUTINE TO REWIND SPECIFIED DECK
343352 315 162 341      0390 HOME    CALL DECKSL
343355 315 117 345      0400         CALL REWIND
343360 303 042 340      0410         JP   COMAND
343363                  0420 DECKSL EQU  341162
343363                  0430 REWIND EQU  345117
343363                  0440 COMAND EQU  340042
```

FIGURE 4 -- Patches to Command Table

CSSB-33-CL


PHI-DECK CONTROLLER
THE DIGITAL GROUP © DENVER, CO. 80206 DG-0006-B
C1 .1µf
R1 2.2K
C2 1µf
C3 .005µf
R2 4.7K
C4 220pf
R3 47K
C1 7400
IC2 7451
IC3 7414
IC4 74107
IC5 7414
IC6 7420
IC7 7493
IC8 7400
C11-.01µf
R28 5K
R29 2.2K
R30 1.2K
IC9 NE555
C12-.0015µf
R40 22K
R41 22K
C13 100µf
C14 100µf
C20 .02µf
IC10 7400
D19
R54 10K
R55 1K
R56 1meg
R50 15K
R51 150K
R52 150K
C25 .0033µf
D13 MPF971
IC11 LM3900
C27 1µf
IC12 LM340-8
IC13 LM3240
R12 220
R13 100K
R14 10K
R15 12K
R16 12K
R17 10K
R18 220K
R19 12K
IC14 7400
IC15 7402
IC16 7400
IC17 7400
IC18 7410
IC19 7410
IC20 7490
IC21 7474
IC22 7420
IC23 74123
IC24 7451
IC25 7400
IC26 7486
C30 1µf
R57 37 Ohm 5%
R58 310 Ohm 5%
39K R4
39K R5
IC27 74125
IC28 74125
IC29 8223
IC30 74195
IC31 74153
IC32 74153
IC33 7475
IC34 7404
R26 1K
R27 82Ohm
T1 2N6410
T2 2N6109
T3 2N6109
T4 2N6109
T5 2N6109
T6 2N5139
T7 thru T10 =2N4403
R31 1K
R32 680
R33 680
Q1
R34 680
R35 680
IC35 74155
IC36 7408
IC37 7493
IC38 7400
IC39 7410
IC40 7404
IC41 7473
IC42 7474
C23 .01µf
C31 .01µf
1K R6
10K R7
10K R8
1K R9
10K R10
10K R11
R20 1K
R21 10K
R22 10K
R23 1K
R24 10K
R25 10K
IC43 8551
IC44 8551
C45 74125
IC46 7475
IC47 7475
IC48 7475
C5
C6
C7
C8
C9
C10
ALL .01µf
D1 thru D15 = 1N4001
D16 thru D19 = 1N4148
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
R36 680
R37 680
R38 680
R39 680
D12
D13
D14
D15
C15-1µf
R43 10K
R44 1.5 Ohm
+C16
+C17
1µf
+5
+C18
C19 1µf
R45 18 Ohm 2W
R46 7.5 Ohm
C21 .01µf
C22 1µf
GND
C24 .1µf
R47 10K
D18
R48 470
R49 4.7K
T11 2N5139
T12 2N5129
IC49 74S00
C26 .01µf
R53 47 Ohm
IC50 7474
C28
C29
.01µf
IC51 75451
IC52 75451
IC53 75451
IC54 75451
IC55 7474
IC56 7474
+C32 1µf
22 +12
1
36
1
A B C D E F H J K L M N P R

DATA ENCODING AND SERIALIZATION

HEAD PREAMP AND WAVESHAPING

BIT SYNCHRONIZATION

CONTROL SEQUENCER AND SYSTEM TIMING

HEAD DRIVER

COMMAND LATCHES

CAPSTAN DRIVE

REGULATOR

MOTOR DRIVE, SENSE, AND CONTROL

DATA INPUT STROBE

COMMAND STROBE

ENABLE/DISABLE

SLOW/FAST

FWD/REND

STOP/RUN

RECORD/READ

ERASE

SEL1

SEL2

DATAOUT STROBE

DO7 DO6 DO5 DO4 DO3 DO2 DO1 DO0

HDA

HDB

ECLK

DCLK

CLOCK 3

CLOCK 4

DATA-OUT-STROBE

ONES

SYNC-GEN

SYNC

RECORD

RECORD

RUN

CLOCK 1

ONESDONE

CMDSTROB

Clock2

SLOW

FWD

DIVIDE BY 5

PULSE

DELAY

SPIN

QUIT

STOPPED

STOP

READ

ERASE

CNTL. V

DATA RATE

RANDATA

ECLR

CX

BX

FRDRV

ENGAJDRV

BOTHDRV

TAKEUPDRV

HDGND

HDA0

HDA1

HDA2

HDA3

HDB0

HDB1

HDB2

HDB3

SUP0

ENG0

SUP1

ENG1

SUP2

ENG2

SUP3

ENG3

ALL 1N4001

D1-D4= 1N4001

ALL .01 MFD

ALGN

DATA READY STATUS STROBE

STOP

NOTBUSY

READY

OVERRUN

MANSTOP

CAPSTUPSPLY

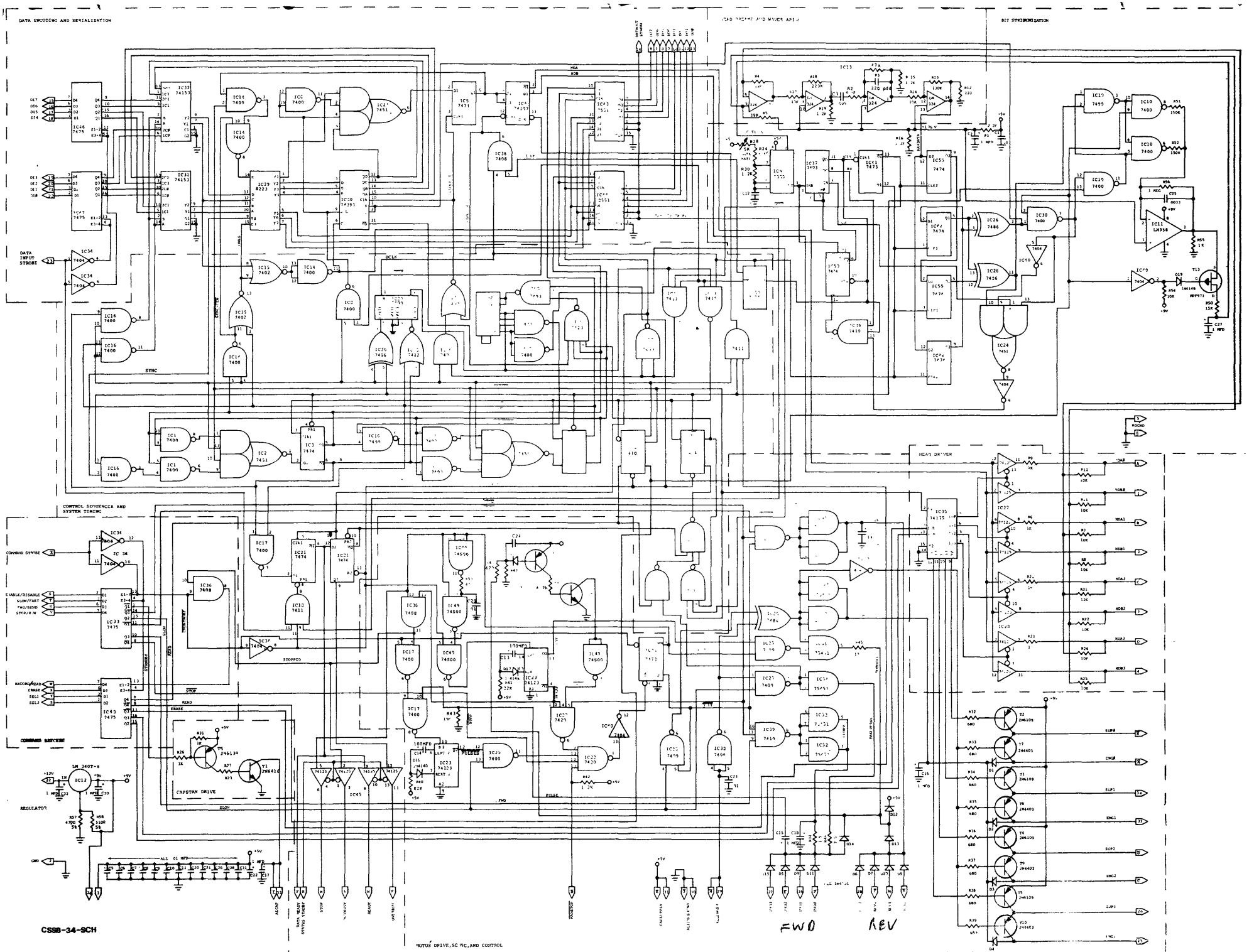
ALLENGSPLY

ALLSPLY

FWD3 FWD2 FWD1 FWD0

REV3 REV2 REV1 REV0

CSSB-34-SCH


DATA ENCODING AND SERIALIZATION
BIT SYNCHRONIZATION
HEAD DRIVER
CONTROL SEQUENCER AND SYSTEM TIMING
MOTOR DRIVE, SENSE, AND CONTROL
CAPSTAN DRIVE
REGULATOR
FWD
REV
CSS8-34-SCH

TWO AND FOUR DRIVE CABINET ASSEMBLY INSTRUCTIONS

CASSETTE STORAGE CABINET PARTS LIST

NOTE: Parts are subject to change without notice due to supplier availability.

		Small parts bag (all cabinets):	
1	Upper Cover	2	4-40x1/2" screws
1	Lower Cover	2	4-40 nuts
2	Side Rails	12	8-32x1/4" screws
1	Front Dress Panel	2	8-32x1/2" screws
1	Front Panel	18	6-32x1/2" screws
1	Rear Panel	18	6-32 nuts
4	Rubber Furniture Guards	1	36 pin connector

TWO AND FOUR DRIVE CABINET ASSEMBLY INSTRUCTIONS

A. LOWER COVER

1. Locate the 4 holes nearest the corners. These will be used to mount the rubber feet. In addition, the 2 holes near the front lip will also be used to mount two of the drives. To mount a rubber foot, insert one 6-32x1/2" screw into the foot, then through the bottom of the lower cover.
   NOTE: The two screws used to mount the front feet are also used to help mount two of the drives and extend up into the cabinet.

2. Position the drives over the remaining holes, then install the 6-32x1/2" screws through the drive legs and through the bottom cover. Do not tighten at this point.

B. FRONT DRESS PANEL, REAR PANEL AND SIDE RAILS

1. Inspect the side rail and note that there is a small extension on each end. One extension is slightly longer than the other. THE END WITH THE LONGEST EXTENSION IS INTENDED TO GO TOWARD THE FRONT OF THE CABINET. After selecting the front end of each rail, attach each rail to the front and rear panels using eight 8-32x1/4" screws. The two outer-most holes on the rear panel are close to the bottom edge.

2. For two drive models without enclosed controller card and for four drive cabinet models, route the power and control wire cables down the side of the drives and out the round end slots provided in the rear panel.

3. Install the front/rear panel assembly on the lower cover with drives by setting the assembly down over the drives and into position in the lower cover. Pull excess cable through the rear panel. Screw the rear panel to the lower cover using the lower two holes on the rear panel that line up with the bracket on the lower cover. Attach using two 8-32x1/4" screws, no hex nuts required.

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C. UPPER COVER

1. Place the upper cover in place over the drives. This job is made easier by removing the plastic cassette cover (plastic door) which simply snaps out of the two hinges. Locate the cover over the drives and adjust the drives to center in the cutouts, then tighten the drive mounting screws.

2. Install two 8-32x1/4" screws through the rear panel at the upper two holes and lock the rear of the upper cover in place.

3. Install two 8-32x1/2" screws through two holes at the front of the cabinet bottom and lock the front of the upper cover in place. Do not over-tighten as these screws will not bottom out automatically. When they are snug, then STOP.

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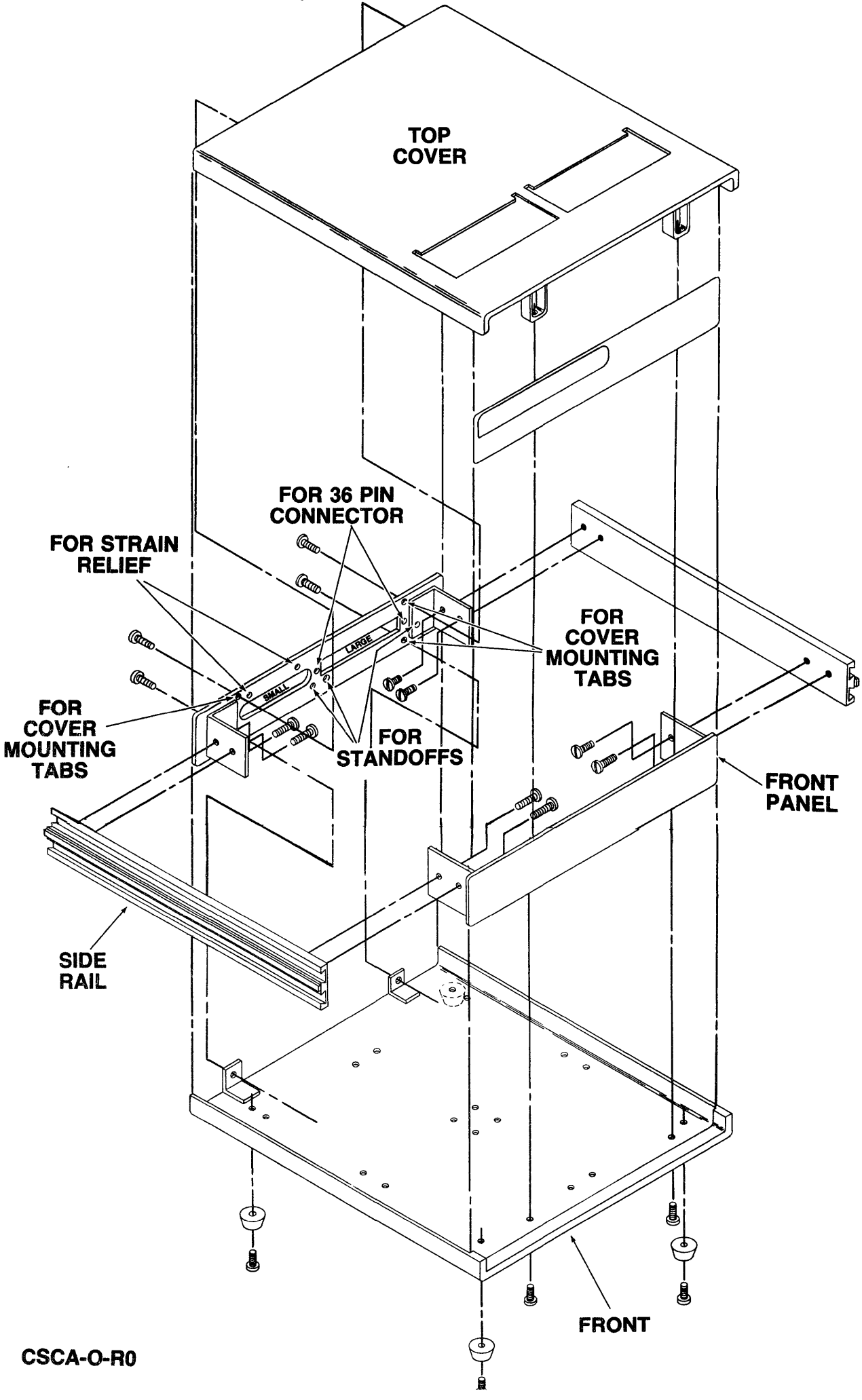
TOP
COVER
FOR 36 PIN
CONNECTOR
FOR STRAIN
RELIEF
LARGE
SMALL
FOR
COVER
MOUNTING
TABS
FOR
STANDOFFS
FOR
COVER
MOUNTING
TABS
FRONT
PANEL
SIDE
RAIL
FRONT
CSCA-O-R0