REVISIONS

LTR	DASH NO.	DESCRIPTION	DATE	APPROVED
A	9001	PROD RLSE PER ECO 1782	2-11-83	
B	9001	REVISED PER ECO 002825	21 JAN 85	DSP GCL DP

NOV 2 [illegible] 1985

CHECK PRINT
NOT FOR FABRICATION

350-334 USED ON
NEXT ASSY
1st APPLICATION

DWG APPROVAL DATE	
DWN	1 JUNE 82
CHK	1 JUN 82
DR MGR	6-1-82
DES ENG	6/1/82

DWG RELEASE DATE	
ENG PROG MGR	
MFG ENG	2-16-83
QA	2-17-83

CENTRONICS
data computer corp.
HUDSON, NEW HAMPSHIRE U.S.A.

TITLE
ENGINEERING PRODUCT SPEC
PHOENIX - BLUE

SIZE	CODE IDENT	NUMBER	REV
A	50163	80002176-9001	B

SCALE ____ DO NOT SCALE PRINT SHEET 1 OF 36

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

1.0 SCOPE

This specification defines the functional characteristics and requirements applicable to the design and construction of the 350-3, -4 (code named "Phoenix Blue") serial matrix printer. The 350-3, -4 contains the printing mechanism, print head, power supply, and the electronics (hereinafter referred to as the "Print Controller" or P.C.) which controls the printing mechanism. Machine functions are determined by an additional electronics board (hereinafter referred to as the "Format Controller" or F.C.) either customer or Centronics supplied which receives the data and from it dictates the method of printing. The Format Controllers are not covered by this specification. The means of communication between the two controllers and the versatility and restrictions of the basic machine are herein described.

2.0 RELATED DOCUMENTS

2.1 SPECIFICATIONS

A. 80002149-9001 Engineering Product Specification, 350 Mechanism

B. 80002150-9001 Engineering Product Specification, 350 Power Supply

C. 80002139-9001 Engineering Product Specification, High Speed Head

D. 80002151-9001 Engineering Product Specification, 350 Ribbon Cassette

E. Centronics Engineering Standard 001.

F. Centronics Engineering Standard 002.

G. Centronics Engienering Standard 003.

H. Centronics Engineering Standard 011.

I. Centronics Engineering Standard 014.

J. FCC Docket #20780, Part 15, Subpart J.

K. UL 114, 478 Regulatory Agency Requirements

L. CSA 22.2 #154 Regulatory Agency Requirements

M. VDE 0550,0730, 0830,0871,0875 Regulatory Agency Requirements

3.0 GENERAL

The Model 350 Serial Matrix Printer with Print Controller is modular in design concept where all effort has been made to de-personalize the basic machine giving flexibility of function and character to the design and implementation of the Format Controller.

The P.C. analyzes arguments and data passed to it by the F.C., performs the printer operation (described later) and returns status information. The machine is capable of 9-wire printing at a speed of 20 ips or 200 characters per second at 10 cpi printing a 7 wide matrix. The P.C. handles the logic seeking and bi-directional printing by analyzing the data and determining the most efficient method of printing. The machine is also capable, dependent on the format controller design, of high density, multi-pass printing.

The printing speed is determined by the pitch of the horizontal dots. Paper motion, reverse or forward, is defined in actual steps of the stepper motor. Each step is equal to 1/120 (.00833) of an inch. Paper slew rate is 8 ips.

3.1 FEATURES

3.1.1 Graphics Non-APA Normal Mode

Character font is 7x8 in a 10H x 8V character cell.

3.1.2 Cut Sheet/Sheet Feeder

Printer is capable of handling cut sheet forms. The margin is moved 1.2 inches to the right of the fanfold margin. For the sheet feeder the margin is moved in .4 inches from the fan fold margin.

3.1.3 Maximum Characters per Line

Char. Density	Max. Characters Available Fanfold	Cut Sheet	Sheet Feeder
5	66	60	64
6	79	72	77
6.7	88	80	85
7.5	99	90	96
8.3	110	100	106
10	132	120	128
12	158	144	154
13.3	176	160	170
15	198	180	192
16.67	220	200	213

4.0 ELECTRICAL DESCRIPTION

4.1 POWER REQUIREMENTS

4.1.1 Print Controller

The following power is required to operate the Print Controller.

		Average
+5V	-	2 Amps max.
+35V	-	3.5 Amps max.
+12V	-	.1 Amp max.
-12V	-	.1 Amp max.

For details on the power supply specification, see Engineering Product Specification, 350 Power Supply, 80002150-9001.

4.1.2 Format Controller

The following power is available for the Format Controller.

+5V	-	5 Amps max.
+12V	-	.65 Amps max.
-12V	-	.75 Amps max.

4.2 POWER CONNECTORS

4.2.1 Print Controller

Power is provided to the Print Controller via a connector as follows.

9 Pin Molex #09-74-1091, CDCC #31301029-1009.

Pin Number	Description
5	Chassis Ground
6	+5 VDC
4	+5 V Return
1	+12 VDC
2	+/-12 V Return
3	-12 VDC
7	+35 VDC
8	+35 V Return
9	Power Fail

4.2.2 Format Controller

Power is provided to the Format Controller via a 6 pin Molex #26-03-4061 as follows:

Pin Number	Description
1	+12 VDC
2	+12 Return
3	-12 VDC
4	+5 Return
5	Chassis Ground
6	+5 VDC

5.0 INTERFACE DESCRIPTION

5.1 General Description

The communications Ram (hereinafter referred to as the C-RAM) is the shared read/write memory used for Arguement/Data/Status communication between the Format Controller and the Print Controller. The C-RAM is physically located on the Format Controller but can be accessed by both the F.C. and the P.C. During a power on or P.C. reset sequence the P.C. will have initial control of the C-RAM until it has completed it's diagnostics. Any subsequent access to the C-RAM by the P.C. will be in response to the F.C. having raised and lowered the "HOLDIT" handshake signal.

The following sections will describe the bus architecture that will be utilized by the P.C. to communicate with the C-RAM. Refer to figures 1 & 2 for specifics on the read/write and control signal timing.

5.1.1 Signal Description

5.1.1.1 Data Bus - D0 Thru D7

These 8 bidirectional data lines allow the Printer Controller to communicate with the character generator ROM's or RAM and the C-RAM buffer.

5.1.1.2 Address Bus - A0 Thru A12

These 13 unidirectional lines are used to address an 8K block of contiguous memory addresses. Two additional select lines are provided ($\overline{\text{CGSEL}}$, CRSEL) to select either the C-RAM or character generator address block. The format controller uses additional decoding logic under firmware control to allow the character generator options to use the same address block.

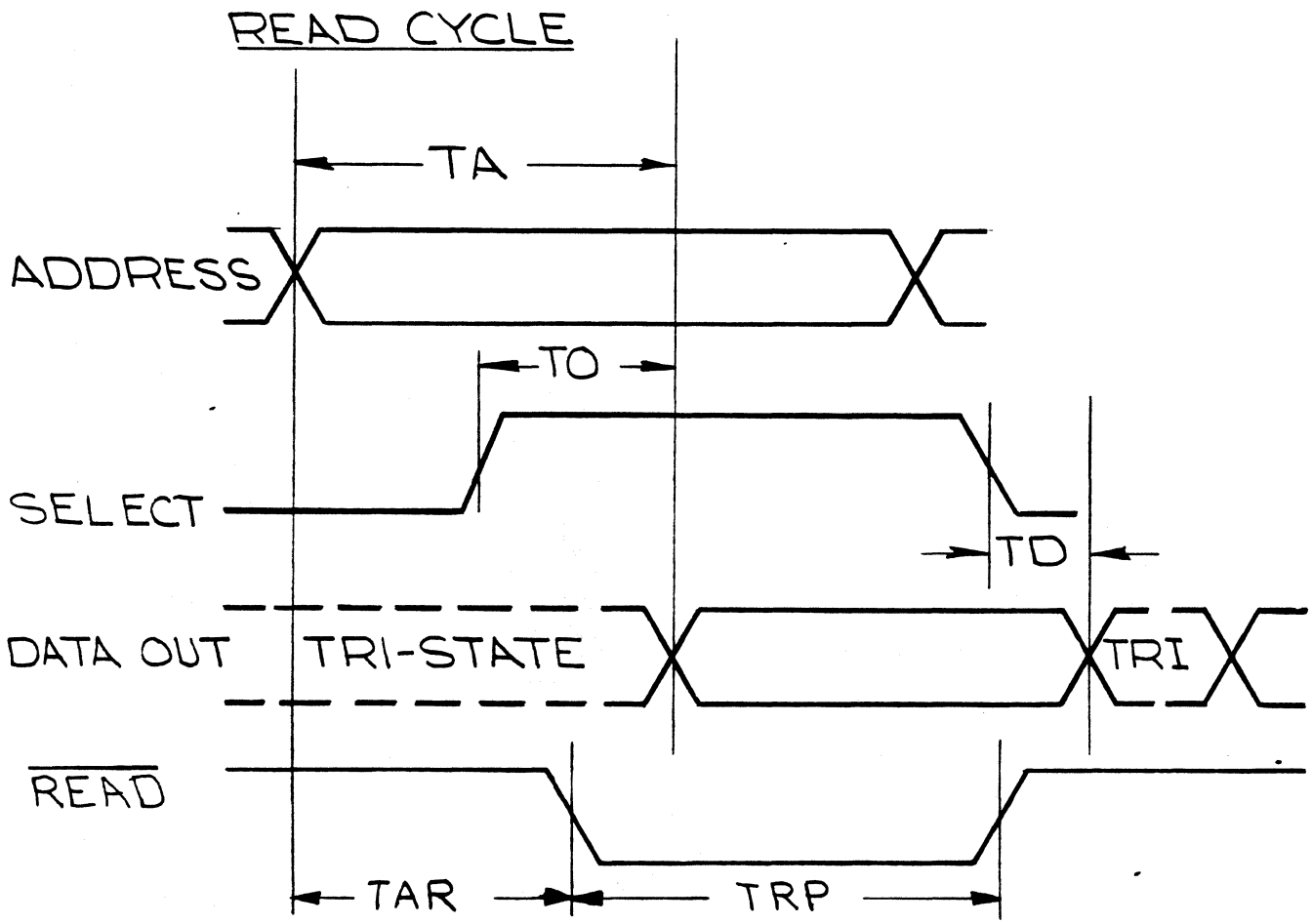
5.1.1.3 Control Bus

There are ten (10) control lines available at the remote C-BUS connector.

5.1.1.3.1 $\overline{\text{RESET}}$

RESET originates from the Print Controller and is used to reset the logic on the Format Controller during power-on. A low level indicates the $\overline{\text{RESET}}$ condition. While the $\overline{\text{RESET}}$ signal is asserted "GOT IT" will also be asserted and the P.C. must have control of the C-RAM. The "RESET" signal is released prior to "GOT IT" being released by 1-3 us.

"C" BUSS READ TIMING

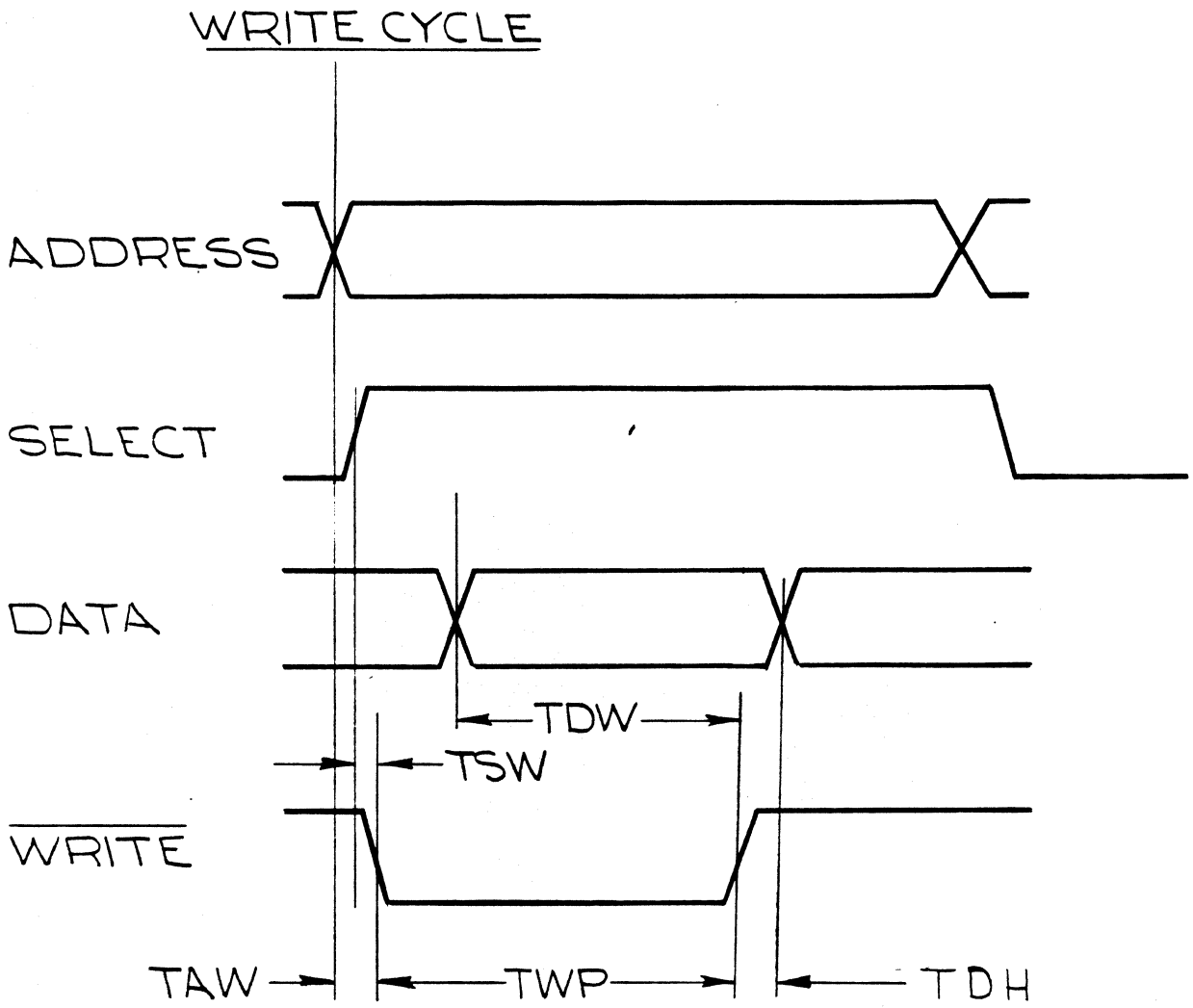


RISE AND FALL TIMES SHALL BE LESS THAN 30 NANOSECS.

TRP	MIN	420 NS	READ PULSE WIDTH
TA	MAX	520 NS	ACCESS TIME
TAR	MIN	280 NS	ADDRESS SET UP TIME
TO	MAX	400 NS	CHIP ENABLE TO O/P TIME
TD	MAX	100 NS	CHIP ENABLE TO O/P DISABLE TIME.

Figure 1.

"C" BUSS WRITE TIMING



TDW	MIN	380 NS	SET UP TIME
TAW	MIN	280 NS	ADDRESS SET UP TIME
TWP	MIN	420 NS	WRITE PULSE WIDTH
TSW	MIN	160 NS	CHIP SELECT TO WRITE
TDH	MIN	10 NS	DATA HOLD AFTER WRITE

Figure 2.

5.1.1.3.2 HOLD IT

This handshake originates from the Format Controller. A high level indicates that the Format Controller has read/write control of the C-RAM. The Print Controller is prohibited at this time from accessing the C-RAM. When this level goes low, it means that the Format Controller has relinquished control of the C-RAM and is requesting the Print Controller to act on the data in the C-RAM.

5.1.1.3.3 PWR FAIL

Originates from the power supply. It indicates that the power supply will continue to remain in spec for only 4 msec before failing. Upon detecting this signal, the P.C. will release C-RAM and turn off the carriage motor. If this signal should go low and stay low for a period of time(indicating a false power fail) a cold start will take place.

5.1.1.3.4 GOT IT

This handshake signal originates from the Print Controller. A high means that the Print Controller has read/write control of the C-RAM and action is in progress. The Format Controller is prohibited from accessing the C-RAM at this time. When this signal goes low, it means that the Print Controller has relinquished control of the C-RAM, and that action is complete.

On power up, this signal is high. At this time, the Print Controller must have access to the C-RAM in order to perform a self-test. Once the self-test and Print Controller initialization is complete "GOT IT" is dropped and $\overline{\text{RESET}}$ is raised (see Section 5.1.1.3.1).

5.1.1.3.5 $\overline{\text{CGSEL}}$

This line originates from the Print Controller and is used to select the 8K block of memory addresses for the character generator. A low level indicates that a READ or WRITE operation to the character generator is in progress.

5.1.1.3.6 CRSEL

This line originates from the Print Controller and is used to select the 4K block of memory addresses for the C-RAM and graphics RAM buffer. A HIGH level indicates that a READ or WRITE operation to the buffer is in progress.

5.1.1.3.7 $\overline{\text{WRITE}}$

This line originates from the Print Controller and is used to strobe data into the C-RAM or character generator RAM. A low level indicates a data write to memory.

5.1.1. 3.8 $\overline{\text{READ}}$

This line originates from the Print Controller and is used to strobe data from the C-RAM or character generator RAM/ROM. A low level indicates a data read from memory.

5.1.1.3.9 $\overline{\text{CDCC FMAT}}$

This line originates from the Format Controller and is used to provide compaability with current CDCC Format Controllers and CDCC test equpment. When this line is a low level, the 10 ns. min. hold time will not be guaranteed during a write operation to C-RAM or character generator RAM.

5.1.1.3.10 $\overline{\text{P.C. RESET}}$

This line originates from the Format Controller. A low level of 90 ms. min. will cause the Print Controller Logic to be reset.

5.1.2 Connector Pin Out

The 34 way connector on each P.C. board and F.C. board will use the following pin out.

34 WAY PIN #	DESCRIPTION	
30	DATA D0	DATA
13	DATA D1	
29	DATA D2	
12	DATA D3	
28	DATA D4	
11	DATA D5	
27	DATA D6	
10	DATA D7	
1	ADDR A0	ADDRESS
18	ADDR A1	
2	ADDR A2	
19	ADDR A3	
3	ADDR A4	
20	ADDR A5	
4	ADDR A6	
21	ADDR A7	
14	ADDR A8	
15	ADDR A9	
16	ADDR A10	
17	ADDR A11	
32	ADDR A12	
7	$\overline{\text{RESET}}$	CONTROL
6	HOLD IT	
23	GOT IT	
8	CRSELH	
31	$\overline{\text{CGSEL}}$	
25	$\overline{\text{WRITE}}$	
5	GROUND	
22	CDCC FMAT	
9	GROUND	
26	GROUND	
24	$\overline{\text{PWR FAIL}}$	
34	$\overline{\text{PC RESET}}$	
33	$\overline{\text{READ}}$	

5.1.3 Physical Description

Cable shall be ribbon cable compatible with the mating connector for receptacle defined by Centronics part number 31240080-1040. The maximum cable length shall be 6 inches. The T/B Ansley part number for the 34 way connector is 609-3429M.

5.1.4 C-RAM Interface electrical Characteristics

5.1.4.1 Input Signals

All input signals to the P.C. are TTL compatible voltage levels (logical low 0.8 volts, logical high 2.0 volts) and will not exceed one TTL load (1.6 ma sink).

5.1.4.2 Output Signals

All output signals to the F.C. are TTL compatible voltage levels (logical low 0.8 volts, logical high 2.8 volts) and are capable of driving five (5) TTL loads (8 ma sink).

5.2 DATA/ARGUMENTS DEFINITION

Action by the printer is dictated by the placement of parameters in the C-RAM by the Format Controller and the signaling of the Print Controller with the lowering of the 'Hold It' line that action is requested. The C-RAM is divided into two sections, the Control Block and the Data block (Figure 3). Control information is located at addresses 00_{16} to $1F_{16}$. The data area is located from 20_{16} to $7FF_{16}$. Arguments for the print functions and status of the printer are passed in the control block.

5.2.1 Status Bytes

The status occupies, location 00-04 and OE_{16} while the arguments occupy locations 05_{16} - 14_{16} except for OE_{16} Arguments for five events are defined, four for paper motion, and one for print action. The five events are performed in sequence. (See Figure 3).

COMMUNICATIONS RAM MAP

BYTE	DESIGNATION	SOURCE	COMMENTS
00	PRINTER STATUS	PRINT CONTROLLER	
01	ACCUMULATED PAPER	PRINT CONTROLLER	STATUS INFO.
02	MOTION STEPS		
03	UNCOMPLETED PAPER	PRINT CONTROLLER	STATUS OF
04	MOTION STEPS		FAILED MOTION
05	REVERSE PAPER MOTION	FORMAT	EVENT 1
06	BEFORE PRINT	CONTROLLER	
07	FORWARD PAPER MOTION	FORMAT	EVENT 2
08	BEFORE PRINT	CONTROLLER	
09	PRINT COMMAND	FORMAT CONTROLLER	EVENT 3
0A	REVERSE PAPER MOTION	FORMAT CONTROLLER	EVENT 4
0B	AFTER PRINT		
0C	FORWARD PAPER MOTION	FORMAT CONTROLLER	EVENT 5
0D	AFTER PRINT		
0E	SELF TEST BYTE	PRINT CONTROLLER	STATUS OF SELF TEST
0F	DENSITY SELECTION	P.C./F.C.	
10	MACHINE OPTIONS	FORMAT CONTROLLER	MECHANICAL FEATURES
11		RESERVED	
12	GRAPHIC OPTIONS	FORMAT CONTROLLER	
13	OPTIONAL PITCH SELECTION	FC	MULTI-PASS DENSITIES
14	ALTERNATE SPEED BYTE	FC	LOWER CPS
15 1E		RESERVED	
1F	MATRIX SIZE	FORMAT CONTROLLER	OPTIONAL
20 FF	ASCII DATA	FORMAT CONTROLLER	
20 7FF	GRAPHICS PIN DATA	FORMAT CONTROLLER	

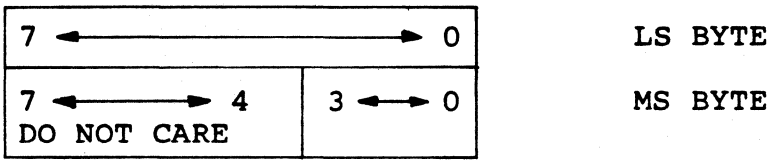
Figure 3.

Status is updated by the Print Controller before each transfer of the C-RAM to the Format Controller. The print function arguments are not changed by the Print Controller only acted upon. After the completion of a "Print Command", the data buffer is returned to a reset mode, i.e., full of null codes. Should an abort occur, the data is left intact and passed back to the Format Controller with the appropriate event bit set in the "Printer status" byte. If no print action is requested, Print Command, Bit 4 = 0, the print buffer is neither interroggated nor changed.

5.2.2 Paper Motion Argument Description

The four paper motion arguments (Bytes 05_{16} - 08_{16} and $0A_{16}$ - $0D_{16}$) are stated as a 2 byte numbers. The argument forms a 12 bit binary number. Bits 0 - 7 of the lower order address bytes contain the eight (8) least significant bits of the argument value. Bit 0 - 3 of the higher order address bytes from the four (4) most significant bits of the argument values Bits 4 - 7 of the higher order address bytes are ignored.

PAPER MOVEMEMENT ARGUMENT



2 BYTES FORM 12 BIT BINARY NUMBER

ONE BIT REPRESENTS 1 STEP = .00833 INS PAPER MOVEMENT (FANFOLD PAPER)

120 FULL STEPS = 1 INCH
20 FULL STEPS = 1/6 INCH PAPER MOVEMENT
15 FULL STEPS = 1/8 INCH PAPER MOVEMENT
14 FULL STEPS = VERTICAL DISTANCE FOR 8 PIN GRAPHICS

TOTAL MOVEMENT IS 4095 FULL STEPS = 34.125 INCHES (86.67 cm)

CUT SHEET MODE

108 FULL STEPS = 1 INCH
18 FULL STEPS = 1/6 INCH
13 to 14 FULL STEPS = 1/8 INCH

NOTE: Formatter should alternate 13 steps for first movement and 14 steps for second movement, as actual movement in this mode is 13.5 steps.

For 8 Pin cut sheet graphics, the formatter will have to alternate between 12 and 13 steps as actual movement is 12.6 steps.

To maximize throughput, paper motion before print should be utilized whenever possible as seeking a line of print will take place while paper motion is in progress. Also, control of the C-RAM is passed back to the formatter with five characters left to print if there is no paper motion after print.

5.2.3 Byte 00 - Printer Status (Figure 5)

This byte is written by the Print Controller after each printer action (prior to the return of the control of C-RAM to the Formatter) and shows the printer status as defined below. The transfer of control from the Format Controller to the Print Controller with all events zero will update paper out only.

PRINT STATUS BYTE 00

BIT NO.	DESIGNATION
7	EVENT ABORTED
6	ABORT ON EVENT 1
5	ABORT ON EVENT 2
4	ABORT ON EVENT 3
3	ABORT ON EVENT 4
2	ABORT ON EVENT 5
1	FAULT/TEST FAIL
0	PAPER OUT

Figure 5

SELF TEST ERROR MAP BYTE 0E

BIT NO.	DESIGNATION
7	Head Jam/No Video
6	Bad Video Count
5	Cover Open (Interlock)
4	Reserved
3	P.C. Ram Check
2	Pin Fire Test
1	CRAM Check
0	CRC on Program PROM

Figure 6

5.2.3.1 Printer Status - Bit 7

When set shows that one of the five events was aborted because of either a fault or paper out condition. If this bit is set along with Bit 1 and none of the event bits are set, then a head prime has been aborted. Interrogate byte OE_{16} (self test byte) for future definition of the failure. Whenever an abort does occur, a prime should be requested on the next pass of C-RAM.

5.2.3.2 Printer Status - Bits 2 - 6

When bit 7 is set showing an abort of one of the events, one of the bits 2 thru 6 may be set showing the event in progress when the abort occured. (see sect. 5.2.3.1)

The events are polled in order with event one first and five last. Since the events are acted upon in order, it must be assumed that all events that follow an aborted event have not been acted upon.

5.2.3.3 Printer Status - Bit 1

There are three conditions for which bit 1 can be set:

A. If a print head jam or an open interlock occurs during a print cycle, bit 7, 4 and 1 will be set indicating a print cycle has been terminated.

B. When a self test has been initiated and a failure has been recognized, Self Test byte should then be polled.

C. If during a head prime the video processor indicates a failure or an open interlock has occurred, this bit along with Bit 7 will be set.

5.2.3.4 Printer Status - Bit 0

When set, indicates a paper out condition. If paper out should occur while paper motion is in progress, that paper motion will be completed. However, all other events will be aborted. Paper motion will never be started if a paper out condition exists unless the override bit is set (see Section 5.2.9.5). Paper motion without head movement is allowed with the interlock opened.

5.2.4 Byte OE_{16} - Self Test Status Byte (Figure 6)

The self test status byte is located in OE_{16}. Figure 6 shows the error map that is possible for this location. The format controller initiates the self test by setting the appropriate bit in the print command byte (see Figure 7). The print controller will then proceed with a self test and write the results in the self test byte location.

On power-up the print controller performs the tests associated with Bits 0, 1, 3, and 5 and places the results in the self test byte location. When the bit is set, it indicates a failure in the test being performed. If the self test bit is set at any other time the tests associated with bits 0 thru 7 are performed.

If the prime bit is also set the wire printout test is executed as described in sec. 5.2.9.7 along with the other tests.

After the tests are completed the head is returned to the left side.

5.2.4.1 Self Test Status - Bit 0 - Firmware CRC Test

CRC check on the firmware program chip on the P.C. A one signals an error condition.

5.2.4.2 Self Test Status - C-RAM Test

Checks that reading and writing C-RAM is functioning correctly. A one signals an error condition. This test is a non-destructive data test.

5.2.4.3 Self Test Status - Bit 2 - Pin Fire Test

The head drive circuitry is checked during this test by firing each pin in the head individually. Any failures are reported by setting this bit.

5.2.4.4 Self Test Status - Bit 3 - P.C. Ram Test

Checks that reading and writing the scratch pad RAM are functioning correctly. This test is non-destructive data test. A one signals an error condition.

5.2.4.5 Self Test Status - Bit 4 -

NOT USED

5.2.4.6 Self Test Status - Bit 5 - Cover Interlock Check

If the cover is open while any head motion is taking place, this bit will be set and the carriage motor will be turned off. The print status byte should be checked for aborted events. Paper motion without print will be allowed with the cover open.

5.2.4.7 Self Test Status - Bit 6 - Video Count Accuracy Test

Video circuitry is checked by causing the head to move from the left side frame to the right side frame and a count is made of the video interrupts. If set, it indicates a video count with an error greater than 2% of the accepted value was recieved.

5.2.4.8 Self Test Status - Bit 7 - Loss of video/Head Jam Test

If set, it indicates no video signals were recieved.

5.2.5 Byte 01_{16} and 02_{16} - Accumulated paper motion steps.

This two byte, 16 bit number is a signed integer count of the number of steps that paper has moved. Zeroed on initialization, forward paper motion steps are added to the number and reverse are substracted as each step is done. The Format Controller can zero this at each logical top of form if the total steps per form are to be accumulated. Each step of motion is equal to 0.00833 inches (120 steps/inch) when using fanfold paper.

5.2.6 Byte 03_{16} and 04_{16} - Paper Motion steps remaining after abort

If the Print Controller is forced to abort a paper motion event because of a power failure, the number of forward paper motion steps that were not completed during that pass of the C-RAM, are stored here by the Print Controller.

5.2.7 Byte 05_{16} and 06_{16} - Event No. 1

Reverse paper motion before print step count.

5.2.8 Byte 07_{16} and 08_{16} - Event No. 2

Forward paper motion before print step count.

5.2.9 Byte 09_{16} - Event No. 3

Print Command (Figure 7) - The Print Command indicates to the Print Controller the action, other than paper motion, that is requested. Results will be placed in the status word.

PRINT COMMAND

BIT NO.	DESIGNATION
7	PRIME
6	PRINT UNDERLINE
5	PRINT EXPANDED
4	PRINT DATA
3	OVERRIDE
2	CHARACTER SET
1	SELECTION
0	TEST

Figure 7.

5.2.9.1 Print Command - Bit 7 - Prime

When set causes the carriage to move to the left home position. This takes priority over all other events except self-test.

When this bit is set in conjuction with bit 0 (test bit) the P.C. will also perform the wire printout test. See Section 5.2.9.7 for details.

5.2.9.2 Print Command - Bit 6 - Print Underline

When set causes the data in the print buffer to be printed with an underline. Embedded nulls are not underlined.
Note; During underline, print speed is reduced by 30%.

5.2.9.3 Print Command - Bit 5 - Print Expanded

When set causes the data in the print buffer to be printed expanded (i.e. Horozontal size is Doubled).
Note: during expanded print speed is reduced by 15%

5.2.9.4 Print Command - Bit 4 - Print

When set indicates that data is to be printed. This bit must be set to initiate any print action. To print underline expanded, bits 6, 5, and 4 must be all set to ones. For normal print only bit 4 would be set. Bits in the Print Command word are processed MSB to LSB with the exception of the test bit (bit 0) which is interrogated and acted upon first (any failure will cause an abort). If bit 7 was set in the above examples the head would move to the left before printing.

5.2.9.5 Print Command - Bit 3 - Override

When set the request events will be processed regardless of a paper out condition.

5.2.9.6 Print Command - Bits 2 and 1 - Character Generator Offset

These bits provide the four 2K offset arguments into the character generator (see table below). The P.C. will ADD the relative address as defined by Bits 1 and 2 to the base address of the 8K character generator block. (see sect. 5.4)

B2	B1	Relative Base Address (Hex)
0	0	0 0 0 0
0	1	0 8 0 0
1	0	1 0 0 0
1	1	1 8 0 0

5.2.9.7 Print Command - Bit 0 - Test

When set will cause the Print Controller to self-test. This will include a C-RAM and Scratch Ram Check, a Pin Fire Check, program CRC check and the moving of the head from the left margin to the right and back to verify video count. Results will be placed in the status Byte (Byte OE_{16}). If the prime bit (bit 7) is also set along with this bit the wire printout test will occur . The purpose of this printout is to detect a mechanical failure in the head. The test consists of a "W" followed by the print head wire number and a series of dots (actuations of that wire). The test is repeated for each of the nine (9) wires in the head.

5.2.10 Byte OA_{16} and OB_{16} - Event no. 4, reverse paper motion after print step count.

5.2.11 Byte OC_{16} and OD_{16} - Event no. 5, forward paper motion after print step count.

5.2.12 Byte OF_{16} - Print Density/Type

Bits 0 through 2 are used by the Format Controller for the selection of character density as follows:

B2	B1	B0		
0	0	0	=	10 cpi
0	0	1	=	not used
0	1	0	=	not used
0	1	1	=	12 cpi
1	0	0	=	13.3 cpi
1	0	1	=	15 cpi
1	1	0	=	16.67 cpi
1	1	1	=	not used

Bit 3 is set to indicate a graphics mode. To determine which mode has been selected, Byte 12_{16} the graphics options byte, will be interrogated. When Bit 3 is set, Bits 0 through 2 are ignored. When printing graphics, the pin data comes from the F.C. (see sect. 5.4.3)

Bit 4 is set to indicate high density printing. When Bit 4 is set, Bits o through 3 are ignored. Byte 13_{16}, the optional Pitch Selection byte, will be interrogated to determine what density (10 or 12 CPI) will be printed. Multi-pass printing must be performed by setting Bit 4 and changing character set locations with Byte 09_{16} Bit 7 will also be interrogated to determine uni-directional or bi-directional printing.

Bit 5 - If this bit is set all previous bits are ignored and printing will be done at one of three possible speeds as specified by the value stored in byte 14_{16}, the Alternate speed byte.(see sect. 5.2.16 for further information)

Bit 6 - When Bit 6 is set, the P.C. will interpret the data in C-Ram as character set information. The P.C. will transfer 2K bytes of the C-Ram data into the character generator RAM location as defined by the setting of Bits 1 and 2 in the Print Cmd Byte (see 5.2.9.6). During the transfer, a read after write check is performed on each byte for load validity. If an error is detected, the transfer is aborted at that point and the C-Ram is returned to the F.C. with Bit 6 left set. If the transfer is completed with no errors, Bit 6 is cleared before returning C-Ram control to the F.C. In either case, the 2K block of C-Ram is always cleared before releasing control. No other events will be acted on.

Bit 7 - If this bit is set along with either Bits 3 or 4, uni-directional printing will take place, which means that a high speed seek of the left end of the next line will occur at 20 ips. If it is not set and either Bits 3 or 4 are set, bi-directional printing is assumed. The exception to this is APA Graphics, which is always unidirectional.

5.2.13 Byte 10_{16} - Machine Options

Bit 0 - If set a cut sheet mode is indicated. The P.C. will shift the margin in from the left side. Also the maximum line lengths will be adjusted to reflect this shift. (see section 3.1.2 and 3.1.3)

Bit 1 - When set by the P.C. a sheet feeder paper out condition exists. The P.C. will not abort printing or paper motion as a result of this condition. It is updated with each pass of the C-RAM.

Bit 2 - If set a sheet feeder mode is indicated. The left margin will be shifted in from the left side. (see section 3.1.2 and 3.1.3)

Bits 3 - 6

Not used

Bit 7 - If this bit is set the print head will seek the right side. All printing will be done inverted and in the reverse direction from the right side. This feature will be used in conjuction with the sheet feeder to print the return address on an envelope.

5.2.14 Byte 12_{16} - Graphics Mode

If Bit 3 of the print density byte was set, this byte should be checked to determine which of three possible graphics modes is to be selected. These modes are as follows:

Byte 12_{16} = 00 - Reserved

Byte 12_{16} = 01 Non-APA normal printing is assumed. Pin data is still taken directly from the C-RAM and dot spacing is every six encoder lines (.0100 inch), however, adjacent dots cannot be fired. The first seven columns out of ten will contain printable dot information. The remaining three colmns must contain null codes for inter-character spacing. Failure to do this could cause serious damage to the head. Printing can be done uni or bi-directionally.

Byte 12_{16} = 02 - Non-APA Graphics printing is assumed. Dot spacing is every six encoder lines (.0100 inch) and adjacent dots cannot be fired. Printing can be done uni or bi-directionally. It is assumed that every column will have printable dot information.

Byte 12_{16} = 03 - APA Graphics (all points available) is assumed This type of graphics can only be done in the uni-directional mode. Dote spacing is every six encoder lines (.0100 inch) and adjacent dots can be fired.

5.2.15 Byte 13_{16} - Optional Pitch Selection
When bit 4 of the Print Density byte is set this byte will be interrogated to determine which of the two multi-pass densities are desired.

Byte 13_{16} = 00 - 10 CPI multi-pass

Byte 13_{16} = 01 - 12 CPI multi-pass

5.2.16 Byte 14_{15} - Alternate Speed Selction

When bit 5 of the Print Density/Type byte (byte OF_{16}) is set this byte will be examined to determine at what print rate the line should be printed. Below is a chart that indicates the three possible print rates that may be selected. If byte 14_{16} is zero a special 10 CPI character will be printed as indicated in the chart. The other two selections will effect the print rates of all the print densities except muti-pass.

BYTE 14_{16} =	PRINT RATE (GPS)	LINE/ COLUMNS	DOT SPACING	LINES/ INERCHAR.
00	240	7	0.0117	18
01	150	ALL DENSITIES		
02	120	ALL DENSITIES		

5.2.17 Byte $1F_{16}$ - Matrix Size

This binary number indicates the horizontal character width and is used to calculate the address of the character within the character generator (see paragraph 5.4 "Character Pattern Generation"). For a value of 0 to 7, the character is assumed to be seven wide. For any other value, it is assumed to be nine wide.

5.3 Positional Information and Use

Positional information comes in as quadrature from an encoder mounted on the horizontal drive motor. This information comes directly into a seperate microprocessor which signals the main microprossor with both column and positional information on divide-by arguments it is presented. The encoder with dual sensors gives positional information at a rate of 600 edges per inch or every (0.00167 inch). See Engineering Specification 80002149-9001 for signal specification.

5.3.1 Standard Character Placement

For the standard 7 wide character, column spacing is as follows:

CPI	Line/Columns	Dot Spacing (In)	Lines/Interchar.	Total Lines
10	6	0.0100	24	60
12	5	0.0083	20	50
13.3	5	0.0083	15	45
15	4	0.0067	16	40
16.67	4	0.0067	12	36

When the character width is changed to a 9 wide dot matrix with the placement of a binary 1001 in argument $1F_{16}$ of the C-RAM, the standard spacing for the 9 wide character is used. This spacing is as follows:

CPI	Line/Columns	Dot Spacing (In)	Lines/Interchar.	Total Lines
10	5	0.0083	20	60
12	4	0.0067	18	50
13.3	4	0.0067	13	45
15	3	0.0050	16	40
16.67	3	0.0050	12	36

NOTE: In the above, adjacent dot positions cannot be fired.

5.3.2 Graphics Modes

When Bit 3 of the print density argument is set indicating grahics, byte 12_{16} is then interrogated to determine which of the three modes is to be used. In any case, dot placement will be every six encoder lines or every 0.010 inches. Differences between them are outlined below.

APA Graphics - Adjacent dots can be fired. Printing is done uni-directionally only. Printing speed is 3.9 IPS.

Non-APA Graphics - Adjacent dots cannot be fired. Every column can contain printable dot information. Printing speed is 7.5 IPS.

Non-APA Normal - Adjacent dots cannot be fired. Out of every ten colmns, seven can contain printable dot information. The other three colmns must be nulls. The resulting print density is 10 CPI. Printing speed is 20 IPS.

5.3.3 High Density Print

When bit 4 of the Print Density argument is set byte 13_{16} (Optional Pitch Selection byte) will be interrogated to determine which of the two possible high density multy-pass print modes is being selected

Printing will be done in multiple passes. For each pass bits 1 & 2 of the Print Command (byte 09_{16}) are interrogated to determine which 2K block of character generator the pin data should be taken from for that pass.

Printing can be done either bi-directionally or uni-directionally. Adjacent dots cannot be fired on a single pass. Each pass should be offset vertically by one step or by .00833 of an inch to provide overlapping of the dots.

Both modes consist of a fifteen column wide matrix. The differences are outlined below.

5.3.3.1 10 CPI Multi-pass

In this mode there are three (3) encoder lines per column for a horizontal dot spacing of .005 inch. There are five (5) inter-character spacing columns. Print speed is 9.35 IPS.

5.3.3.2 12 CPI Multi-pass

In this mode there are two (2) encoder lines per column for a horizontal dot spacing of .0033 inch. There are ten (10) inter-character spacing columns. Print speed is 7.55 IPS.

5.4 CHARACTER PATTERN GENERATION

It is the responsibility of the Format Controller to insure that the character generator complies to the method of printing requested. When printing standard characters the address as shown below and a ROM select are presented by the P.C. on the address lines of the character generator connector and eight bits of data representing pin fire information are read. The LSB represents Pin 1 (top most pin) and the MSB is Pin 8 information. When printing characters, only alternate dots can be fired. Pin 9 is only available (other than underline) for the 7 wide character.

5.4.1 Character Generator - Standard 7 Wide Character

The following is the address presented to the character generator for standard 7 wide characters. All numbers are hexidecimal. The eighth byte of each character code contains the ninth pin data. The eighth bit of the byte (Bit 7) represents the left-most column of the character and the second bit (Bit 1) represents the right column or seventh column of the character. The first bit (Bit 0) is ignored. However, in the case of underline, the eighth byte information is ignored.

Char. Code	Char. Gen Address
00	000-006
01	008-00E
02	010-016
03	018-01E
.	
.	
.	
41 (A)	208-20E
.	
.	
:	
7E	3F0-3F6
7F	3F8-3FE
80	400-406
:	
:	
C1	608-60E
:	
:	
FE	7F0-7F6
FF	7F8-7FF

5.4.2 Character Generator Address - Non-Standard Width

In this case, Pin 9 is not available except for underline. Addresses for 9 wide are computed in the following manner:

(Character Code) x (Width) = First Column
First Column + Width - 1 = Last Column

Example: For a character 9 wide (Shown in Hex)

Character Code 00 = (00) x (09) = 00 First Column
00 + (09) -1 = 08 Last Column

Character Code 03 = (03) x (09) = 1B First Column
1B + 09 - 1 = 23 Last Column

Character Code 41 = (41) x (09) = 249 First Column
249 + 09 - 1 = 251 Last Column

5.4.3 Graphic Mode

When Bit 3 is set in the print density argument of the C-Ram, the graphics byte (Byte 12_{16}) is interrogated to determine which of the three possible graphics modes is to be used. Pin data

is taken directly from the C-Ram with the eight bits representing the eight pins on the print head that can be fired. The first column comes from Location 20_{16} and the last column from 547_{16} for a total of 1320 possible column firings. Once all pin data has been obtained, all 1320 locations are cleared.

5.4.4 High Density Print

High density print is defined as a 15 (0F Hex) wide matrix. Adjacent dots cannot be fired. Using the method described in Section 5.4.2, the dot formation in the character generator is as follows (calculations shown in hex):

Character Code 01 = 01 x 0F = 0F First Column
0F + 0F - 1 = 1D Last Column

Character Code 41 = 41 x 0F = 33F First Column
33F + 0F - 1 = 34D Last Column

5.5 RESTRICTIONS

The following restrictions apply when printing with the 350 Print Controller:

A. Logic seeking is done on any leading or trailing nulls in a line. Any other code is considered a printable character.
B. Any embedded nulls in a line are not underlined.
C. Only one type of printing can be done on one transfer of the C-RAM.

6.0 DRIVE CIRCUITRY

6.1 PAPER TRANSPORT

6.1.1 Stepper Motor Excitation Sequence

CW ROTATION	01	02	03	04	
	ON	OFF	ON	OFF	NORMAL
	ON	OFF	OFF	ON	4 STEP
	OFF	ON	OFF	ON	SEQUENCE (FULL STEP)
	OFF	ON	ON	OFF	

ON = 1 = +5
OFF = 0 = 0V

6.1.2 Stepper Driver

Figure 8 describes the driver circuitry for the stepper motor. The energy level in the motor is maintained by chopping the current in each winding with the upper stage drivers. During paper motion, the motor current per winding is 1 AMP with V hold at 0V. When no paper motion is required, current per winding is approximately 250ma with V hold at +5. This minimizes power loss when paper motion is not required.

Average current per winding:

V hold ON 250 ma
V hold OFF 1 Amp

Voltage required:

+35V, +5V

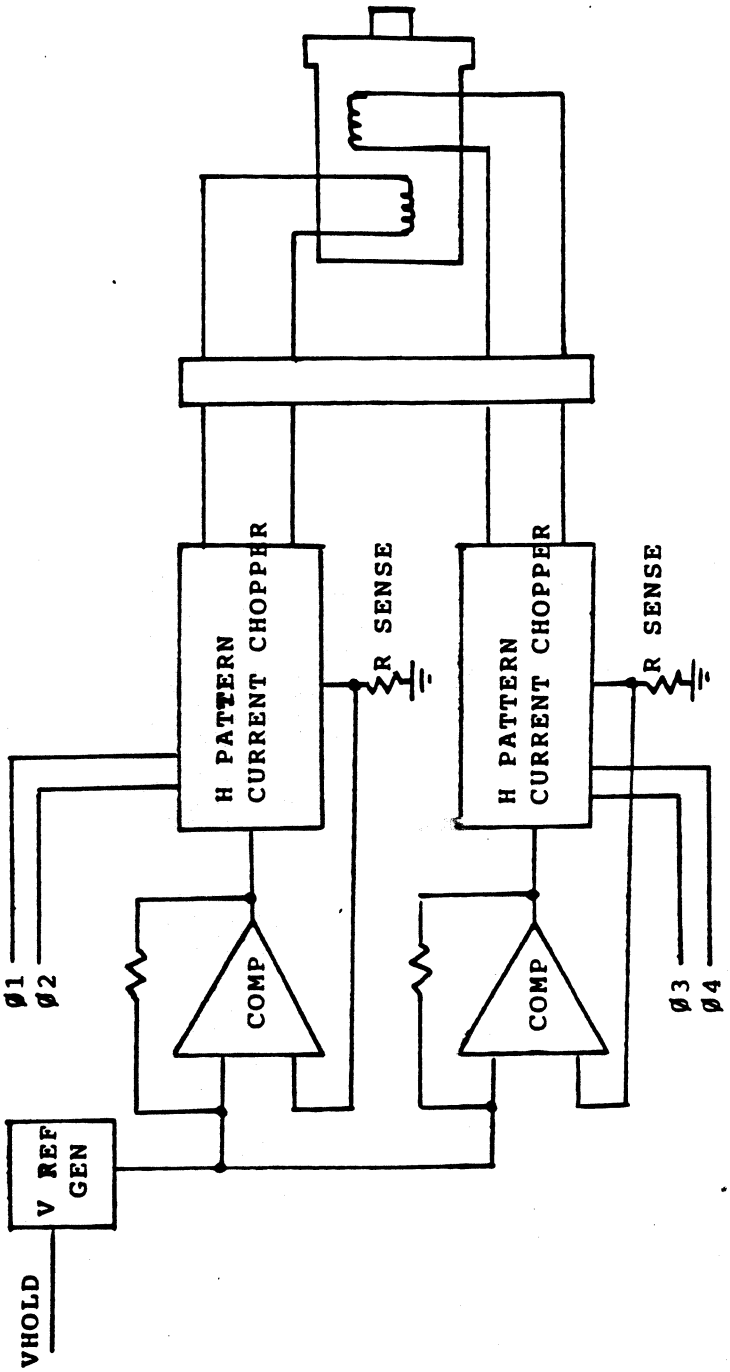


Figure 8. STEPPER MOTOR DRIVER

6.2 CARRIAGE SERVO SYSTEM

6.2.1 DC Motor Controller

Figure 9 describes the DC motor drive circuitry and velocity control circuit.

Control	Signal	DC Motor Shaft Rotation	Carriage Direction
FWD REV	0 0	None	-
FWD REV	1 0	CCW	Forward Left Side Frame to Right Side Frame
FWD REV	0 1	CW	Reverse Right Side Frame to Left Side Frame
FWD REV	1 1	None	-

1 = ON = +5
0 = OFF = 0V

Carriage motion is achieved by applying the control signals described above as well as the TACH signal described below.

Velocity control is achieved by maintaining a constant error voltage between an internal reference and the voltage derived as a result of the input TACH frequency. TACH frequency is derived as a sub-multiple of the video feedback. That is, given the 600 position feedback points per linear inch of carriage motion a variable divider is used to generate the TACH FREQ for the desired carriage velocity.

The count for the divider is selected by considering the rep rate of the matrix head and the number of possible dot firings per inch. The following head speeds are used for the standard densities for a 7-part character:

10 CPI	20 IPS
12 CPI	16.4 IPS
13.3 CPI	14.76 IPS
15 CPI	13.02 IPS
16.67 CPI	11.45 IPS

For a 9-part character, the head speeds are:

10	CPI	16.4	IPS
12	CPI	13	IPS
13.2	CPI	11.5	IPS
15	CPI	9.35	IPS
16.5	CPI	9.35	IPS

Other speeds are:

High Density 12 CPI	7.55	IPS
High Density 10 CPI	9.35	IPS
Graphics Non-APA	7.55	IPS
Graphics APA	3.9	IPS
Non-APA Normal	20.0	IPS
High Speed Return	20.0	IPS

Component selection maintains the above speeds ±10%. There is no speed adjustment. A cap is used to shut the motor down if no video information is received after 46 msec.

6.3 RIBBON MOTOR DRIVER

The ribbon motor driver is a +12V DC motor, controlled by a single transistor shown in Figure 9. The ribbon motor is turned ON when the DC carriage motor is turned on.

Voltages required = +12V

6.4 HEAD DRIVER CIRCUIT

The head driver circuit features a Current Limited Driver circuit to quickly energize the pin solenoids. This drive technique enables high speed printing with minimum power loss since all stages are run in saturation mode. The maximum rep rate per pin is 909us.

Signals required = Pin 1 through Pin 9

1 = ON = +5 = FIRE PIN
0 = OFF = 0V = DO NOT FIRE PIN

Pin Data Strobe = 1-3 us negative going TTL signal

Logic level requirements = TTL

Voltages required = +35V, +5V

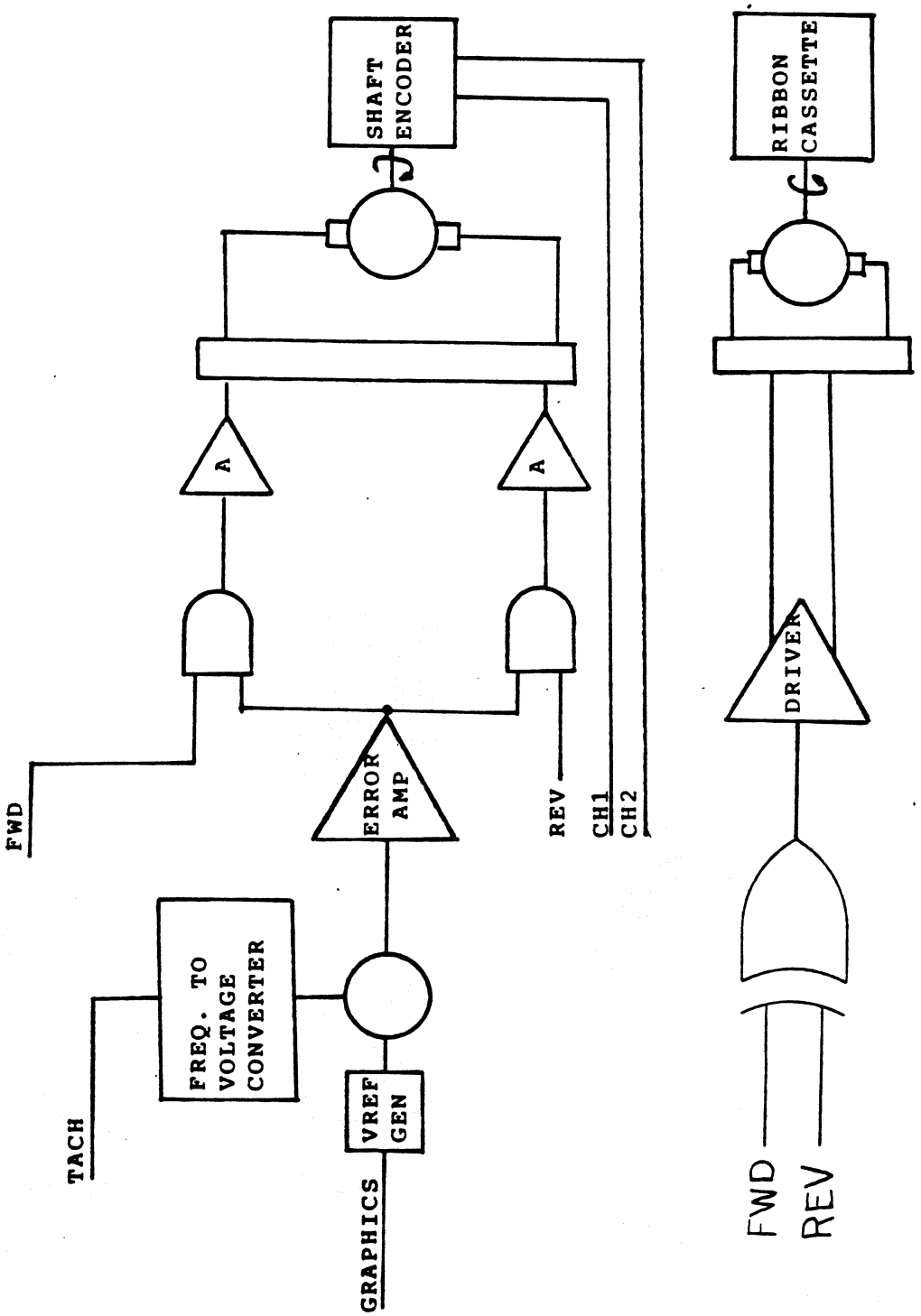


Figure 9. CARRIAGE DRIVE - RIBBON DRIVE VELOCITY

7.0 ENVIRONMENTAL CONDITIONS

7.1 TEMPERATURE/HUMIDITY

The printer will meet the requirements as specified for a "Class B" product in Paragraph 3.0 of Centronics Engineering Standard 001.

7.1.1 Operating

Temperature 10 degrees (50°F) to 40 degrees C (104°F). Relative Humidity 10% to 90% with maximum wet bulb 28 degress C (82°F) and minimum dew point 2 degrees C (36°F).

7.1.2 Non-Operating

-40 degrees C (-40°F) to 66 degrees C (105°F) and 10% to 95% RH.

7.2 ALTITUDE

As per Paragraph 4.0, Centronics Engineering Standard 001, 2.4 Km (8,000 ft.) to -.303 Km (-1,000 ft.).

7.3 MECHANICAL SHOCK

As per Paragraph 5.0, Centronics Engineering Standard 001.

7.3.1 Operating

Half sine shock pulse of 10 Gpk and 10 $\pm$ 3 ms duration applied once in either direction of three orthogonal axes (3 pulse total).

7.3.2 Non-Operating

Table top products shipped in individual packages shall be designed to withstand half sine shock pulses of 40 feet Gpk and 30 $\pm$ 10 ms duration.

7.4 VIBRATION

As per Paragraph 6.0, Centronics Engineering Standard 001.

7.4.1 Operating

5-22	Hz	0.010" DA
22-500	Hz	0.25 Gpk
500-22	Hz	0.25 Gpk
22-5	Hz	0.010" DA

Sweep rate of 1 octave/minute.

7.4.2 Non-Operating

The printer when packaged will withstand the random vibration listed below when the packaged product is affixed to a shaker table.

(These profiles are equivalent to measured vibration spectra in various transportation modes.)

Vertical Axis Excitation - 1.40 Grms overall from 10-300 Hz. Power Spectral Density .029 g2/Hz from 10-50 Hz with 8 dB/octave rolloff from 50-300 Hz.

Longitudinal and Lateral Axis Excitation - 0.68 Grms overall from 10-200 Hz. Power Spectral Density 0.007 g2/Hz from 10-50 Hz with 8 dB/octave rolloff from 50-200 Hz. (See Figure 6).

Test duration shall be one hour in each axis (3 hours total).

7.6 ELECTROMAGNETIC COMPATIBILITY

7.6.1 ESD

The printer will meet the requirements set forth in Centronics Engineering Standard 002 and be tested as per Centronics Engineering Standard 003.

7.6.2 EMI/RFI

As per Centronics Engineering Standard 002. Emission requirements will meet those specified for an international product (i.e., VDE 0871 and VDE 0875 along with the FCC requirements as stated in Docket #20780, Part 15, Subpart J.

8.0 SAFETY

The printer will meet the requirements as specified in Centronics Engineering Standard 011.

9.0 RELIABILITY PROVISIONS

9.1 DEFINITIONS

9.1.1 Failure

A failure is any stoppage or malfunction of the product mechanism or electronics specified herein which prohibits full use of the product as defined by the specifications and is directly caused by the mechanism or electronics.

This excludes stoppages or sub-standard performance caused by operator error, power failure, or environmental conditions exceeding specified limits. Failures are classified into two categories.

A. Critical Failure - A critical failure is defined as any failure which cannot be corrected by a trained operator and requires the services of a trained technical or field service representative for repair.

B. Inconvenient Failure - An inconvenient failure is any failure which can be readily corrected by an operator without requiring the services of a field representative. Ribbon jams, paper jams, etc., are examples of inconvenient failures.

9.1.2 Reliability

Reliability is defined as the probability of failure-free performance of the product through a time period at a specified operating environment and duty cycle.

9.1.3 Power-On Time

The period of time during which A.C. Power is applied to the product is defined as Power-On Time. Unless stated otherwise, all hours are expressed in terms of Power-On Time.

9.1.4 Operating Time

Operating Time is defined as that period of time which the product is moving paper or the print head carriage is in motion.

9.1.5 Duty Cycle

Duty Cycle is defined as the ratio of Operating Time to Power-On Time.

9.1.6 Operating Environment

The Operating Environment for reliability parameters for the printer shall be as follows, unless otherwise specified herein:

A. Nominal voltage - 115/230 VAC.
B. 50/60 Hertz.
C. Ambient room temperature of 70° ±5°F.
D. Ambient relative humidity of 50% ± 5%.

9.1.7 Mean-Time Between Failure (MTBF)

The MTBF shall be defined only during the product Useful Life and is calculated as follows:

$$MTBF = \frac{\text{Power-On Time}}{\text{Number of Critical Failures}}$$

9.1.8 Mean-Time to Repair (MTTR)

The MTTR is the average value of time required to perform on-site repair of the product by a properly trained and equipped service representative after it has failed. MTTR is calculated as follows:

$$MTTR = \frac{\text{Total Product Repair Time}}{\text{Number of Repair Actions}}$$

9.1.9 Infant Mortality period

Infant Mortality Period is defined as that time period of early product life when an initially high failure rate decreases to a specified Useful Life failure rate level.

9.1.10 Useful Life

The Useful Life of the product is defined as that period of time during the life of the product when the failure rate is maintained at a constant value due to random failures.

9.2 RELIABILITY PARAMETERS

All Reliability Parameters are based on the following:

A. A Duty Cycle of 25%.
B. The Operating Environment specified in Section 9.1.6.

9.2.1 Population MTBF

The Population MTBF shall exceed 1900 hours per failure (4400 hours excluding print head).

9.2.2 Reliability During Useful Life

The Reliability, R(t), at Time (t), for any time period during Useful Life shall be defined as being equal to EXP -(t/MTBF).

9.2.3 Infant Mortality Period

The Infant Mortality period shall be no longer than 100 hours.

9.2.4 Peak Failure Rate

The Peak Failure Rate for any point in time during Infant Mortality shall be less than .0013 failures per hour.

9.2.5 Mean Time to Repair (MTTR)

The Mean Time To Repair (MTTR) shall be equal to or less than 0.5 hours per repair action.

9.2.6 Repair Actions

Ninety percent (90%) of all repair actions shall require less than one hour to complete.

9.2.7 Failure Rate per Million Hours

The Failure Rate expressed in failures per million hours for the following key subassemblies shall be:

SUBASSEMBLY	FAILURE RATE
Mechanism	100
Print Controller Board	75
Power Supply	50
Print Head	300

10.0 TESTING

Reliability testing will be as specified in Centronics Engineering Standard #014 at a "B10" life with 90% confidence.