REVISIONS

LTR	DASH NO.	DESCRIPTION	DATE	APPROVED
A	9001	PROD RLSE PER ECO 2893	7 MAR 85	TPS GCL JP

CHECK PRINT
NOT FOR FABRICATION

NOV 2 0 1985

355	USED ON	DWG APPROVAL DATE	CENTRONICS data computer corp. HUDSON, NEW HAMPSHIRE U.S.A.
		DWN D. A. L. 5/12/82	
		CHK T. A. R. 20JUL82	TITLE
		DR MGR [illegible] 7-20-82	ENGINEERING PRODUCT SPECIFICATION
		DES ENG [illegible] 7/20/82	ORION
NEXT ASSY	1st APPLICATION	DWG RELEASE DATE	SIZE A / CODE IDENT 50163 / NUMBER 80002181-9001 / REV A
		ENG PROG MGR [illegible] 7/27/82	
		MFG ENG	SCALE / DO NOT SCALE PRINT / SHEET 1 OF 42
		QA	

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1.0 SCOPE

This specification defines the functional characteristics and requirements applicable to the design and construction of the 355 (code named "Orion") serial matrix printer. The 355 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 Controller is 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.	80002182-9001	Eng. Product Spec., 355 Mechanism
B.	80002150-9001	Eng. Product Spec., 350 Power Supply
C.	80002195-9001	Eng. Product Spec., 355 18 Wire Head
D.	TBD	Eng. Product Spec., 355 18 Wire Staggered Head
E.	80002189-9001	Eng. Product Spec., 355 Ribbon
F.	80002188-9001	Eng. Product Spec., 355 Print Quality
G.	80002173-9001	Eng. Product Spec., Auto Sheet Feeder
H.	80001180-9001	Eng. Product Spec., Apollo Format Cont.
I.	Centronics Engineering Standard 001.	
J.	Centronics Engineering Standard 002.	
K.	Centronics Engineering Standard 003.	
L.	Centronics Engineering Standard 011.	
M.	Centronics Engineering Standard 014.	
N.	FCC Docket #20780, Part 15, Subpart J.	
O.	UL 478	Regulatory Agency Requirements
P.	CSA 22.2 #154	Regulatory Agency Requirements
Q.	VDE 0806,0871, 0875	Regulatory Agency Requirements

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3.0 GENERAL

The Model 355 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 18-wire printing at a speed of 40 ips or 400 characters per second at 10 cpi. 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 with fanfold paper and 1/108 (.00936) of an inch with cut sheet paper. 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/Auto Sheet Feeder

The printer is capable of handling cut sheet form, the margin is moved 1.2 inches to the right of the fanfold margin. For the auto sheet feeder the margin is moved in .4 inches from the fanfold margin.

3.1.3 Maximum Characters Per Line

	MAXIMUM CHARACTERS AVAILABLE		
CHAR. DENSITY	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
16.7	220	200	213

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4.0 ELECTRICAL DESCRIPTION

4.1 POWER REQUIREMENTS

4.1.1 Print Controller

The following power is required to operate the Print Controller.

+5V	-	2 A max.
+35V	-	3.2 A max.
+12V	-	.1 A 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.

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4.2 POWER CONNECTORS

4.2.1 To Print Controller

The DC power required by the 355 will be obtained from the power supply via one cable. The pin connections are as follows. Reference CDCC Specification 31301029-1009, 9-pin Molex #09-74-1091.

J507

PIN	SIGNAL
1	+12V
2	+12V RTN
3	-12V
4	+5 RTN
5	Chassis Ground
6	+5V
7	+35V
8	+35V Return
9	Power Fail

4.2.2 To Format Controller

Power is provided to the Format Controller by 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 COMMON PRINTER RAM SPECIFICATIONS

5.1 GENERAL DESCRIPTION

The Communications Ram (hereinafter referred to as the C-RAM) is the shared read/write memory used for Argument/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 "HOLD IT" 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 and 2 for specifics on the read/write and control signal timing.

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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.

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 RESET condition.

While the $\overline{\text{RESET}}$ signal is asserted, GOT IT will also be asserted and the PC must have control of the C-RAM. The $\overline{\text{RESET}}$ signal is released prior to GOT IT being released (1-3 us before).

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 minimum before failing. Upon detecting this signal, the PC will release C-RAM and turn off the carriage servo and ribbon motor. Refer to Section 5.2.6.

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

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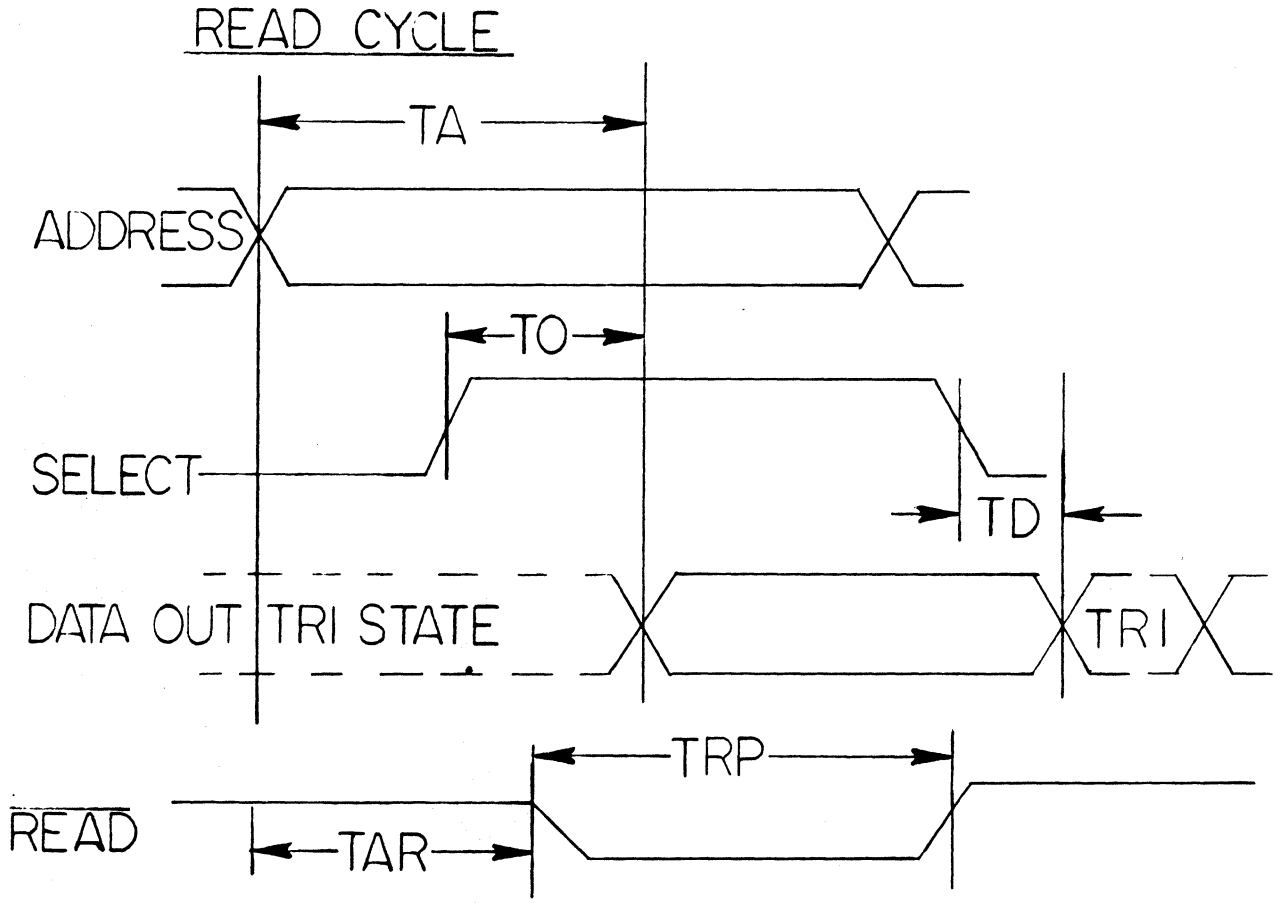
"C" BUSS READ TIMING



RISE AND FALL TIME SHALL BE LESS THAN 30 NANOSECS.

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

Figure 1.

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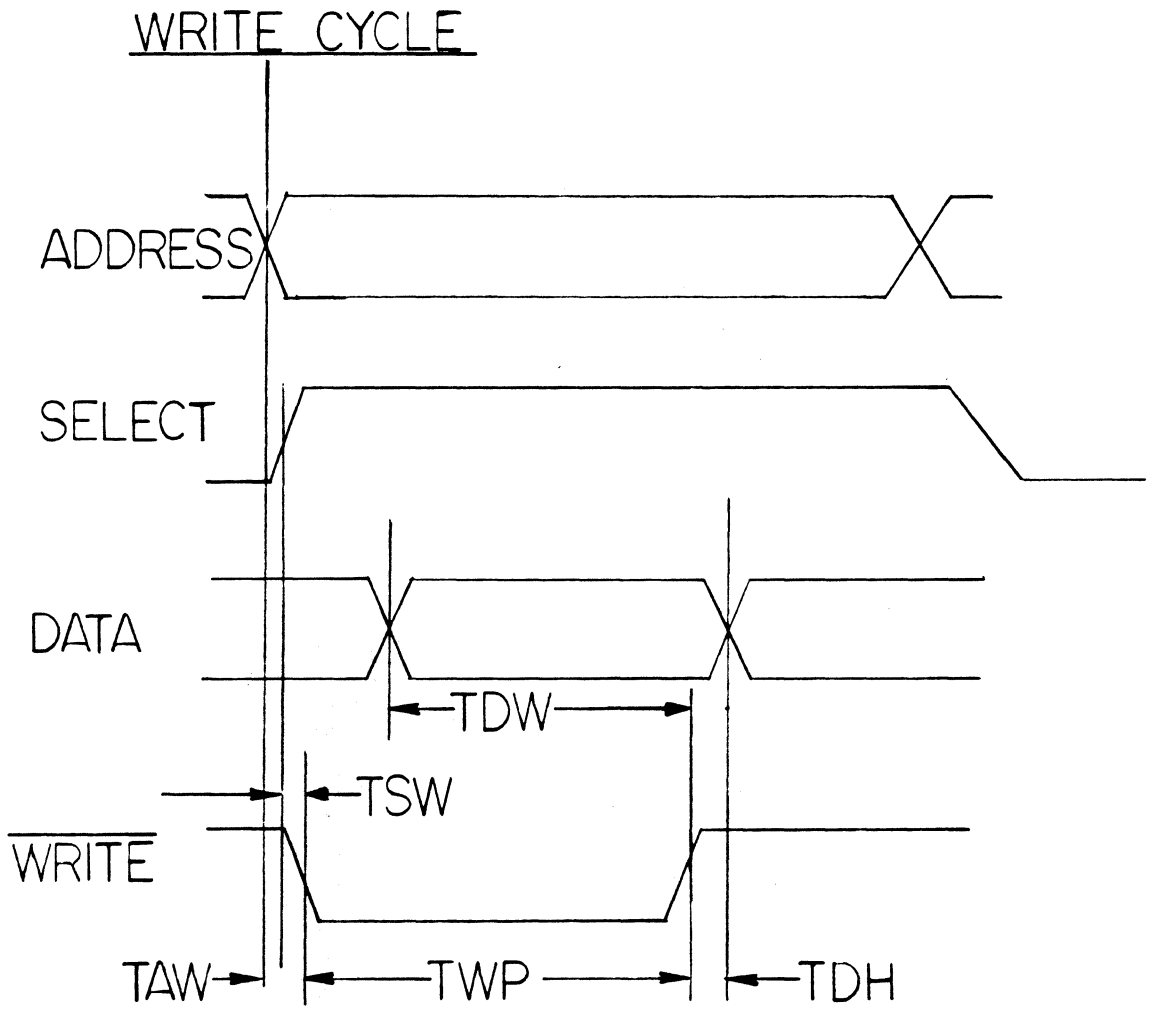
"C" BUSS WRITE TIMING



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

Figure 2.

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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.

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 compatibility with current CDCC Format Controllers and CDCC Test Equipment. 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 $\overline{\text{EXT RESET}}$

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 and pin orientation.

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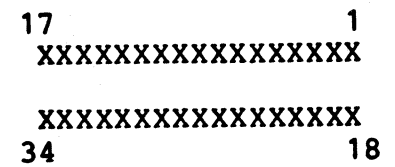
34 WAY PIN #	DESCRIPTION	
30	DATA D0	DATA
13	DATA D1	
29	DATA D2	
12	DATA D3	
28	DATA D4	
11	DATA D5	
27	DATA D6	
10	DATA D7	
1	ADDR A0	ADDRESS
18	ADDR A1	
2	ADDR A2	
19	ADDR A3	
3	ADDR A4	
20	ADDR A5	
4	ADDR A6	
21	ADDR A7	
14	ADDR A8	
15	ADDR A9	
16	ADDR A10	
17	ADDR A11	
32	ADDR A12	
7	$\overline{\text{RESET}}$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



TOP VIEW

Pin Orientation

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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 9 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, OE_{16} and $1E_{16}$ while the arguments occupy locations 05_{16} - 14_{16} except for OE_{16}. Byte $1E_{16}$ is unique in that it contains both status and arguments relative to color printing. 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). If a self-test or a head prime is requested, self-test takes top priority and head prime is next.

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COMMUNICATIONS RAM MAP

BYTE	DESIGNATION	SOURCE	COMMENTS
00	PRINTER STATUS	PRINT CONTROLLER	
01 02	ACCUMULATED PAPER MOTION STEPS	PRINT CONTROLLER	STATUS INFO.
03 04	UNCOMPLETED PAPER MOTION STEPS	PRINT CONTROLLER	STATUS OF FAILED MOTION
05 06	REVERSE PAPER MOTION BEFORE PRINT	FORMAT CONTROLLER	EVENT 1
07 08	FORWARD PAPER MOTION BEFORE PRINT	FORMAT CONTROLLER	EVENT 2
09	PRINT COMMAND	FORMAT CONTROLLER	EVENT 3
0A 0B	REVERSE PAPER MOTION AFTER PRINT	FORMAT CONTROLLER	EVENT 4
0C 0D	FORWARD PAPER MOTION AFTER PRINT	FORMAT CONTROLLER	EVENT 5
0E	SELF TEST BYTE	PRINT CONTROLLER	STATUS OF SELF TEST
0F	DENSITY SELECTION	PRINT CONTROLLER/ FORMAT CONTROLLER	
10	MACHINE OPTIONS	FORMAT CONTROLLER	MECHANICAL FEATURES
11	RESERVED		
12	GRAPHIC OPTIONS	FORMAT CONTROLLER	
13	OPTIONAL PITCH SELECTION	FORMAT CONTROLLER	
14	ALTERNATE SPEED SELECTION	FORMAT CONTROLLER	REDUCES CPS
15 1C		RESERVED	
1D	OPTIONS	PRINT CONTROLLER	
1E	COLOR	FORMAT CONTROLLER, PRINT CONTROLLER	
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 control 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,

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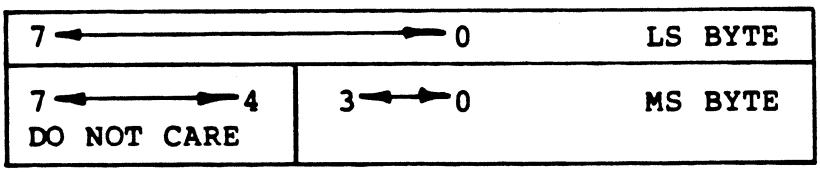
however, the 'Print Command' byte is not changed. Should an abort occur, the data is left intact and passed back to the Format Controller with the appropriate bit set in the "Printer Status" Byte. If no print action is requested, Print Command, Bit 4 = 0, the print buffer is neither interrogated nor changed.

5.2.2 Paper Motion Argument Description (Figure 4)

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.

Figure 4.

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

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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 about ten 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	FANFOLD 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 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 interrogate Byte 0E for further definition of the failure.

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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.

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. Bits 7-2 should be checked to determine if any event in progress was aborted because of this condition. Paper motion will never be started if a paper out condition exsists unless override bit is set (see Section 5.2.9.5). Paper motion without head movement is allowed with the interlock opened. If paper motion is in progress when this condition occurs then that paper motion will be completed. All other events will be aborted.

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.

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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 Section 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 chips on the P.C. A one signals an error condition.

5.2.4.2 Self Test Status - Bit 1 - 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 - PC RAM Test

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

5.2.4.5 Self Test Status - Bit 4

Reserved.

5.2.4.6 Self Test Status - Bit 5 - Cover Interlock Check

Cover is open (interlock has been broken). This bit will be updated on power on. If the cover is opened while any head motion is taking place, this bit will be set and the carriage motor will be turned off. The Printer 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 greater or less than 2% of the accepted value was received.

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

If set, it indicates no video signals were received.

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 initializtion, 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.

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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 conjunction 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.

5.2.9.3 Print Command - Bit 5 - Print Expanded

When set causes the data in the print buffer to be printed expanded.

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 requested 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 Section 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

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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 printing 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 eighteen (18) wires in the head.

5.2.10 Byte $0A_{16}$ and OB_{16} - Event No. 4

Reverse paper motion after print step count.

5.2.11 Byte $0C_{16}$ and OD_{16} - Event No. 5

Forward paper motion after print.

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 Section 5.4.3).

Bit 4 is set to indicate high density printing. To determine which mode has been selected, Byte 13, the matrix options byte, will be interrogated. When Bit 4 is set, Bits 0 through 2 are ignored. 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.

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Bit 5 - If this bit is set all previous bits are ignored. The print throughput will be reduced to a speed as specified by the value stored in Alternate Speed Byte. See Sec. 5.2.16.

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 RAM character generator 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. Refer to Engineering Product Specification 80002131-9001, Section 3.4.3.13 for further information.

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. If it is not set and either bits 3 or 4 are set, bi-directional printing is assumed.

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, an auto sheet feeder mode is indicated. The P.C. will shift the margin in from the left side to the auto sheet feeder margin.

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 conjunction with the sheet feeder to print the return address on an envelope.

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5.2.14 Byte 12_{16} - Graphics Mode Selection

If Bit 3 of the print density byte (Byte $0F_{16}$) is set, this byte will be checked to determine which graphics mode is being selected. The following table is a summary of the mode argument bits.

B2	B1	B0			
0	0	0	=	66 dpi	6 Pin Only
0	0	1	=	50 dpi	(non-APA Normal) 8 Pin
0	1	0	=	50 dpi	(non-APA) 8 Pin
0	1	1	=	100 dpi	(APA) 8 Pin
1	0	0	=	75 dpi	8 Pin
1	0	1	=	150 dpi	8 Pin
1	1	0	=	Not Used	
1	1	1	=	120 dpi	8 Pin

Byte 12_{16} = 00 - This is 66 dpi mode. In this mode, there are 872 column locations within the 13.2 in. page (66 x 13.2). Dot spacing is every eighteen encoder lines (.015 inch). Adjacent dots can be fired.

Byte 12_{16} = 01 - This mode allows the F.C. to place character pin information in the C-Ram. The actual column spacing is every twelve encoder lines (.010 inch) which is equivalent to 100 DPI, however, adjacent dots cannot be fired. In addition, the F.C. must assure that there are three columns of null codes (inter-character space) for every seven columns of pin information. Failure to comply with this can cause serious print head damage. This mode is also referred to as Non-APA Normal. In this mode, there are 1320 column locations within the 13.2 inch page (100 x 13.2) for a 132 total of .1 inch characters. (Note that 396 of these columns cannot contain pin data -- must be nulls.)

Byte 12_{16} = 02 - This mode allows placement of columns every twelve encoder lines (.010 inch) which is equivalent to 100 DPI. As in the Non-APA Normal mode, adjacent columns cannot be fired. This mode doesn't have any other restrictions (such as null columns). In this mode, there are 1320 column locations within the 13.2 inch page (100 x 13.2) and any column may contain some pin data. This mode is also referred to as Non-APA

Byte 12_{16} = 03 - This mode also allows placement of columns every twelve encoder lines (.010 inch) or 100 DPI. This mode has no restrictions as to dot placement (i.e., adjacent dots may be fired). In this mode, there are 1320 column locations within the 13.2 inch page (100 x 13.2). This mode is also referred to as APA.*

* APA - All Points Available.

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Byte 12_{16} = 04 - This is the 75 dpi mode. In this mode, there are 990 possible column locations. Dot spacing is every sixteen encoder lines (.0133 inches). Adjacent dots can be fired.

Byte 12_{16} = 05 - This is the 150 dpi mode. In this mode, there are 1,980 possible column locations. Dot spacing is every eight encoder lines (.0066 inches). Adjacent dots can be fired.

Byte 12_{16} = 06 Not used.

Byte 12_{16} = 07 This is the 120 dpi mode. In this mode there are 1584 possible column locations. Dot spacing is every 10 encoder lines (0.0083 inches). Adjacent dots can be fired.

5.2.15 Byte 13_{16} - Optional Pitch Selection

If Bit 4 of the print density byte is set (Byte $0F_{16}$), this byte will be checked to determine which mode of high density printing is being selected. The following table is a summary of the mode argument bits.

B1	B0		
0	0	=	10 cpi multi-pass
0	1	=	12 cpi multi-pass
1	0	=	reserved
1	1	=	reserved

See Section 5.3.3 for further definition of these modes.

5.2.16 Byte 14_{16} - Alternate Speed Selection

When Bit 5 of the print density/type byte (Byte OF_{16}) is set this byte will be examined to determine at what thru-put the line should be printed. In the chart below are all the different types of thru put speeds that can be selected. All densities are effected except multi-pass.

BITS	2	1	0	THRU PUT SPEEDS
	0	0	0	400 cps
	0	0	1	350 cps
	0	1	0	340 cps
	0	1	1	260 cps
	1	0	0	200 cps
	1	0	1	150 cps
	1	1	0	120 cps
	1	1	1	Not used

Bit 6 is set to indicate a 400 cps mechanism.

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5.2.17 Byte $1D_{16}$ - Print Controller Options

When Bit Ø is set, this indicates to the Format Controller that a staggered 18 wire print head is installed in the printer and when clear, it indicates that an in-line 18 wire print head is installed. With a staggered head installed, multipass printing is performed in a single pass. Also, the multipass character set must be contiguous with the first pass set preceeding the second and must be located on an even 4K boundary. The installation of a staggered head does not affect any other modes, except that the speeds of all the modes are reduced.

5.2.18 Byte $1E_{16}$ - Color Argument/Status Byte

This byte contains; status information set by the print controller and arguments set by the format controller. The status information is the ribbon type installed in the printer and is encoded as follows:

B6	B5	B4		
0	0	0	=	all black
0	0	1	=	cyan/magenta/yellow/black
0	1	0	=	red/green/blue/black
0	1	1	=	reserved
1	0	0	=	reserved
1	0	1	=	reserved
1	1	0	=	reserved
1	1	1	=	all black

The argument is used to select one of four tracks on the ribbon and is encoded as follows:

B1	B0		
0	0	=	select track 2
0	1	=	select track 1
1	0	=	select track 4
1	1	=	select track 3

Track 1 is the upper track on the ribbon. The argument is ignored when an all black ribbon is installed. Bits 7, 3 and 2 are reserved.

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5.2.19 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. The encoder with dual sensors gives positional information at a rate of 1200 edges per inch or every (0.000833 inch). See Engineering Product Specification 80002182-9001 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	12	0.0100	48	120
12	10	0.0083	40	100
13.3	10	0.0083	30	90
15	8	0.0067	32	80
16.67	8	0.0067	24	72

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	10	0.0083	40	120
12	8	0.0067	36	100
13.3	8	0.0067	26	90
15	6	0.0050	32	80
16.67	6	0.0050	24	72

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 four modes is to be used. Differences between them are outlined in Section 5.2.14.

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5.3.3 High Density Print

When Bit 4 of the print density byte (Byte $0F_{16}$) is set indicating a high density type of matrix, Byte 13, matrix options will be set to one of the following optional types of printing.

Byte 13 = 00 - 10 CPI Multi-Pass

In this mode, there are six encoder lines per column for a horizontal dot spacing of .005 inch. Printing can be done either bidirectionally or unidirectionally. The character matrix consists of fifteen printable columns and five inter-character spacing columns. Printing is a two-pass operation and allows dot placement of every .010 inch per pass. Between the two passes, the paper is moved in a forward direction one step (.00833 inch) to provide a vertical as well as horizontal overlapping of the dots.

With an 18-wire staggered head installed, printing is a single pass operation and the one step paper motion is not required, the dot placement remains the same.

Byte 13 = 01 - 12 CPI Multi-Pass

In this mode, there are four encoder lines per column for a dot spacing of .0033 inches. Printing can be done either unidirectionally or bidirectionally. The character matrix consists of fifteen printable columns and ten intercharacter spacing columns. Printing is a two pass operation and allows dot placement of every .0066 inch per pass. Paper movement between the two passes is the same as 10 CPI.

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 unless otherwise specified.

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 hexadecimal.

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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, this 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 - Standard 9 Wide Character

The following is the address presented to the character generator for the standard nine wide characters. All numbers are hexadecimal. The tenth and eleventh byte of each character code contains the ninth pin data for the nine horizontal columns. (i.e., each character requires eleven bytes of pin information). The character location is determined by multiplying the character code (ASCII-hex) times eleven to determine the first column location. The ninth (last column) location is the first column location plus eight.

Example:

Character Code 00 =	(00) x (0B) = 00	First Column
	00 + 08 = 08	Last Column
Character Code 01 =	(01) x (0B) = 0B	First Column
	0B + 08 = 13	Last Column

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Notice in the example locations 09 and 0A were skipped. These locations hold the pin nine data for the nine horizontal columns (columns 1-8 in location 09, column 9 in location 0A).

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 six possible graphics modes is to be used. Pin data is taken directly from the C-Ram. The first column comes from Location 20_{16} and the last column depends on the graphics density (dots/inch).

5.4.4 High Density Print

High density print can be selected as one of two different methods: 10 CPI Multi-Pass or 12 CPI Multi-Pass.

5.4.4.1 10 CPI Multi-Pass

This mode consists of a fifteen column wide matrix eight and one-half dots high. The horizontal dot spacing is every six encoder lines (.005 inch). Adjacent dots can not be fired on a single pass. It should be noted that while the horizontal locations remain constant through both passes of the print head, the second pass is offset vertically by .00833 inch. Each pass of the print head requires 2K of character generator. The base address of the 2K block is passed in the print command byte bits 1 and 2 (see Section 5.2.9.6). The actual character column information in the character generator is derived by using matrix size (OF_{16}) as a multiplier and multiplying it times the ASCII character code to find the first column of pin data. The last column location is derived by adding $0E_{16}$ to the first column location (i.e., matrix size - 1).

Example:

Character Code 01 =	(01) x (0F) = 0F	First Column
	(0F) + (0E) = 1D	Last Column
Character Code 02 =	(02) x (0F) = 1E	First Column
	(1E) + (0E) = 2C	Last Column

5.4.4.2 12 CPI Multi-Pass

The same rules apply here as for the 10 CPI Multi-Pass except the horizontal dot spacing is four encoder lines (.0033 inches).

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5.5 RESTRICTIONS

The following restrictions apply when printing with the 355 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 = +5V
OFF = 0 = 0V

6.1.2 Paper Stepper Driver

Figure 8A describes the driver circuitry for the paper 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

6.1.3 Ribbon Stepper Driver

Figure 8B depicts the ribbon stepper drive circuit. The IC contains a bidirectional four-position synchronous counter and four-phase unipolar driver stage. Run current typically is 320 to 360 mA total and hold current is less than 100 mA. A direction bit, hold/run bit and step bit is required.

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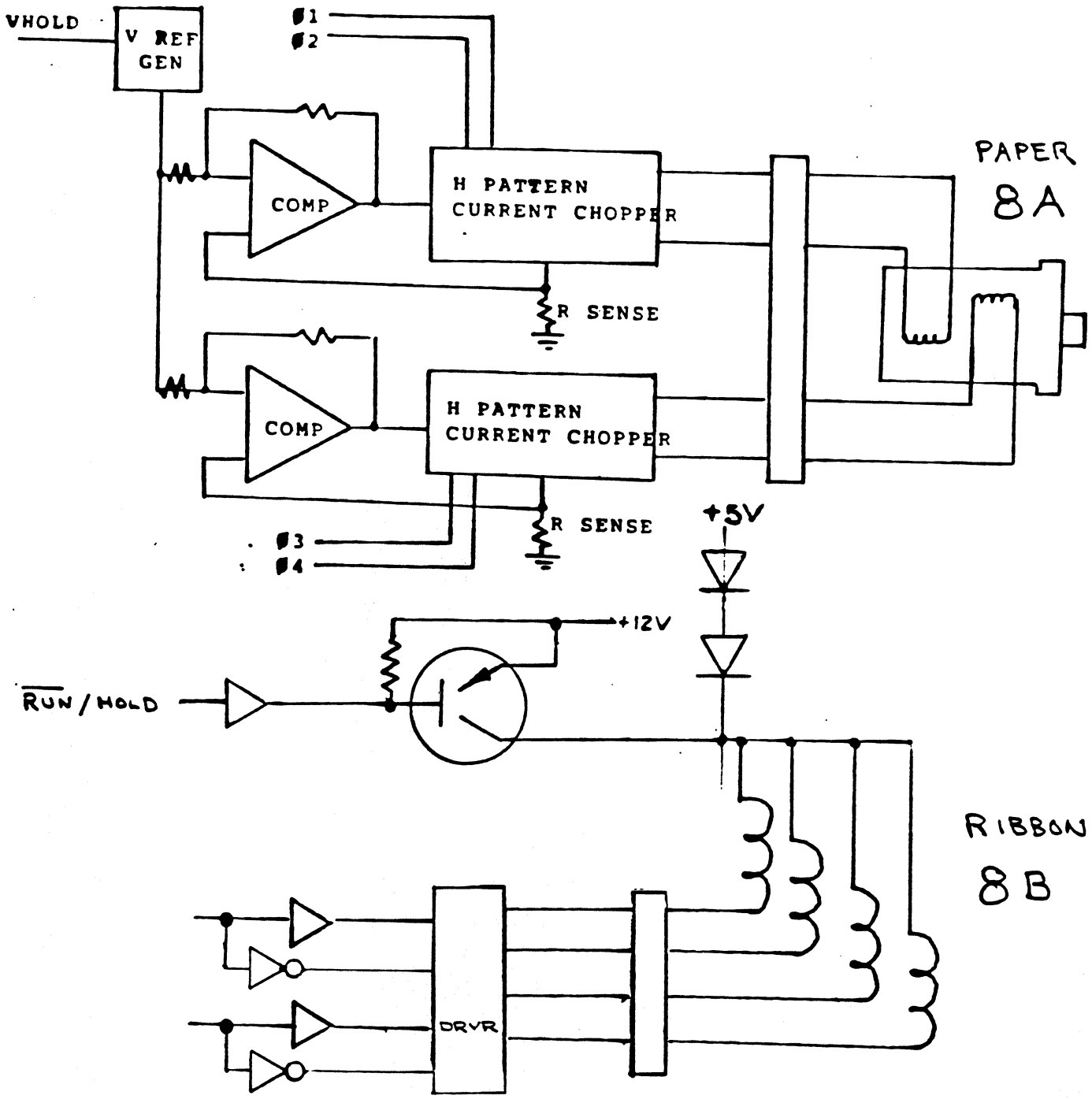

Figure 8. A STEPPER MOTOR DRIVER

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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
$\overline{\text{RUNIT}}$	1	None	-
FWD/$\overline{\text{R}}$	1		
$\overline{\text{RUNIT}}$	0	CCW	Forward
FWD/$\overline{\text{R}}$	1		Left to Right Side Frame
$\overline{\text{RUNIT}}$	0	CW	Reverse
FWD/$\overline{\text{R}}$	0		Right to Left Side Frame
$\overline{\text{RUNIT}}$	1	None	-
FWD/$\overline{\text{R}}$	0		

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

Carriage velocity control is achieved by employing a closed loop velocity feedback system. Velocity feedback is derived from the shaft encoder pulses, divided by two to assure duty cycle independence. The time between pulses is compared against a preset time and the result of this comparison is used to modulate the on-time of the carriage motor drive circuit. The comparison is performed via a D type flip flop and the preset time is received from a programmable one shot. If the time between pulses is greater than the preset time, the one shot will time out and a zero (off) will be clocked through to the carriage motor drive circuit. If the time is less, a one (on) will be clocked through. Thus, the on-time of the carriage motor drive circuit is a function of the time set in the programmable one shot.

Potentiometer adjustment maintains Figure 10 speeds $\pm$5%. 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

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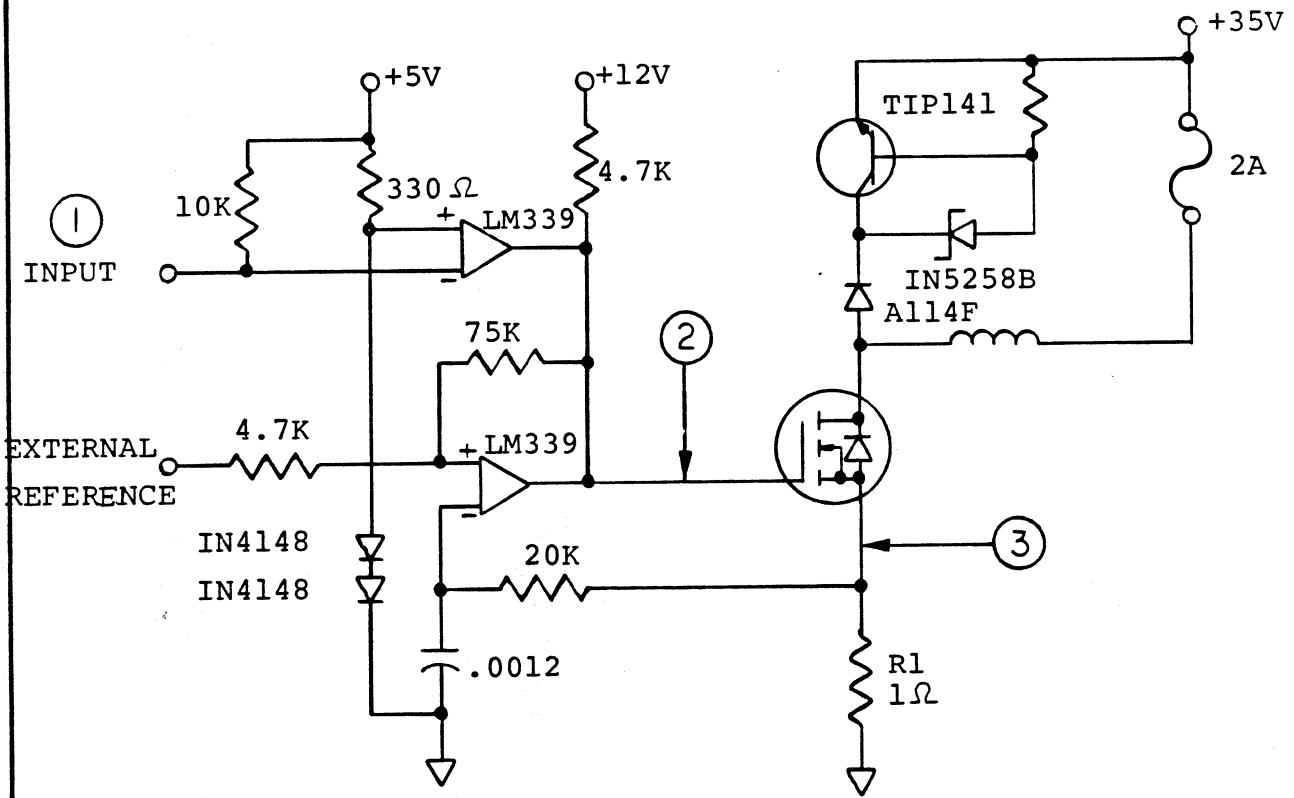
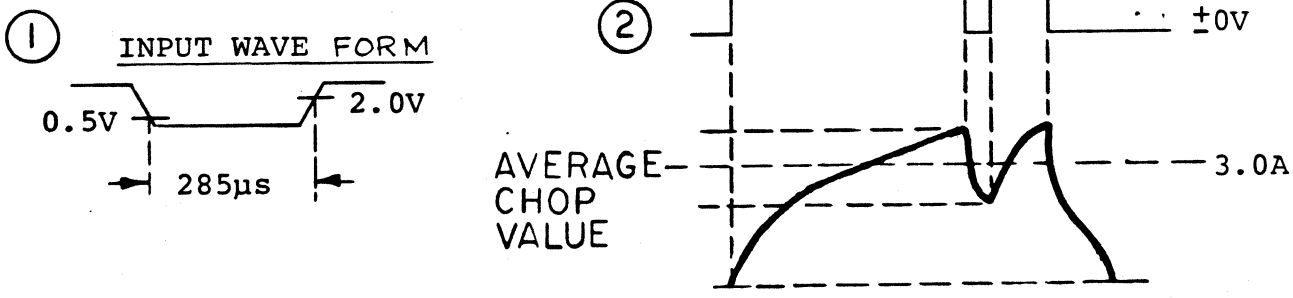
6.4 HEAD DRIVER CIRCUIT

The print head driver features a current chopping MOSFET circuit. When the current supply to the coil reaches a threshhold value, referenced through a sense resistor (R1) against an external reference voltage, the supply is removed for a time specified by a resistor-capacitor network. The chopping will continue for the duration of the print strobe.



OUTPUT WAVE FORMS



1 INPUT WAVE FORM

NOTE: Times and levels are for reference only and will vary with Rev Level.

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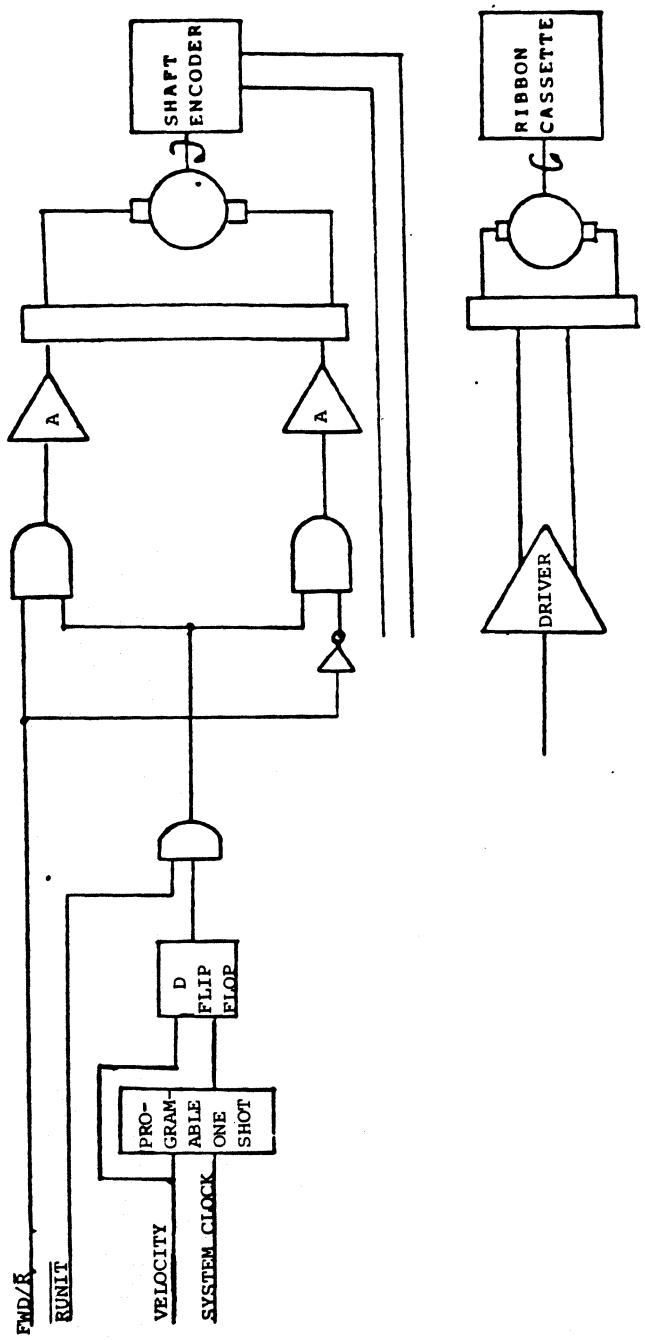

Figure 9. CARRIAGE DRIVE - RIBBON DRIVE VELOCITY

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IN-LINE 18 WIRE PRINT HEAD

MODE & CHAR. PITCH	HEAD SPEED IN IPS	HEAD FIRE RATE PER SEC.	PRINT RATE	TYPICAL THRUPUT OF 80 CHAR. LINE	
7x9, 7x8, 10 CPI	40	2000	400 CPS	205 LPM	
9x9, 10 CPI	40	2400	400	205 LPM	
7x9, 12 CPI	35	2100	420	213 LPM	
9x9, 12 CPI	31	2325	372	196 LPM	
7x9 13.3 CPI	35	2100	465	228 LPM	Note 1
9x9, 13.3 CPI	31	2325	412	211 LPM	
7x9, 15 CPI	31	2325	465	228 LPM	
9x9, 15 CPI	24	2400	360	211 LPM	
7x9, 16.7 CPI	28	2100	465	228 LPM	
9x9, 16.7 CPI	24	2400	400 CPS	205 LPM	

	FWD	REV		(PINS)	(8 INCH LINE)	(MINUTES/PORT)	
Unidirectional Normal Non-APA	40	40	2000	<1/2 of 400 CPS	103 LPM		
Unidir. Graphics 50DPI (Non-APA)	28	40	1400	8x1400 DPS	89 LPM	.67	Note 3
66.7 DPI	21	40	1386	6x1386 DPS	78 LPM	.87	Note 2
75 DPI	15	40	1125	8x1125 DPS	65 LPM	.67	
100 DPI (APA)	11	40	1100	8x1100 DPS	53 LPM	1.04	
Unidir. Graphics 150 DPI	7.5	40	1125	8x1125 DPS	40 LPM	2.05	
Bidir. Normal Non-APA	40	40	2000	400 CPS	205 LPM		
Bidir. Graphics 50 DPI (Non-APA)	28	28	1400	8x1400 DPS	159 LPM	.42	
66.7 DPI	21	21	1386	6x1386 DPS	127 LPM	.55	
75 DPI	15	15	1125	8x1125 DPS	96 LPM	.42	
100 DPI (APA)	11	11	1100	8x1100 DPS	73 LPM	.83	
Bidir. Graphics 150 DPI	7.5	7.5	1125	8x1125 DPS	51 LPM	1.69	Note 4
Unidir. Multipass 10 CPI	20	40	2000	<1/2 of 200 CPS	47 LPM		
Unidir. Multipass 12 CPI	16	40	2400	<1/2 of 192 CPS	45 LPM		
Bidir. Multipass 10 CPI	20	20	2000	-1/2 of 200 CPS	61 LPM		
Bidir. Multipass 12 CPI	16	16	2400	-1/2 of 192 CPS	59 LPM		

NOTES:
1) As CPI increases, the turn around and LF time play greater role in LPM. Assumption 90 ms TA and LF time.
2) Carriage returns at 40 IPS in unidirectional mode.
3) Graphics mode calculated in minutes per portrait. Portrait size defined as 8 in. Horiz. by 6 in. Vertical.
4) 1426 DPI Vert. by 150 DPI Horiz.
5) For an 18 pin head, the maximum firing rate of any one pin will not exceed 2/3 of the head firing rate.

Figure 10.

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STAGGERED 18 WIRE PRINT HEAD

MODE & CHAR. PITCH	HEAD SPEED IN IPS	HEAD FIRE RATE PER SEC.	PRINT RATE	TYPICAL THRUPUT OF 80 CHAR. LINE
7x9, 7x8, 10 CPI	32	1600	320 CPS	176 LPM
9x9, 10 CPI	26	1560	260	150 LPM
7x9, 12 CPI	26	1560	312	173 LPM
9x9, 12 CPI	21	1575	252	147 LPM
7x9 13.3 CPI	26	1560	345	186 LPM Note 1
9x9, 13.3 CPI	21	1575	279	157 LPM
7x9, 15 CPI	21	1575	315	174 LPM
9x9, 15 CPI	16	1600	240	141 LPM
7x9, 16.7 CPI	20	1500	332	181 LPM
9x9, 16.7 CPI	16	1600	266 CPS	153 LPM

	FWD	REV		(PINS)	(8 INCH LINE)
Unidirectional Normal Non-APA	32	40	1600	8x1600	94 LPM
Unidir. Graphics 50DPI (Non-APA)	20	40	1000	8x1000	76 LPM
66.7 DPI	15	40	990	6x 990	65 LPM
75 DPI	10	40	750	8x 750	50 LPM
100 DPI (APA)	7.5	40	750	8x 750	40 LPM * See Note 3
Unidir. Graphics 150 DPI	5	40	750	8x 750	29 LPM * See Note 3
Bidir. Normal Non-APA	32	32	1600	8x1600	176 LPM
Bidir. Graphics 50 DPI (Non-APA)	20	20	1000	8x1000	122 LPM
66.7 DPI	15	15	990	6x 990	96 LPM
75 DPI	10	10	750	8x 750	67 LPM
100 DPI (APA)	7.5	7.5	750	8x 750	51 LPM * See Note 3
Bidir. Graphics 150 DPI	5	5	750	8x 750	33 LPM * See Note 3
Bidir. Multipass 10 CPI	16		1600	160 CPS	101 LPM
Bidir. Multipass 12 CPI	10		1500	120 CPS	79 LPM

NOTES:
1) As CPI increases, the turn around and LF time play greater role in LPM. Assumption 90 ms TA and LF time.
2) Carriage returns at 40 IPS in unidirectional mode.
*3) It is highly recommended that the high density graphics modes not be used with a staggered head.
4) 1426 DPI Vert. by 150 DPI Horiz.

Figure 10

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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 (151°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 shiped in individual packages shall be designed to withstand half sine shock pulses of 40 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.

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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.

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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 $70^{o} \pm 5^{o}F$.
D. Ambient relative humidity of $50\% \pm 5\%$.

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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.

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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.

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